Great Lakes Coastal Wetland Monitoring Program

Semi-annual Progress Report
April 1, 2025 – September 30, 2025

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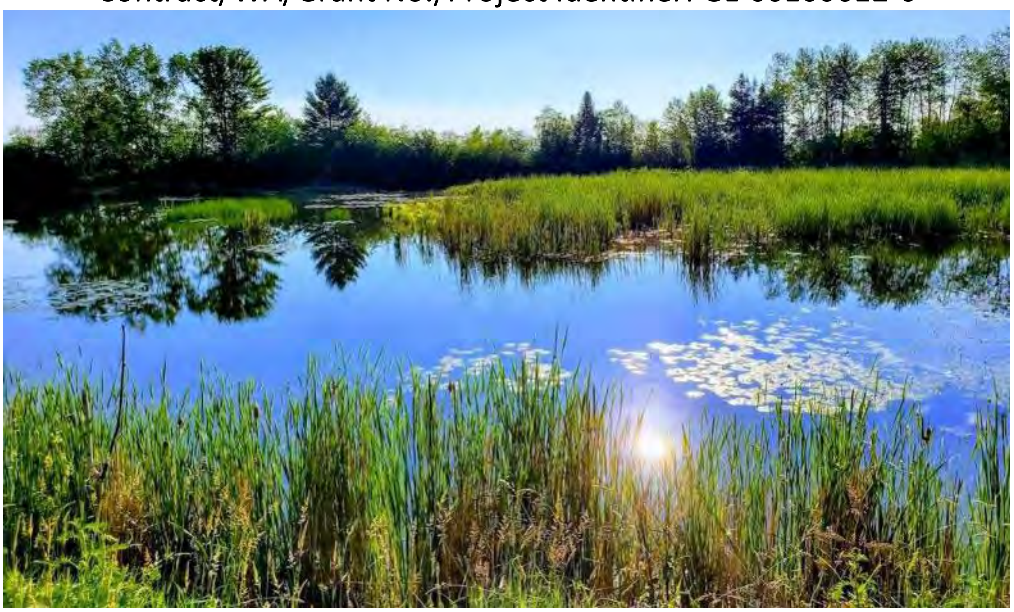

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Table of Contents

INTRODUCTION

Monitoring the biota of Great Lakes coastal wetlands began as a project funded under the Great Lakes Restoration Initiative on 10 September 2010. The project had the primary objective of implementing a standardized basin-wide coastal wetland monitoring program. Our first five years of sampling (2011-2015) set the baseline for future sampling years and showed the power of the datasets that can be used to inform decision-makers on coastal wetland conservation and restoration priorities throughout the Great Lakes basin. During round one, we 1) developed a database management system; 2) developed a standardized sample design with rotating panels of wetland sites to be sampled across years, accompanied by sampling protocols, QAPPs, and other methods documents; and 3) developed background documents on the indicators.

We have completed three five-year rounds of monitoring and this summer embarked on year 5 of the third five-year sampling round (2021 – 2025). This is our first full 5-year sampling round as a sampling program rather than a project. During the second round (2016-2020) we combated high water levels that made wetland sampling challenging and drowned out some wetlands. Fortunately, Great Lakes water levels have moderated for round 3, to the extent that we are now facing low water levels again. In addition, we continue to support wetland restoration projects by providing data, information, and context.

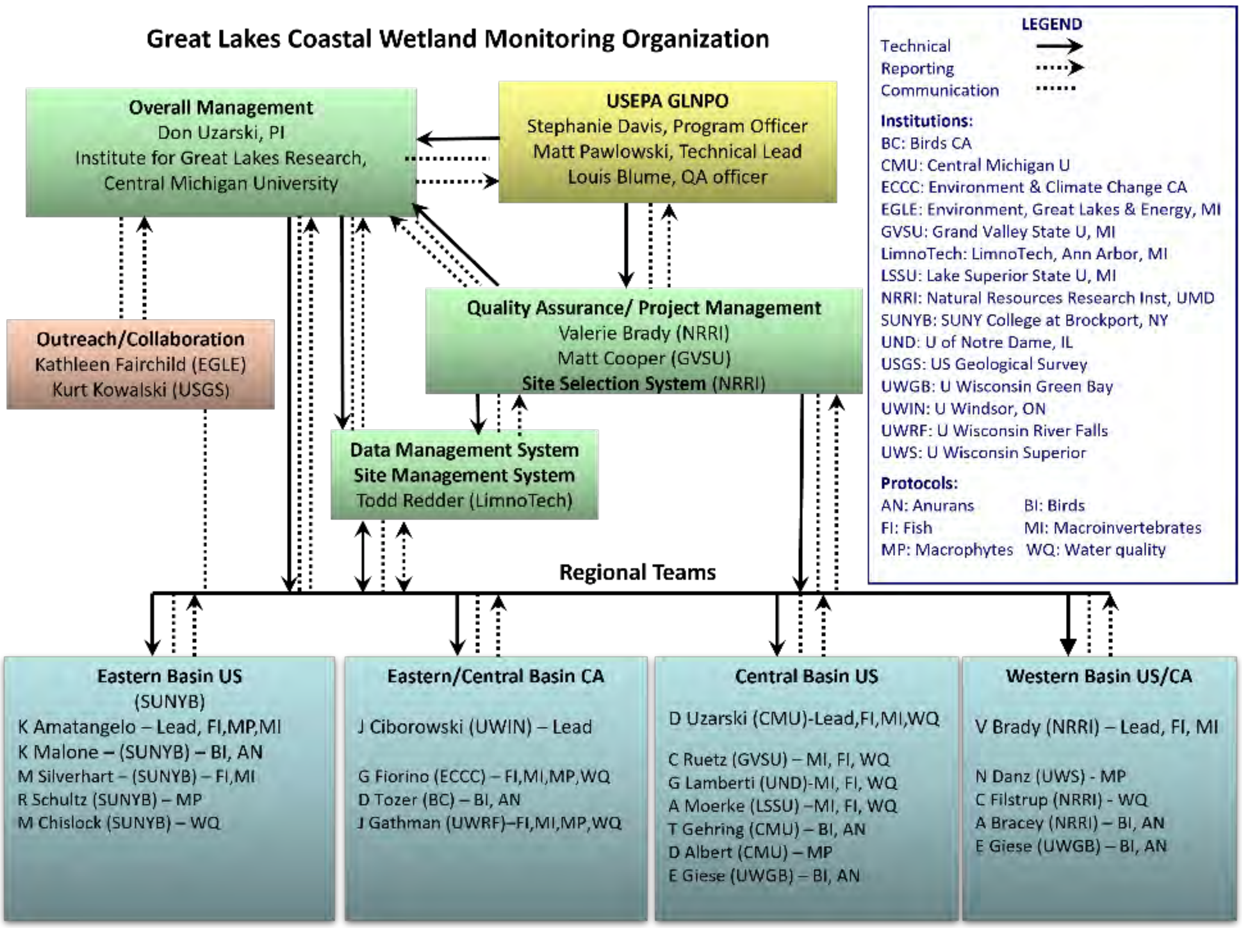
SUMMARY OF SAMPLING SCHEDULE

Our yearly sampling schedule proceeds in this manner: During the winter, PIs and crew chiefs meet to discuss issues, update each other on progress, and ensure that everyone is staying on track for QA/QC. Sites are selected by March using the on-line site selection database system, and field crew training takes place from March – June, depending on sampling type. Anuran sampling typically begins in late March/early April with bird sampling beginning in April or May, and finally vegetation, fish, macroinvertebrate, and water quality sampling begins in June. Sampling start dates are weather and temperature dependent. Phenology is followed across the basin so that the most southerly sites are sampled earlier than more northerly sites. In the fall and early winter, data are entered into the database, unknown fish and plants are identified, and macroinvertebrates are identified. The goal is to have all data entered and QC’d by March. Metrics and IBIs are calculated in late March in preparation for the spring report to US EPA GLNPO.

Full summaries of the first two 5-year rounds of sampling have been submitted to US EPA and are available at http://www.greatlakeswetlands.org/Reports-Publications.vbhtml.

PROGRAM ORGANIZATION

Figure 1 shows our current organization. Our project management team has not changed.



PROGRAM TIMELINE

The program timeline remains unchanged and we are on schedule (Table 1). During the next project period we will process all remaining samples collected this summer, identify the macroinvertebrates and remaining macrophytes, enter all remaining data and QC it, and generate the metrics and indicators for each taxonomic group and water quality. We will also continue to fix issues found by data QC queries to ensure a high-quality dataset.

Table 1. Timeline of tasks and deliverables for the Great Lakes Coastal Wetland Monitoring Program.

	2021				2022				2023				2024				2025				2026			
Tasks	**W**	**Sp**	**Su**	**F**	**W**	**Sp**	**Su**	**F**	**W**	**Sp**	**Su**	**F**	**W**	**Sp**	**Su**	**F**	**W**	**Sp**	**Su**	**F**	**W**	**Sp**	**Su**	**F**
Funding received			X																					
PI meeting	X				X				X				X				X				X			
Site selection system updated	X				X				X				X				X							
Site selection for summer		X			X				X				X				X							
Sampling permits acquired		X				X				X				X				X						
Field crew training		X	X			X	X			X	X			X	X			X	X					
Wetland sampling		X	X			X	X			X	X			X	X			X	X					
Mid-season QA/QC evaluations			X				X				X				X				X					
Sample processing & QC				X	X			X	X			X	X			X	X			X	X			
Data QC & upload to GLNPO					X	X			X	X			X	X			X	X		X	X	X		
Report to GLNPO		X		X		X		X		X		X		X		X		X		X		X		X
Re-code Site Management System								X	X															

Table 2a. GLRI Action Plan Measure of Progress. Wetlands are sampled during the summer.

Applicable Measure of Progress – GLRI Action Plan	Total Progress Anticipated	Progress During This Reporting Period		Total Progress to Date	
		#	%	#	%
4.1.3		**This reporting Period**	**%**	**Total to Date**	**%**
Number of Great Lakes coastal wetlands assessed for biotic condition - sampling	900 wetlands	174	20%	892	100%
(If numeric) How this measure was calculated: Count of wetlands sampled each summer of the 5 year sampling period. Wetlands can only be sampled in the summer. Number of wetlands able to be sampled following strict QAPP protocols varies with Great Lakes water levels. Dropping water levels removed some wetlands from the sampling pool in summer 2025.					
Number of Great Lakes coastal wetlands assessed for biotic condition – data processing & IBI calculation	900 wetlands	0	0%	718	80%
(If numeric) How this measure was calculated: How this measure was calculated: Count of wetlands for which samples were processed during the winter, data entered and QC'd, and IBIs calculated.					
TOTAL MOP 4.1.3 PROGRESS	**900 wetlands**	**174 wetlands**	**20%**	**892 wetlands**	**100%**

Table 2b. Work progress for this monitoring program.

ALL Other Workplan Metrics	Anticipated	Reporting Period	Total to date	% Complete to date	Status (Completed, in progress, Approved, Under review)
# Site Selection System Updates	5	1	5	100%	Completed
# Data Entry System Updated	5	1	4	80%	In progress
# Field Crew Trainings	5	1	5	100%	Completed
# Mid-season QA/QC Evaluations	5	1	5	100%	Completed
# Data QC and Upload	5	1	4	80%	In progress

SITE SELECTION

Year fifteen site selection was completed in March 2025. We have completed our 5-year sampling scheme twice (round 1: 2011-2015; round 2: 2016-2020) and are finishing up the fifth year of round 3 sampling (2021-2025) of our list of Great Lakes coastal wetlands. Differences in the site lists between successive sampling rounds are most often associated with special benchmark sites or changes due to lake levels and our ability to access sites safely and with permission. Benchmark sites (sites of special interest for restoration or protection) can be sampled more than once in the five-year sampling rotation, may need to be sampled in a different year to accommodate restoration work and may be sites that were not on the original sampling list. The dramatic change in Great Lakes water levels has also affected what wetlands we are able to sample for which biota. The list of wetlands sampled this year (2025) was previously sampled in 2015 and 2020, with some differences due to benchmarks, safe access, and water levels.

ORIGINAL DATA ON GREAT LAKES COASTAL WETLAND LOCATIONS

The GIS coverage used was a product of the Great Lakes Coastal Wetlands Consortium (GLCWC) and was downloaded from http://www.glc.org/wetlands/data/inventory/glcwc_cwi_polygon.zip on December 6, 2010. See http://www.glc.org/wetlands/inventory.html for details.

SITE MANAGEMENT SYSTEM

The Site Management System was completely rebuilt and reprogrammed in 2024 and is now in full use. This replaces the original Site Selection System that was used from 2011 through 2024.

Background

In 2011, a web-based database application was developed to facilitate site identification, stratified random site selection, and field crew coordination. This database is housed at NRRI and backed up routinely. It is also password-protected. Using this database, potential wetland polygons from the GLCWC GIS coverage were reviewed by PIs and those that were greater than four hectares, had herbaceous vegetation, had (or appeared to have) a lake connection navigable by fish, and were influenced by lake water levels were placed into the site selection random sampling rotation (Table 3). That is, these 1014 wetlands became our wetland sampling universe, with minor modifications and additions for benchmark sites, as previously described, and some sites being dropped due to lack of any crew ever being able to access them. See the QAPP for a thorough description of site selection criteria. Note that the actual number of sampleable wetlands fluctuates year-to-year with lake level, continued human activity and safe access for crews. Based on the number of wetlands that proved to be sampleable thus far, we expect that the total number of sampleable wetlands will be around 900 in any given year; we sample roughly 180 of these (one fifth) per year.

Table 3. Counts, areas, and proportions of the 1014 Great Lakes coastal wetlands deemed sampleable in 2011 following Great Lakes Coastal Wetland Consortium protocols based on review of aerial photography. Area in hectares.

Country	Site count	Site percent	Site area	Area percent
Canada	386	38%	35,126	25%
US	628	62%	105,250	75%
Totals	**1014**		**140,376**	

This wetland coverage shows more wetlands in the US than in Canada, with an even greater percent of wetland area in the US (Table 3). We speculate that this is partly due to poor representation of Georgian Bay (Lake Huron) wetlands in the sampleable wetland database. This area is also losing wetlands rapidly due to a combination of glacial rebound and topography that limits the potential for coastal wetlands to migrate downslope during periods of low lake levels and to recover with rising water levels. Another component of this US/CA discrepancy is the lack of coastal wetlands along the Canadian shoreline of Lake Superior due to the rugged topography and geology. A final possibility is unequal loss of wetlands between the two countries, but this has not been investigated.

Strata

Geomorphic classes

Geomorphic classes (riverine, barrier-protected, and lacustrine) were determined for each site in the original coastal wetland GIS coverage. Many wetlands inevitably combine aspects of multiple classes, with an exposed coastal region transitioning into protected backwaters bisected by riverine elements. Wetlands were classified according to their predominant geomorphology. Note that we typically do not revisit or change the class originally assigned to a wetland during our 2011 initial site review process.

Regions

Existing ecoregions (Omernik 1987, Bailey and Cushwa 1981, CEC 1997) were examined for stratification of sites. None were found which stratified the Great Lakes' shoreline in a manner that captured a useful cross section of the physiographic gradients in the basin. To achieve the intended stratification of physiographic conditions, a simple regionalization was adopted that divided each lake into northern and southern components, with Lake Huron being split into three parts and Lake Superior being treated as a single region (Figure 2). The north-south splitting of Lake Michigan is common to all major ecoregion systems (Omernik / Bailey / CEC).

Panelization

Randomization

To create our stratified random wetland site sampling design, the first step was the assignment of selected sites from each of the project's 30 strata (10 regions x 3 geomorphic wetland types) to a random year or panel in the five-year rotating panel. Because the number of sites in some strata was quite low (in a few cases less than 5, more in the 5-20 range), simple random assignment would not produce the desired even distribution of sites within each strata over time. Instead it was necessary to assign the first fifth of the sites within a stratum, defined by their pre-defined random ordering, to one year, and the next fifth to another year, etc. All sites were assigned to panels in 2011, prior to the first round of sampling.

In 2012, sites previously assigned to panels for sampling were assigned to sub-panels for re-sampling. The project's sampling design requires that 10% of sites are re-sampled the year after they were sampled based on their main panel designation to help determine interannual variability and the effects of changing water levels. This design requires five primary panels, *A-E*, one for each year of a five-year rotation, and ten sub-panels, *a-j,* for the 10% resample sites. If 10% of each panel's sites were simply randomly assigned to sub-panels in order *a-j*, sub-panel *j* would have a low count relative to other sub-panels. To avoid this, the order of sub-panels was randomized for each panel during site-to-sub-panel assignment, as can be seen in the random distribution of the '20' and '21' values in Table 4.

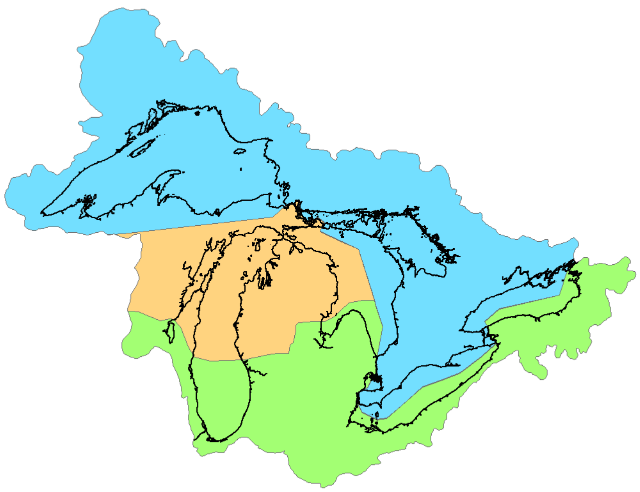


Figure 2. Divisions of lakes into regions. Note that stratification is by region *and* lake, so northern Lake Erie is not in the same region as Lake Superior, etc.

For the first five-year cycle, sub-panel *a* was re-sampled in each following year, so the 20 sites in sub-panel *a* of panel *A* were candidates for re-sampling in 2012. The 20 sites in sub-panel *a* of panel *B* were candidates for re-sampling in 2013, and so on. In 2016, panel *A* was sampled for the second time, so the 21 sites in sub-panel *a* of panel *E* became the re-sample sites. This past summer (2023), panel *C* was sampled for the third time and the sites in sub-panel *c* of panel *B* comprised the re-sample sites. The total panel and sub-panel rotation covers 50 years.

Table 4. Sub-panel re-sampling, showing year of re-sampling for sub-panels *a-c*.

	Subpanel										
Main Panel	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**TOTAL**
A: 2011 2016 2021	20/2012	21/2017	21/2022	20	21	20	21	21	21	21	207
B: 2012 2017 2022	20/2013	20/2018	20/2023	21	20	21	21	20	21	21	205
C: 2013 2018 2023	21/2014	21/2019	21/2024	21	21	20	21	21	21	21	209
D: 2014 2019 2024	22/2015	21/2020	**21/2025**	21	21	21	21	21	21	21	211
E: 2015 2020 **2025**	21/2016	20/2021	21/2026	21	21	21	20	21	21	21	208

Workflow states

Each site is assigned a particular 'workflow' status. During the field season, sites selected for sampling in the current year move through a series of sampling states in a logical order, as shown in Table 5. The *data_level* field is used for checking that all data have been received and their QC status. Users set the workflow state for sites in the web tool, although some states can also be updated by querying the various data entry databases. In 2020 we ran into the problem of being unable to sample sites because of the global pandemic, Covid-19. The site status code “could not sample” was added as a workflow state in the site selection list for crews to have more options to indicate problems sampling sites. “Could not access” is used to indicate when a crew cannot safely get to a site for some reason, while “could not sample” is used to indicate the inability to sample a site even though they can get to it (e.g., water is too deep for their sampling gear; for Covid, this would be things like no access onto tribal lands, etc.).

Team assignment

With sites assigned to years and randomly ordered within years, specific sites were then assigned to specific teams. Sites were assigned to teams initially based on expected zones of logistic practicality, and the interface described in the ‘Site Status’ section is used to exchange sites between teams for efficiency and to better assure that distribution of effort matches each team’s sampling capacity.

Field maps

Multi-page PDF maps are generated for each site for field crews each year. The first page depicts the site using aerial imagery and a road overlay with the wetland site polygon boundary. The image also shows the location of the waypoint provided for navigation to the site via GPS. The second page indicates the site location on a road map at local and regional scales. The remaining pages list information from the database for the site, including site informational tags, team assignments, and the history of comments made on the site, including information from previous field crew visits intended to help future crews find boat launches and learn about any hazards a site poses.

Table 5. Workflow states for sites listed in the Site Status table within the web-based site selection system housed at NRRI. This system tracks site status for all taxonomic groups and teams for all sites to be sampled in any given year. Values have the following meanings: -1: site will not generate data, 0: site may or may not generate data, 1: site should generate data, 2: data received, 3: data QC'd.

Name	Description	Data_level
too many	Too far down randomly-ordered list, beyond sampling capacity for crews.	-1
Not sampling BM	Benchmark site that will not be sampled by a particular crew.	-1
listed	Place holder status; indicates status update needed.	0
web reject	Rejected based on regional knowledge or aerial imagery in web tool.	-1
will visit	Indicates site assignment to a team with intent to sample.	0
could not access site	Site proved impossible to access safely.	-1
could not sample	Added in 2020; indicates inability of crew to sample for some reason other than safety or lack of an appropriate wetland.	-1
visit reject	Visited in field, and rejected (no lake influence, no wetland present, etc.).	-1
will sample	Interim status indicating field visit confirmed sampleability, but sampling has not yet occurred.	1
sampled	Sampled, field work done.	1
entered	Data entered into database system.	2
checked	Data in database system QC-checked.	3

Browse map

The *browse map* feature allows the user to see sites in context with other sites, overlaid on either Google Maps or Bing Maps road or aerial imagery. Boat ramp locations are also shown when available. The *browse map* provides tools for measuring linear distance and area. When a site is clicked, the tool displays information about the site, the tags and comments applied to it, the original GLCWC data, links for the next and previous site (see *Shoreline ordering* and *Filter sites*), and a link to edit the site in the site editor.

2025 SITE SELECTION

For 2025, 201 sites were selected for sampling. Of these, 10 were benchmark sites. Another 18 sites were re-sample sites and 18 were pre-sample sites, which will be re-sample sites next year (2026). Benchmark, re-sample, and pre-sample sites are sorted to the top of the sampling list because they are the highest priority sites to be sampled. By sorting next year's resample sites to the top of the list, this helps ensure that most crews sample them, allowing more complete comparison of year-to-year variation when the sites are sampled again the next year. Because this is our third sampling round, crews were familiar with most of the sites on the 2025 site list.

Benchmark sites are sites that are not on the site list, are special interest sites that were too far down the site list and risked not being sampled by all crews, or are sites that are considered a reference of some type and are being sampled more frequently. Sites that were not on the site list typically are too small, disconnected from lake influence, or are not a wetland at this time, and thus do not fit the protocol. These sites are added back to the sampling list by request of researchers, agencies, or others who have specific interest in the sites. Many of these sites are scheduled for restoration, and the groups who will be restoring them need baseline data against which to determine restoration success. Each year, Coastal Wetland Monitoring (CWM) researchers get a number of requests to provide baseline data for restoration work.

We now have approximately 100 sites for which at least a portion of sampling is designated as "benchmark." Of these sites, about 40 are to evaluate restoration efforts and about a dozen serve as reference sites for their area or for nearby restoration sites. The rest are more intensive monitoring sites at which the extra data will help provide long-term context and better ecological understanding of coastal wetlands. Although most benchmark sites are in the US, several recently added benchmark sites are in Canada.

Wetlands have a "clustered" distribution around the Great Lakes due to geological and topographic differences along the Great Lakes coastline. As has happened each sampling season so far, several teams ended up with fewer sites than they had the capacity to sample, while other teams' assigned sites exceeded their sampling capacity. Within reason, teams with excess sampling capacity expanded their sampling boundaries to assist neighboring over-capacity teams in order to maximize the number of wetlands sampled. The site selection and site status tools are used to make these changes.

Site Management System Improvements

The original Site Selection System had been in use for almost 15 years and had recently experienced multiple failures, with each fix becoming more tenuous due to old software and incompatibility issues with newer servers, image sources, and browser software. For the future integrity of the monitoring program, we completely re-constructed the system to become a Site Management System and move it to the servers that host the main CWMP website and Data Management System at Central Michigan University. The Site System problems and associated down time emphasized the critical importance of this system to the running of our program because it allows us to allocate sites correctly and efficiently across teams and the basin each sampling year in a manner that upholds the statistical design of our sampling program. It also allows us to track and note conditions and safety issues at each site as well as maintain notes on why sites are benchmarks and what we know about their benchmark and restoration status and progress.

The new Site Management System was thoroughly tested over the winter of 2024/2025 against the old Site Selection System and produced yearly site sampling lists that exactly matched the old system. We brought the new system online in February 2025 and used it to generate the 2025 site sampling list, establish benchmark sites, resample and presample sites, and allocate sites to teams across the basin. It did all of this correctly, with enhanced functionality and, most importantly, stability compared to the old system. The Site Management System is fully integrated into the main CWMP web application and database that support the Data Management System. The integrated system is currently housed on a dedicated CMU server. Going forward, the new, integrated Site Management System will provide opportunities for more effective and efficient data verification workflows because it is now possible to conduct real-time checks of the Data Management System data against the information in the Site Management System.

TRAINING

All personnel responsible for sampling invertebrates, fish, macrophytes, birds, anurans, and water quality received training and were certified prior to this sampling program beginning in 2011. During that first year, teams of experienced trainers held training workshops at several locations across the Great Lakes basin to ensure that all PIs and crews were trained in Coastal Wetland Monitoring methods. Now that PIs and crew leaders are experienced, field crew training is being handled by each PI at each regional location, with more experienced trainers providing assistance, including in-person training by the management team, as necessary when major personnel changes take place (e.g., new field crew leader, new PI). As is true every field season, all crew members still had to pass all training tests and mid-season QC were conducted. As has become standard protocol, the trainers were always available via phone and email to answer any questions that arose during training sessions or during the field season.

The following is a synopsis of the training conducted by PIs each spring. See the individual team reports for information on how each team conducted crew training. Some crews were trained by the crew leader; some crews used only experienced personnel who had worked for the project for years and needed minimal retraining. In general, each PI or field crew leader trained all field personnel on meeting the data quality objectives for each element of the project; this included reviewing the most current version of the QAPP, covering site verification procedures, providing hands-on training for each sampling protocol, and reviewing record-keeping and archiving requirements, data auditing procedures, and certification exams for each sampling protocol. All field crew members had to pass all training certifications before they were allowed to work unsupervised. Those who did not pass all training aspects were only allowed to work under the supervision of a crew leader who had passed all training certifications.

Training for bird and anuran field crews includes tests on anuran calls, bird vocalizations, and bird visual identification. These tests are based on an online system established at the University of Wisconsin, Green Bay – see http://www.birdercertification.org/GreatLakesCoastal. In addition, individuals were tested for proficiency in completing field sheets, and audio testing was done to ensure their hearing is within the normal ranges. Field training was also completed to ensure guidelines in the QAPP are followed: rules for site verification, safety issues including caution regarding insects (e.g., Lyme's disease), GPS and compass use, and record keeping.

Fish, macroinvertebrate, and water quality crews were trained on field and laboratory protocols. Field training included selecting appropriate sampling points within each site, setting fyke nets, identifying fish, sampling and sorting invertebrates, and collecting water quality and habitat covariate data. Laboratory training included preparing water samples, titrating for alkalinity, and filtering for chlorophyll. Other training included GPS use, safety and boating issues, field sheet completion, and GPS and records uploading. All crew members were required to be certified in each respective protocol prior to working independently.

Training for fish and invertebrate crews now includes specific instructions for sampling in deep water. These techniques were trialed in 2019 and found to work to allow sampling in at least somewhat deeper water than we have been sampling. Specifically, to sample invertebrates in depths greater than 1 m, D-frame dip net handles were extended and sampling was done from the boat by moving around the boat and by allowing the boat to swing around one of its anchors. To set fyke nets in deeper water, the boat can be used to set the cod end of the net and the frame can be set underwater, using rock bag anchors to weight the cod end.

Vegetation crew training also included both field and laboratory components. Crews were trained in field sheet completion, transect and point location and sampling, GPS use, and plant curation. Plant identification was tested following phenology through the first part of the field season. All crew members were certified in all required aspects of sampling before starting in the field unless supervised.

Training on data entry and data QC was provided by Valerie Brady and Terry Brown through a series of conference calls/webinars during the late summer, fall, and winter of 2011. All co-PIs and crew leaders responsible for data entry participated in these training sessions and each regional laboratory has successfully uploaded data. Additional training on data entry, data uploading, and data QC was provided in 2016 with the implementation of the updated version of the data entry/data archiving system by Todd Redder at LimnoTech. Training on data entry and QC continues via webinar as needed for new program staff and was done in both 2017 and 2018 as new staff joined the program. Additional training on data entry is provided as needed.

CERTIFICATION

To be certified in a given protocol, individuals must pass a practical exam. Certification exams were conducted in the field in most cases, either during training workshops or during site visits early in the season. When necessary, exams were supplemented with photographs (for fish and vegetation) or audio recordings (for bird and anuran calls). Passing a given exam certifies the individual to perform the respective sampling protocol(s). Since not every individual is responsible for conducting every sampling protocol, crew members were only tested on the protocols for which they are responsible. Personnel who were not certified (e.g., part-time technicians, new students, volunteers) were not allowed to work independently nor to do any taxonomic identification except under the direct supervision of certified staff members. Certification criteria are listed in the project QAPP. For some criteria, demonstrated proficiency during field training workshops or during site visits is considered adequate for certification. Training and certification records for all participants are collected by regional team leaders and copied to Drs. Brady and Cooper (QC managers) and Uzarski (lead PI). Note that the training and certification procedures explained here are separate from the QA/QC evaluations explained in the following section. However, failure to meet project QA/QC standards requires participants to be re-trained and re-certified.

DOCUMENTATION AND RECORD

All site selection and sampling decisions and comments are archived in the Site Management System (see “site selection”). These include comments and revisions made during the QC oversight process.

Regional team leaders archive copies of the testing and certification records of all field crew members. Summaries of these records are also archived with the QC managers (Brady and Cooper).

WEB-BASED DATA ENTRY SYSTEM

The CWMP uses a web-based data management system (DMS) that was originally developed by NRRI in 2011 to collect field and laboratory data and then redeveloped by LimnoTech during 2015-16. The current web-based system uses Microsoft's Active Server Pages .NET (ASP.NET) web application framework running on a Windows Server 2019 Datacenter and hosted on a virtual machine at Central Michigan University (CMU). The open source PostgreSQL Relational Database Management System (RDMS) with PostGIS spatial extensions is used to provide storage for all CWMP data, including both the DMS and the Site Management System, on the same Windows 2019 server that hosts the web application.

The CWMP database includes collections of related tables for each major taxonomic group, including vegetation, fish and macroinvertebrates, anurans, and birds. Separate data entry/editing forms are created for data entry based on database table schema information that is stored in a separate PostgreSQL schema. Data entry/editing forms are password-protected and can only be accessed by users that have "Project Researcher" or "Admin" credentials associated with their CWMP user account and permissions for specific taxa group(s).

Specific features of note for the CWMP data management system include:

- Automated processes for individual users to request and confirm accounts;
- An account management page where a limited group of users with administrative privileges can approve and delete user accounts and change account settings as needed;
- Numerous validation rules employed to prevent incorrect or duplicate data entry on the various data entry/editing forms;
- Custom form elements to mirror field sheets (e.g. the vegetation transects data grid), which makes data entry more efficient and minimizes data entry errors;
- Domain-specific "helper" utilities, such as generation of fish length records based on fish count records;
- Dual-entry inconsistency highlighting for anuran and bird groups who use dual-entry for quality assurance;
- Tools for adding new taxa records or editing existing taxa records for the various taxonomic groups; and

- GPS waypoint file (*.gpx) uploading utilities and waypoint processing to support matching of geographic (latitude/longitude) coordinates to sampling points.

The CWMP data management system also provides separate webpages that allow researchers to download "raw" data for the various taxonomic groups as well as execute and download custom queries that are useful for supporting dataset review and QA/QC evaluations as data entry proceeds during and following each field season. Users from state management agencies are able to access the separate download pages for raw data and custom queries. Such organizations include GLNPO and its subcontractors and Michigan EGLE. Index of Biological Integrity (IBI) metrics are currently included as a download option based on static scores that reflect data collection through the 2024 field season. Over the past few years, a standalone .NET-based program has been developed and fully tested to automate the calculation of IBI metric scores for vegetation, invertebrates and fish on an annual (spring) schedule after data have been entered and gone through QA/QC.

Raw data downloads are available in both Microsoft (MS) Excel spreadsheet and MS Access database formats, while custom query results are available in spreadsheet format only. All available data/query export and download options are automatically regenerated every night, and users have the option of either downloading the last automated export or generating a new export that provides a snapshot of the database at the time the request is made (the former option is much faster). Currently, datasets for the major taxonomic groups must be downloaded individually; however, a comprehensive export of all pertinent data tables is generated in a single MS Access database file and provided to GLNPO on a bi-annual schedule in fall and spring of each program year.

In addition to providing CWMP researchers with data entry and download access, the CWMP data management team is providing ongoing technical support and guidance to GLNPO to support its internal management and application of the QA/QC'ed monitoring datasets. GLNPO, with support from subcontractors, maintains a separate, offline version of the CWMP monitoring database within the Microsoft Access relational database framework. In addition to serving as an offline version of the database, this version provides additional querying and reporting options to support GLNPO's specific objectives and needs under GLRI. CWMP data management support staff generate and provide to GLNPO and its contractors a "snapshot" of the master CWMP PostgreSQL database as a Microsoft Access database twice per year, corresponding to a spring and fall release schedule. This database release is then used by GLNPO and its contractors to update the master version of the Microsoft Access database used to support custom querying and reporting of the monitoring datasets.

A full backup of the CWMP PostgreSQL database is created each night at 3:00 AM Eastern time using a scheduled backup with the PostgreSQL Backup software application. Nightly database backups are automatically uploaded to a dedicated folder on LimnoTech's Sharefile system where they are maintained on a 30-day rolling basis. In the event of significant database corruption or other failure, a backup version can be restored within an hour with minimal data loss. The server that houses the DMS has also been configured to use CMU's Veeam Backup Solution. This backup solution provides end-to-end encryption including data at rest. Incremental backups are performed nightly and stored at secure locations (on premise and offsite). Nightly backup email reports are generated and sent to appropriate CMU IT staff for monitoring purposes. Incremental backups are kept indefinitely and restores can be performed for whole systems, volumes, folders and individual files upon request. Nightly backup email reports are generated and sent to appropriate CMU IT staff for monitoring purposes. Incremental backups are kept indefinitely and restores can be performed for whole systems, volumes, folders and individual files upon request.

RESULTS-TO-DATE (2011-2024, WITH EXCEPTIONS NOTED)

A total of 176 wetlands were sampled in 2011, with 206 sampled in 2012, 201 in 2013, 216 in 2014, and 211 in 2015 our 5th and final summer of sampling for the first project round. Overall, 1010 Great Lakes coastal wetland sampling events were conducted in the first round of sampling (2011-2015; Tables 6 and 7), and we have completed sampling these wetlands a second time for the second complete round of coastal wetland assessment, 2016-2020. Note that this total number is not the same as the number of unique wetlands sampled because of temporal re-sampling events and benchmark sites that are sampled in more than one year per 5-year sampling round. For the second round of sampling, we sampled 192 wetlands in 2016, 209 wetlands in 2017, 192 wetlands in 2018, 211 wetlands in 2019, and 174 wetlands in 2020 (fewer wetlands sampled due to the global pandemic).

Round 3 (2021-2015) began summer 2021 with teams sampling 175 wetlands (again, fewer than in Round 2 due to the pandemic; Tables 6 and 7). In 2022 teams sampled 188 wetlands, 174 wetlands were sampled in 2023, and 180 wetlands were sampled in 2024. This year, teams sampled 174 wetlands (Tables 6 and 7, Figures 3 and 4).

In all years, more wetlands are sampled on the US side due to the uneven distribution of wetlands between the two countries. The wetlands on the US side also tend to be larger (see area percentages, Tables 6 and 7). When compared to the total number of wetlands targeted to be sampled by this project (Table 3), we are achieving our goals of sampling 20% of US wetlands per year, both by count and by area. However, each year 60-65% of total sites sampled are US coastal wetlands, with 75-80% of the wetland area sampled on the US side. Overall, we have sampled most of the large, surface-connected Great Lakes coastal emergent wetlands by count and by area. A few wetlands cannot currently be sampled due to a lack of safe access or a lack of permission to cross private lands.

Table 6. Counts, areas, and proportions of US Great Lakes coastal wetlands sampled in Round 1 (2011 – 2015), Round 2 (2016 – 2020) and Round 3 (2021 – 2025) sampling by the Coastal Wetland Monitoring Program. Percentages are of overall total sampled each year. Area in hectares.

US	Site count	Site %	Site area	Area %
Round 1 (2011 – 2015)				
2011	126	72%	22,008	87%
2012	124	60%	21,845	73%
2013	130	65%	18,939	73%
2014	144	67%	26,836	80%
2015	134	64%	26,681	73%
US total Round 1	**658**	**65%**	**116,309**	**77%**
Round 2: 2016 – 2020				
2016	129	67%	24,446	85%
2017	139	67%	30,703	80%
2018	125	65%	17,715	82%
2019	135	64%	30,281	80%
2020	119	69%	29,325	77%
US total Round 2	**647**	**66%**	**132,470**	**82%**
Round 3: 2021 – 2025				
2021	122	70%	24,734	85%
2022	128	68%	29,625	82%
2023	112	64%	18,648	82%
2024	117	63%	24,695	75%
2025	109	63%	20,199	71%
US total Round 3	**588**	**66%**	**117,901**	**79%**

Table 7. Counts, areas, and proportions of Canadian Great Lakes coastal wetlands sampled in Round 1 (2011 – 2015), Round 2 (2016 – 2020) and Round 3 (2021 – 2025) sampling by the Coastal Wetland Monitoring Program. Percentages are of overall total sampled each year. Area in hectares.

Canada	Site count	Site %	Site area	Area %
Round 1: 2011 - 2015				
2011	50	28%	3,303	13%
2012	82	40%	7,917	27%
2013	71	35%	7,125	27%
2014	72	33%	6,781	20%
2015	77	36%	10,011	27%
CA total Round 1	**352**	**35%**	**35,137**	**23%**
Round 2: 2016 - 2020				
2016	63	33%	4,336	15%
2017	70	33%	7,801	20%
2018	67	35%	3,356	18%
2019	76	36%	7,746	20%
2020	55	32%	8,603	23%
CA total Round 2	**331**	**34%**	**31,843**	**18%**
Round 3: 2021 - 2025				
2021	53	30%	4,264	15%
2022	59	32%	6,637	18%
2023	62	36%	4,097	18%
2024	63	35%	8,137	25%
2025	65	37%	8,117	29%
CA total Round 3	**302**	**34%**	**31,252**	**21%**
Overall Totals Round 1	**1010**		**151,446**	
Overall Totals Round 2	**978**		**164,312**	
Overall Totals Round 3	**890**		**149,153**	

Ability to sample sites depends not only on access but also on water levels. Teams were able to sample more sites in 2014 due to higher lake levels on Lakes Michigan and Huron, which allowed crews to access sites and areas that have been dry or inaccessible in previous years. By 2015 water depths in some coastal wetlands had become so deep that crews had difficulty finding areas shallow enough to set fish nets in zones typically sampled for fish (cattail, bulrush, SAV, floating leaf, etc.). In 2017 Lake Ontario levels reached highs not seen in many decades. Water levels were again near historic highs in 2019 and 2020 and crews continued to report sampling challenges due to the high water, with coastal wetlands flooded out and only beginning to migrate upslope into areas that remain covered by terrestrial vegetation (shrubs, trees, etc.) or being blocked in this upslope migration by human land use or shoreline hardening. This highlights the difficulty of precisely determining the number of sampleable Great Lakes coastal wetlands in any given year, and the challenges crews face with rising and falling water levels.

In 2021, water levels had moderated slightly and crews reported fewer difficulties in sampling. This trend continued through 2024, with some crews finding water levels low enough in some wetlands to impact sampling due to low water, and in some areas wetland vegetation had not been able to migrate downslope enough even in 2024 to keep up with dropping water levels. The sites sampled in 2024 are shown in Figures 3 and 4 and are color coded by which taxonomic groups were sampled at the sites and by wetland types, respectively. Many sites were sampled for all taxonomic groups. Sites not sampled for birds and anurans typically were sites that were impossible to access safely, often related to private property access issues, or, during the pandemic, due to border closures. Most bird and anuran crews do not operate from boats since they need to arrive at sites in the dark or stay until well after dark. There are also a number of sites sampled only by bird and anuran crews because these crews can complete their site sampling more quickly and thus have the capacity to sample more sites than do the fish, macroinvertebrate, and vegetation crews. In both 2022 and 2023, bird and anuran crews faced a very cold, late spring across much of the region, compressing fieldwork into a shorter timeframe. Spring of 2024 was also slow to warm up, and in some areas of the Great Lakes was followed by an unseasonably cool and wet early summer. 2025 brought even lower water levels particularly in Lakes Michigan and Huron, making fish sampling a challenge in a number of wetlands.

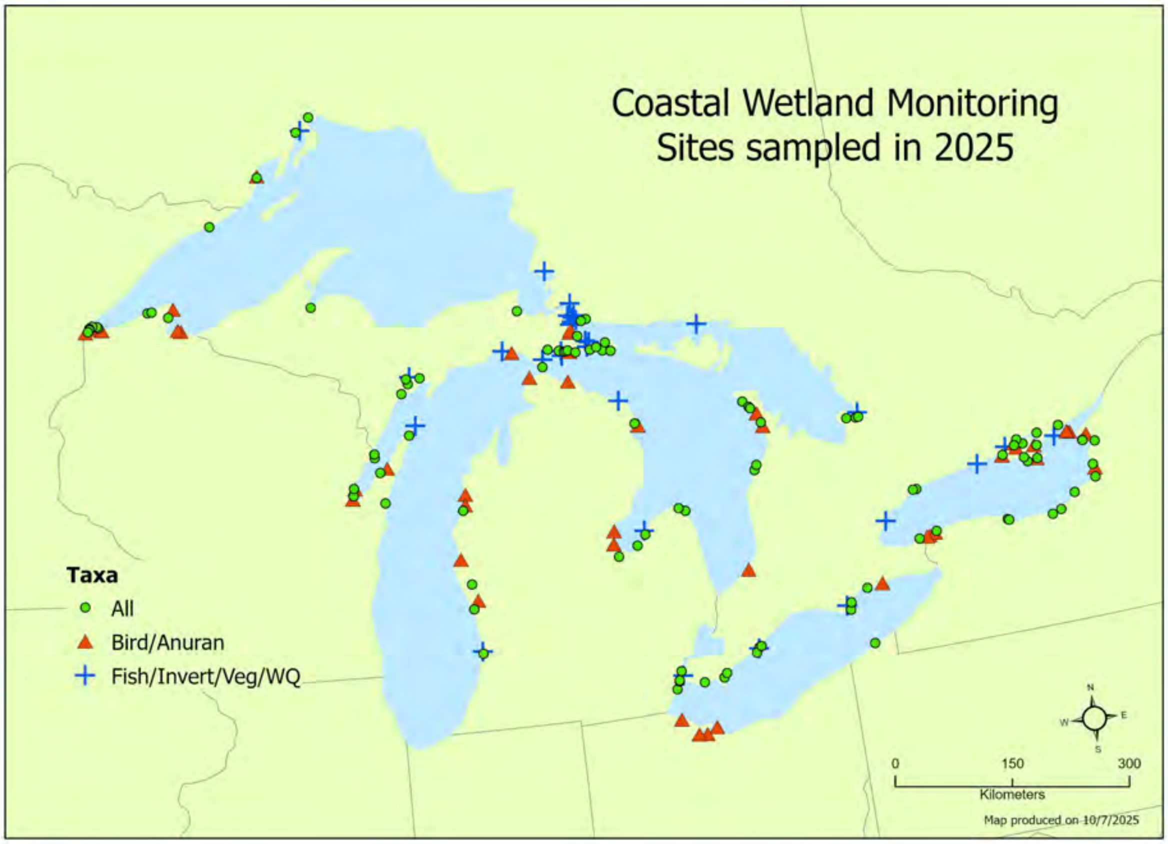


Figure 3. Locations of the 174 Great Lakes coastal wetlands sampled in 2025, color-coded by taxonomic groups. Sites sampled only by bird and anuran crews (due to their greater sampling capacity) are shown with a red triangle.

Wetland types are not distributed evenly across the Great Lakes due to fetch, topography, and geology (Figure 4). Lacustrine wetlands occur in more sheltered areas of the Great Lakes within large bays or adjacent to islands. Barrier-protected wetlands occur along harsher stretches of coastline, particularly in sandy areas, although this is not always the case. Riverine wetlands are somewhat more evenly distributed around the Great Lakes. Low water levels in 2011-2013 and much higher water levels from 2014 – 2020 require that indicators be relatively robust to Great Lakes water level variations, or that data users are very cognizant of water level effects on indicators.

Benchmark sites are sites that are were not on the site list, are special interest sites that were too far down the site list and risked not being sampled by all crews, or are sites that are considered a reference of some type and are being sampled more frequently. Sites that were not on the site list typically are too small, disconnected from lake influence, or are not a wetland at this time, and thus do not fit the protocol. These sites are added back to the sampling list by request of researchers, agencies, or others who have specific interest in the sites. Many of these sites are scheduled for restoration, and the groups who will be restoring them need baseline data against which to determine restoration success. Each year, Coastal Wetland Monitoring (CWM) researchers get a number of requests to provide baseline data for restoration work.

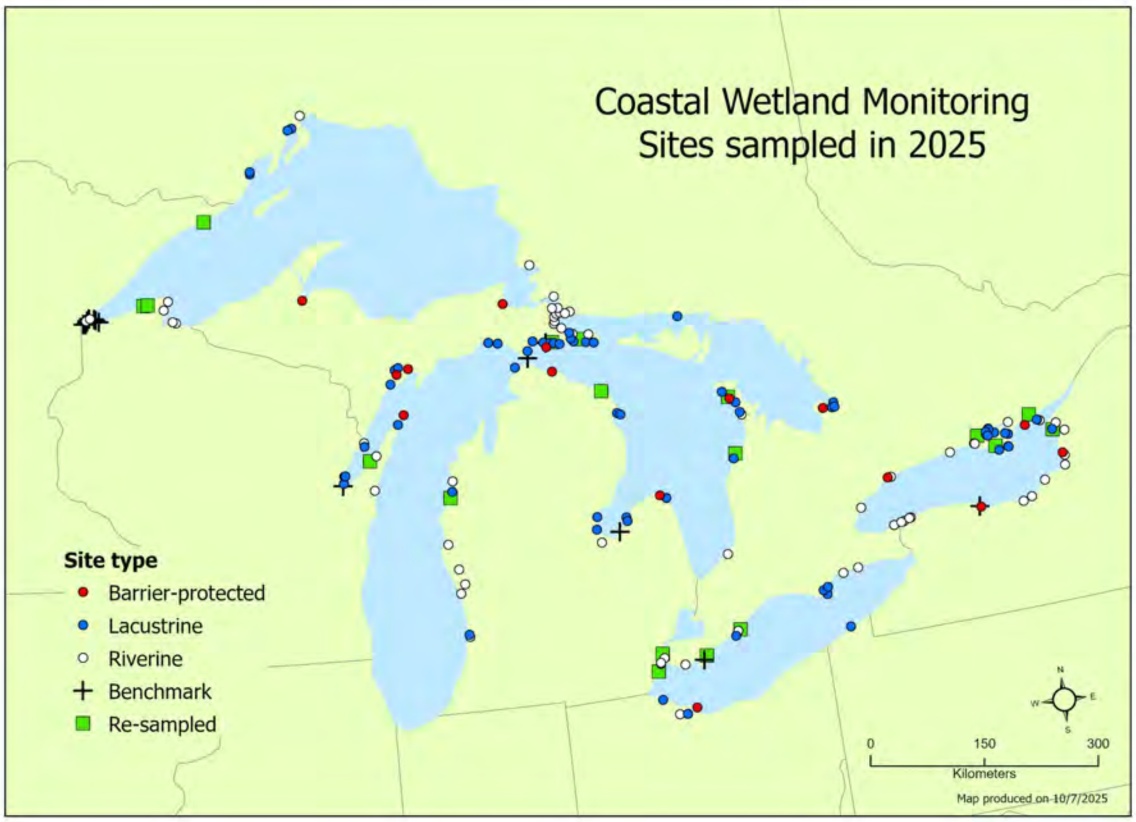


Figure 4. Locations of the 174 Great Lakes coastal wetlands sampled in 2025, color-coded by site type. Wetland types exhibit a clumped distribution across lakes due to geology and topography.

We now have about 100 sites that are or have been sampled as a “benchmark.” Of these, about 40 are to evaluate restoration efforts and about a dozen serve as reference sites for their area or for nearby restoration sites. The rest are more intensive monitoring sites at which the extra data will help provide long-term context, help us adjust indicators to be robust against water level fluctuations, and gain better ecological understanding of coastal wetlands. Almost all benchmark sites are in the US, with a few Canadian benchmark sites recently added.

Determining whether some of these benchmark sites would have been sampled at some point as part of the random site selection process is difficult because several of the exclusion conditions are not easy to assess without site visits. Our best estimate is that approximately 60% of the 17 benchmark sites from 2011 would have been sampled at some point, but they were marked “benchmark” to either sample them sooner (to get ahead of restoration work for baseline sampling) or so that they could be sampled more frequently. Thus, about 40% of 2011 benchmark sites were either added new because they were not (yet) wetlands, are small, or were missed in the wetland coverage, or would have been excluded for lack of connectivity. This percentage decreased in 2012, with only 20% of benchmark sites being sites that were not already in the list of wetlands scheduled to be sampled. In 2013, 30% of benchmark sites were not on the list of random sites to be sampled by CWM researchers in any year, and most were not on the list for the year 2013. For 2014, 26% of benchmark sites were not on the list of sampleable sites, and only 20% of these benchmark sites would have been sampled in 2014. These tend to be sites that are degraded former wetlands that no longer appear on any wetland coverage but for which restoration is a goal or, in a few cases, wetlands that are diked and the dike is being breached for restoration. There are a number of benchmark sites that are being sampled every year or every other year to collect extra data on these locations. At this point we are adding relatively few new sites as benchmarks each year (for 2023, only 2 new benchmarks were added; these are sites [7078, 7079] with major restorations planned for them). In 2024 we added a single new benchmark site (7080) in order to sample important wetlands on the upstream edge of the St. Louis River estuary that were missed in original site selection.

BIOTIC COMMUNITIES AND CONDITIONS (based on 2011-2024 data)

We can now compile good statistics on Great Lakes coastal wetland biota because we have sampled nearly 100% of the medium and large coastal wetlands that have a surface water connection to the Great Lakes and are hydrologically influenced by lake levels. The following indicators and information are from data collected through 2024 and will be updated again in the spring of 2026 when we have analyzed this summer’s (2025) data.

Wetlands average 23-26 bird species; richness at high quality sites was as great as 54 bird species (Table 8). There are many fewer calling amphibian species (anurans) in the Great Lakes (8 total), and coastal wetlands averaged about 4 species per wetland, with some benchmark wetlands containing no anurans (Table 8). However, there were wetlands where 8 anuran species were heard over the three sampling dates.

Table 8. Bird and anuran species in wetlands; summary statistics by country. Data from 2011 through 2024, using only the latest year sampled for each wetland.

Country	Site count	Mean	Max	Min	St. Dev.
Birds					
Can.	254	26.9	55	9	10.2
U.S.	463	23.2	54	5	8.9
Anurans					
Can.	234	4.4	8	0	1.6
U.S.	407	4.1	8	0	1.4

Bird and anuran data in Great Lakes coastal wetlands by lake (Table 9) shows that wetlands on most lakes had an average number of bird species in the mid-twenties. The greatest number of bird species at a wetland occurred on lakes Erie, Huron, and Ontario. These data include the benchmark sites, many of which are in need of or are undergoing restoration, so the minimum number of species can be quite low.

Calling anuran species counts show less variability among lakes simply because fewer of these species occur in Great Lakes coastal wetlands. Wetlands averaged about four calling anuran species regardless of lake (Table 9). Similarly, there was little variability by lake in maximum or minimum numbers of species. At some benchmark sites, and occasionally during unusually cold spring weather, no calling anurans were heard.

Table 9. Bird and anuran species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of species per wetland for wetlands sampled from 2011 through 2024, using only data from the latest year sampled for each wetland.

	Birds				Anurans			
Lake	Sites	Mean	Max	Min	Sites	Mean	Max	Min
Erie	89	25.0	54	5	81	4.1	7	1
Huron	219	24.4	54	8	192	4.2	8	0
Michigan	130	23.9	50	5	116	4.0	7	0
Ontario	194	25.7	55	6	186	4.5	8	1
Superior	85	22.7	41	5	66	3.8	7	1

An average of 9 to 13 fish species were collected in Canadian and US Great Lakes coastal wetlands, respectively (Table 10). Again, these data include sites in need of restoration, and some had very few species. On the other hand, the wetlands with the highest richness had as many as 20 (CA) or 28 (US) fish species. The average number of non-native fish species per wetland was approximately one, though some wetlands had as many as 5. An encouraging sign is that there are wetlands in which no non-native fish species were caught in fyke nets, although some non-native fish are adept at net avoidance (e.g., common carp).

Table 10. Total fish species in wetlands, and non-native species; summary statistics by country for sites sampled from 2011 through 2024, using only data from the latest year sampled for each wetland.

Country	Sites	Mean	Max	Min	St. Dev.
Overall					
Can.	143	8.8	20	1	3.6
U.S.	253	12.8	28	0	4.7
Non-natives					
Can.	145	0.8	3	0	0.8
U.S.	253	1.0	5	0	1.1

From 2016-2020, we collected no non-native fish in 44% of Great Lakes coastal wetlands sampled, and we caught only one non-native fish species in 40% of Great Lakes coastal wetlands (Figure 5). We caught more than one non-native fish species in far fewer wetlands. It is important to note that the sampling effort at sites was limited to one night using passive capture nets, so these numbers are likely quite conservative, and wetlands where we did not catch non-native fish may actually harbor them.

Total fish species did not differ greatly by lake, averaging 10-12 species per wetland (Table 11). Lakes Erie and Michigan had the most species of fish in a wetland, 26-28 species; the other lakes had a maximum of 19-22 species in a wetland. Because sites in need of restoration are included, some of these sites had very few fish species, as low as only a single species. Wetlands averaged 1 non-native fish species captured. Having very few or no non-native fish is a positive and all lakes had some wetlands in which we caught no non-native fish. This result does not necessarily mean that these wetlands are free of non-natives. Our single-night net sets do not catch all fish species in wetlands, and some species are quite adept at avoiding passive capture gear. There are well-documented biases associated with each type of fish sampling gear. For example, active sampling gears (e.g., electrofishing) are better at capturing large active fish, but perform poorly at capturing smaller fish, forage fish, and young fish that are sampled well by our passive gear.

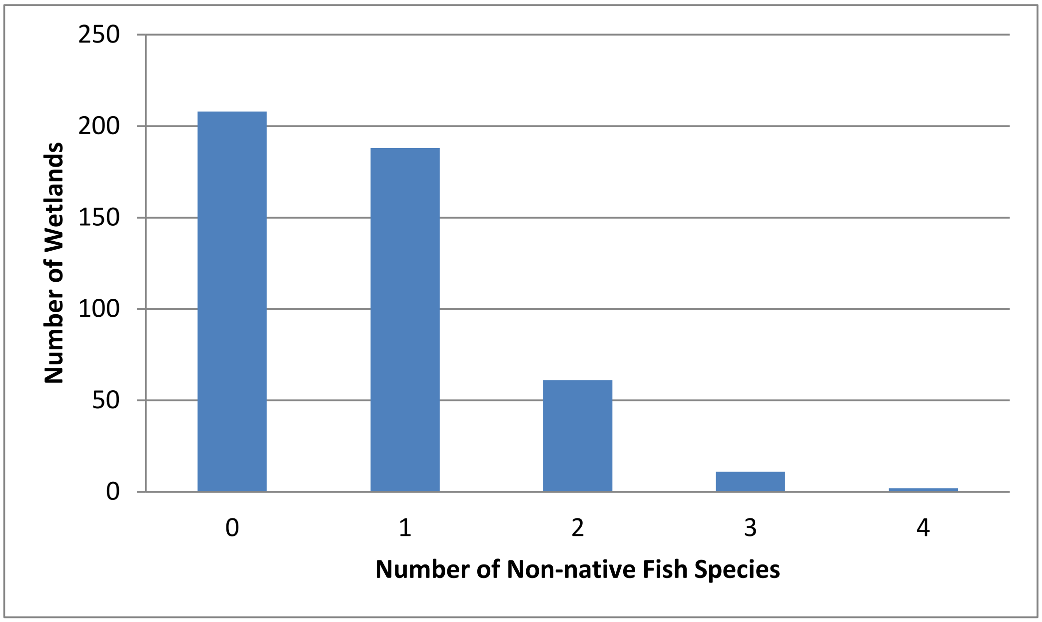


Figure 5. Number of Great Lakes coastal wetlands containing non-native fish species. Data from 2016 through 2020.

Table 11. Fish total species and non-native species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of species per wetland. Data from 2011 through 2024, using only data from the most recent year sampled for each wetland.

		Fish (Total)			Non-native		
Lake	**Sites**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
Erie	48	11.4	28	4	1.5	5	0
Huron	143	11.3	28	1	0.7	4	0
Michigan	56	12.2	26	0	1.1	4	0
Ontario	95	10.2	25	3	0.9	3	0
Superior	54	12.7	22	3	1.1	4	0

The average number of macroinvertebrate taxa (taxa richness) per site was about 36 (Table 12), but some wetlands had more than twice this number. Sites scheduled for restoration and other taxonomically poor wetlands had fewer taxa. On a more positive note, the average number of non-native invertebrate taxa found in coastal wetlands was less than 1, with a maximum of no more than 5 taxa (Table 12). Note that our one-time sampling may not be capturing all of the non-native taxa at wetland sites. In addition, some non-native macroinvertebrates are quite cryptic, resembling native taxa, and may not yet be recognized as invading the Great Lakes.

Table 12. Total macroinvertebrate taxa in Great Lakes coastal wetlands, and non-native species; summary statistics by country. Data from 2011 through 2024, using only data from the most recent year sampled for each wetland.

Country	Sites	Mean	Max	Min	St. Dev.
Overall					
Can.	181	36.7	71	18	10.1
U.S.	310	36.7	68	9	12.0
Non-natives					
Can.	181	0.7	4	0	0.9
U.S.	310	0.8	5	0	1.1

There is little variability among lakes in the mean number of macroinvertebrate taxa per wetland, with averages ranging from 31-42 taxa with Lake Erie having lower averages than the upper lakes (Table 13). The maximum number of invertebrate taxa was lowest in Lake Ontario wetlands (54) with the most invertebrate-rich wetlands in the other lakes having a maximum of 65-71 taxa. Wetlands with the fewest taxa are sites in need of restoration. Patterns are likely being driven by differences in habitat complexity, which may in part be due to the loss of wetland habitats. This has been documented in numerous peer-reviewed publications.

Table 13. Macroinvertebrate total taxa and non-native species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of taxa per wetland. Data from 2011 through 2024, using only data from the most recent year sampled for each wetland.

		Macroinvertebrates (Total)			Non-native		
Lake	**Sites**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
Erie	63	33.1	54	12	1.1	5	0
Huron	169	40.0	68	13	0.6	4	0
Michigan	77	35.2	66	9	1.1	4	0
Ontario	114	31.8	71	15	0.7	3	0
Superior	68	41.9	68	19	0.5	4	0

There is little variability among lakes in non-native taxa occurrence. In each lake there were some wetlands in which we found no non-native macroinvertebrates. As noted above, however, this does not necessarily mean that these sites do not contain non-native macroinvertebrates.

We found zero non-native aquatic macroinvertebrates in 55% of Great Lakes coastal wetlands sampled from 2016-2020 (Figure 6), but in a handful of wetlands we found as many as 4-5 non-native invertebrate taxa.

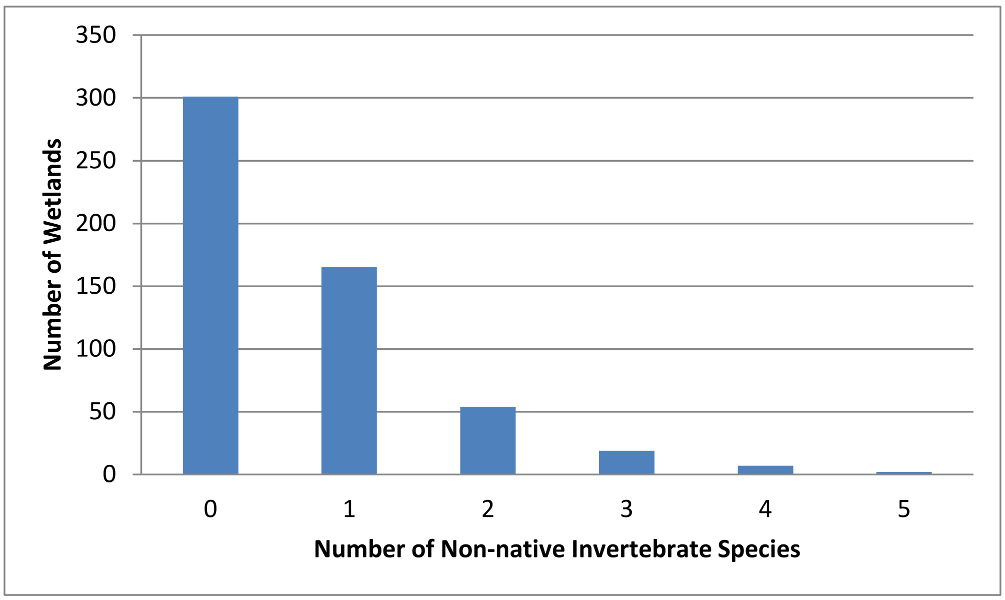


Figure 6. Number of Great Lakes coastal wetlands containing non-native invertebrate species. Data from 2016 through 2020.

In 2014 we realized that we are finding some non-native, invasive species in significantly more locations around the Great Lakes than are being reported on nonindigenous species tracking websites such as the USGS's Nonindigenous Aquatic Species (NAS) website (http://nas.er.usgs.gov/). Locations of aquatic macroinvertebrates are particularly under-reported. The best example of the difference is shown in Figures 7 and 8 for the faucet snail, *Bithynia tentaculata*. Figure 7 shows the range portrayed on the USGS website for this snail before we reported our findings. Figure 8 shows the locations where our crew found this snail. Finally, Figure 9 shows the USGS website map after it was updated with our crews' reported findings.

Figure 7. Locations of *Bithynia tentaculata* in USGS NAS website PRIOR to our project providing additional locations where they were collected.

The faucet snail is of particular interest to USFWS and others because it carries parasites that can cause disease and die-offs of waterfowl. Because of this, we produced numerous press releases reporting our findings (collaborating universities produced their own press releases). The Associated Press ran the story and about 40 articles were generated in the news that we are aware of. See Appendix for a mock-up of our press release and a list of articles that ran based on this press release.

One reason that we were able to increase the geographic range and total number of known locations occupied by faucet snails is the limited number of ecological surveys occurring in the Great Lakes coastal zone. Furthermore, those surveys that do exist tend to be at a much smaller scale than ours and sample wetlands using methods that do not detect invasive species with the precision of our program.

In collaboration with the Great Lakes Environmental Indicators project and researchers at the USEPA Mid-Continent Ecology Division in Duluth and at the University of Wisconsin Superior, a note was published in the Journal of Great Lakes Research about the spread of *Bithynia* in Lake Superior (Trebitz et al. 2015).

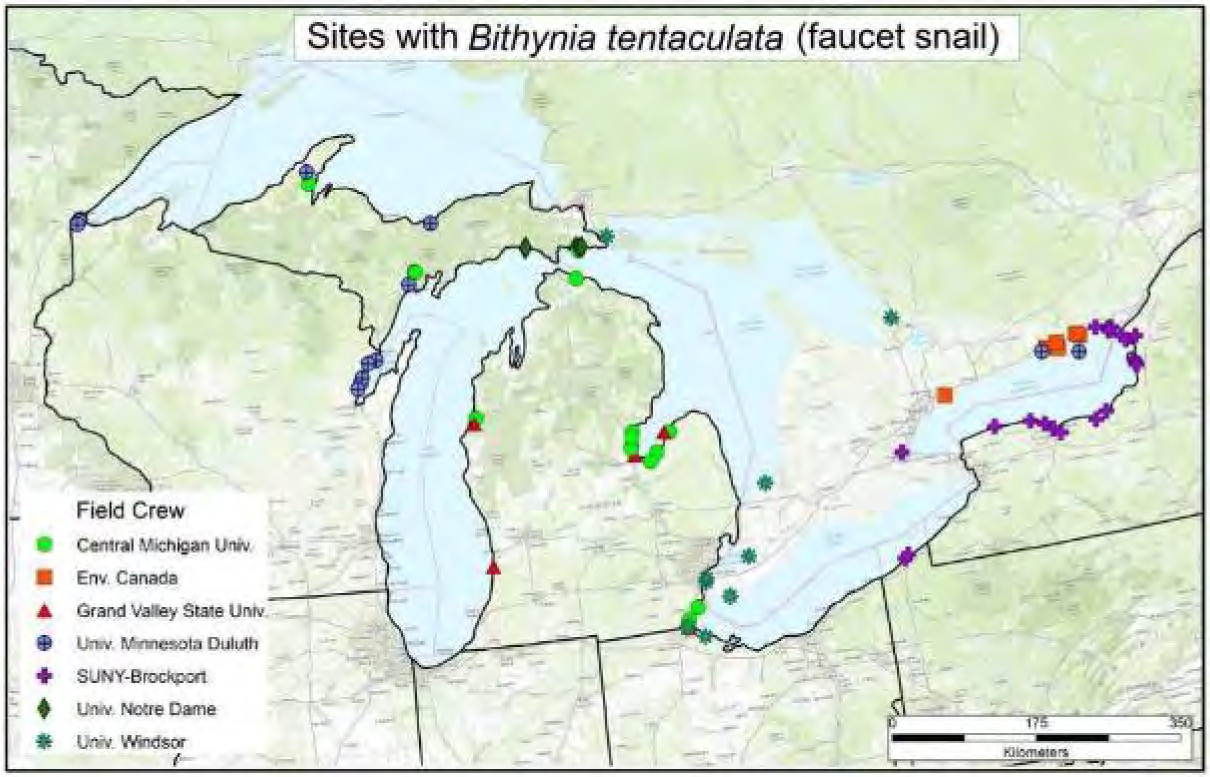


Figure 8. Locations of *Bithynia tentaculata* found by CWM crews, 2011 - 2013.

We also routinely provide data on other non-native macroinvertebrates, fish, and aquatic vegetation to Great Lakes databases and websites that track this information.

On average, there were approximately 40 macrophyte species per wetland (Table 14) with a maximum number of 100 species at exceptionally diverse sites. Some sites were quite depauperate in plant taxa (some having none), particularly in highly impacted areas that were no longer wetlands but were sampled because they are designated for restoration and because of high water levels along higher energy coastlines.

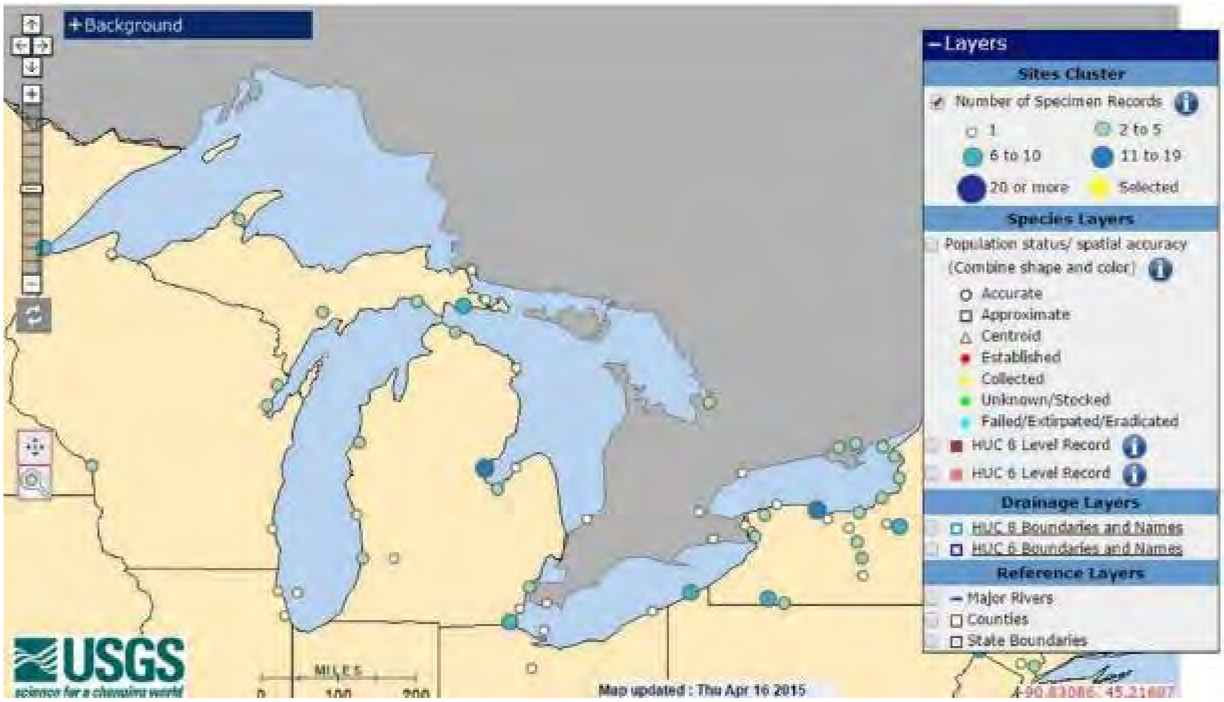


Figure 9. Locations of *Bithynia tentaculata* in USGS NAS website AFTER our project provided additional locations where they were collected; compare to Figure 6.

Non-native vegetation is commonly found in Great Lakes coastal wetlands. We have updated our plant taxa lists to ensure that we are correctly coding all non-native macrophyte taxa, even those that are not currently considered invasive. This update changed the numbers of non-native species for many wetlands because in the past we had focused more on the non-natives that are invasive and are problematic in wetlands.

Coastal wetlands averaged 4-5 non-native species (Table 14). Some wetlands contained as many as 17 non-native macrophyte species, but there were wetlands in which no non-native plant species were found. It is unlikely that our sampling strategy would miss significant non-native plants invading a wetland. However, small patches of cryptic or small-stature non-natives could be missed. Invasive species are a particularly important issue for restoration work. Restoration groups often struggle to keep restored wetland sites from becoming dominated by invasive plant species.

Table 14. Total macrophyte species and non-native macrophytes in Great Lakes coastal wetlands; summary statistics by country. Data from 2011 through 2024, using only data from the most recent year sampled for each wetland.

Country	Site count	Mean	Max	Min	St. Dev.
Overall					
Can.	187	42.9	88	5	18.8
U.S.	354	43.2	95	0	18.7
Non-native					
Can.	187	5.5	17	0	3.5
U.S.	354	4.3	17	0	3.5

Lake Erie wetlands had by far the lowest mean number of macrophyte species (31, Table 15), with the other lakes' wetlands having higher mean numbers of species (34-48, Table 15). Average numbers of non-native species were highest in Lake Ontario (8 species) and lowest in Lake Superior wetlands (1 species; Table 15). Lake Superior had the lowest maximum number of non-native macrophytes in a wetland (8) and Lake Ontario had the highest maximum number with 17. There are wetlands on all lakes in which we did not detect invasive plants.

Table 15. Macrophyte total species and non-native species found in Great Lakes coastal wetlands by lake. Mean, maximum, and minimum number of species per wetland. Data from 2011 through 2024, using only data from the most recent year sampled for each wetland.

		Macrophytes (Total)			Non-native		
Lake	**Sites**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
Erie	60	30.7	70	4	6.0	15	0
Huron	196	47.1	95	3	3.3	13	0
Michigan	89	42.3	82	4	4.5	11	0
Ontario	126	48.0	85	12	8.4	17	0
Superior	70	34.5	63	0	1.4	8	0

Our macrophyte data have reinforced our understanding of the numbers of coastal wetlands that contain non-native plant species (Figure 10, based on 2016-2020 data). Only 7% of 556 sampled wetlands lacked non-native species, leaving 93% with at least one. Sites were most commonly invaded by up to 7 non-native plant species and 13% of sites contained 8 or more non-native species. Detection of non-native species is more likely for plants than for organisms that are difficult to collect such as fish and other mobile fauna, but we may still be missing small patches of non-natives in some wetlands.

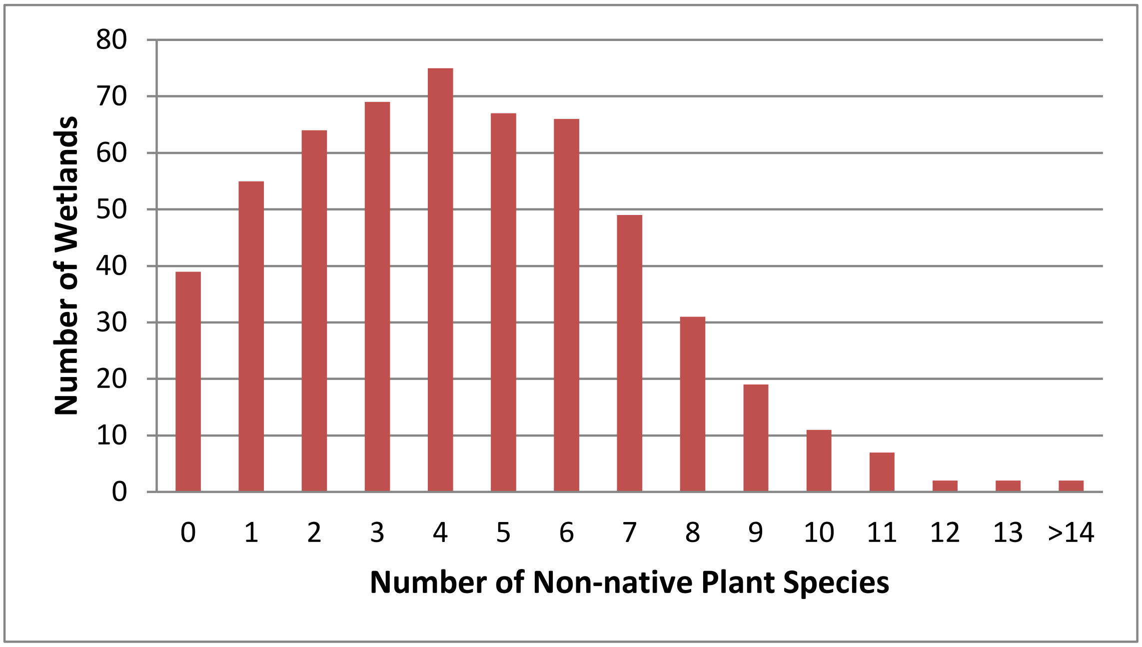


Figure 10. Number of Great Lakes coastal wetlands containing invasive plant species based on 2016 through 2020 data.

As an example for the state of Michigan, we also looked at wetlands with both invasive plants and plant species considered “at risk” (Figure 11). We found that there were a few wetlands at all levels of invasion that also had at-risk plant populations. This information will be useful to groups working to protect at-risk populations by identifying wetlands where invasive species threaten sensitive native species.

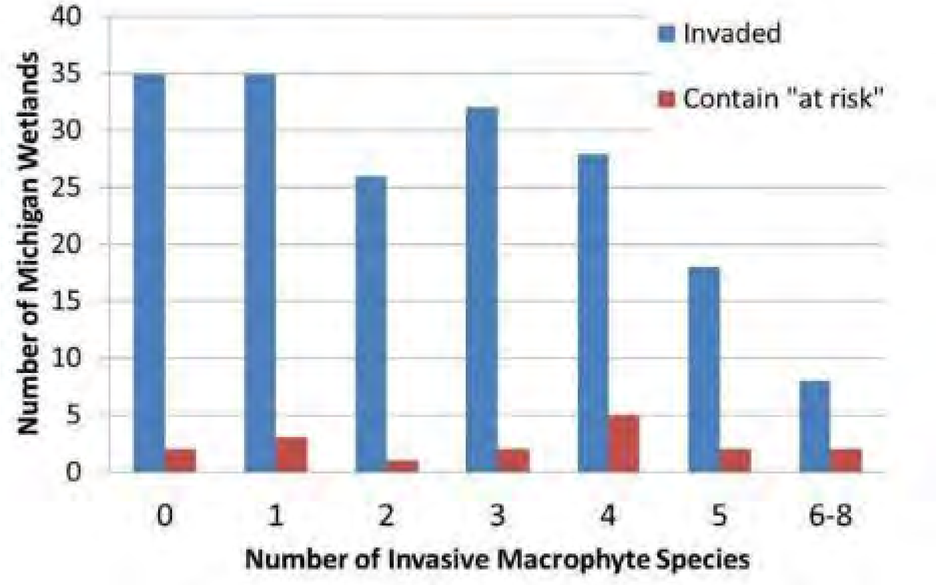


Figure 11. Number of state of Michigan Great Lakes coastal wetlands containing both invasive plant species and "at risk" plant species, based on 2011 through 2014 data.

We created a map of invasion status of Great Lakes coastal wetlands using all invasive species data we collected through 2014 for all taxonomic groups combined (Figure 12). Unfortunately, this shows that most sites have some level of invasion, even on Isle Royale. However, the more remote areas clearly have fewer invasives than the more populated areas and areas with relatively intense human use.

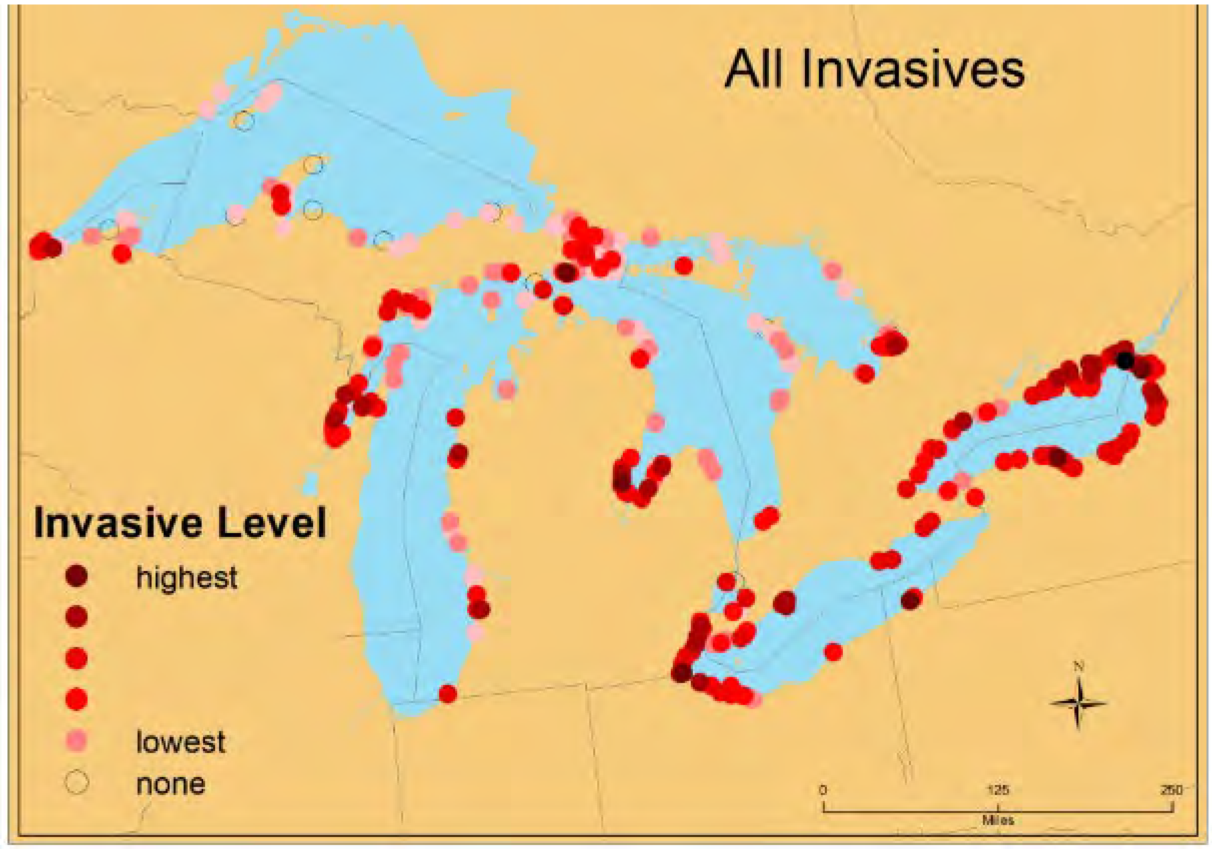


Figure 12. Level of "invadedness" of Great Lakes coastal wetlands for all non-native taxa combined across all taxonomic groups, based on data from 2011-2014.

WETLAND CONDITION (based on 2011 – 2024 data unless otherwise noted)

In the fall of 2012 we began calculating metrics and IBIs for various taxa. We are evaluating coastal wetland condition using a variety of biota (wetland vegetation, aquatic macroinvertebrates, fish, birds, and anurans [calling amphibians]).

Macrophytic vegetation has been used for many years as an indicator of wetland condition (only large plants; algal species were not included). One very common and well-recognized indicator is the Floristic Quality Index (FQI); this evaluates the quality of a plant community using all of the plants at a site. Each species is given a Coefficient of Conservatism (C) score based on the level of disturbance that characterizes each plant species' habitat. A species found in only undisturbed, high quality sites will have a high C score (maximum 10), while a weedy species will have a low C score (minimum 0). We also give invasive and non-native species a rank of 0. These C scores have been determined for various areas of the country by plant experts; we used the published C values for the midwest. The FQI is an average of all of the C scores of the species growing at a site, divided by the square root of the number of species. The CWM wetland vegetation index uses C scores for wetland species, among other metrics.

This IBI has been updated and adjusted multiple times since the start of the project, accounting for the shift in condition scores for some sites. The first adjustment was necessary to reflect changes in the taxonomic treatment of many marsh plants in the 2012 Michigan Flora and Flora of North America. In spring 2020, Dr. Dennis Albert, with assistance from Allison Kneisel, reviewed the data input file for the plants, looking at each individual species (taxa) on the list and observing how many records of each taxon were in the database. First, redundant entries were removed; some taxa had several synonyms in the database. The next step was to remove species that had no occurrences over 9 years of data collection; this eliminated 2082 species or 49.6% of the original species from the data input file.

A final step was to review the database for upland species or species that were outside of their accepted range. Some of these were clearly errors that resulted from the dropdown menu. For example, *Carex oligosperma*, a common northern wetland sedge, was recorded along several transects over several years in a Lake Superior wetland, but then *Carex oligocarpa*, an upland sedge immediately next to *C. oligosperma* on the dropdown list, was recorded at several points along a single transect. This was clearly a data recording error. Similar errors were identified for a handful of species. Another type of error that was identified and corrected in the database occurred when a species was noted that had a range north or south of the Great Lakes but appears very similar to a Great Lakes species so was identified in error. Similarly, cases were found in which an upland species was selected instead of the correct wetland species with very similar characteristics; this was also a rare situation involving less than 10 species.

Collectively, these revisions reduced the plant data input list from 4192 species to 1724 species, a reduction of 59%, which should both speed up and reduce errors in data input.

Allison Kneisel reviewed and modified the existing non-native species list. This process resulted in the addition of 9 species to the non-native species list. For computation of the IBI scores, many of the best-studied non-native species are used in computation of specific IBI metrics. For many of the species that were added to the non-native species list, there are few studies documenting what individual species are responding to, whether the response is to wetland dry down, increased nutrient loading, turbidity tolerance, or other factors.

In 2023 we debuted a draft vegetation-based IBI; this IBI was originally developed by Dr. Dennis Albert during the early stage of Great Lakes-wide biotic sampling for the USEPA (Albert 2008) and is now updated (see Dybiec *et al*. 2020). The structure and many of the metrics of the new

IBI are shared with the original, but the new IBI has increased the number of metrics used and refined the metrics for the submergent zone. The original submergent zone metrics were difficult to compute.

Both the old and new IBIs were calculated by vegetation zone, making it possible to identify the source of degradation in a wetland. In many cases the impact of land or water use can result in the level of degradation in one zone being very different than that in other zones, and identifying the degraded zones can facilitate more effective restoration efforts. The advantage of the Dybiec et al. (2020) version is that the zonal scores are more easily accessible than in the original IBI, and the submergent zone metrics are much more dependable and easier to compute. The zonal scores in both IBIs are combined to create a site-wide score, and these site-wide scores are what are used in individual lake (Erie, Huron, Michigan, Ontario, and Superior) comparisons and long-term tracking of wetland quality change for the individual lakes and the entire Great Lakes.

The scores of the old and new IBIs are strongly correlated for the site-wide scores, with R2 = 0.65 for the entire plant database between 2011-2022 (Figure 13), with a similar R2 = 0.63 for the high-water years of 2021-2022 (Figure 14). It appears that the IBI scores of some of the most open lacustrine sites that had the highest IBI scores (5) with the original IBI, scored much lower with the new IBI, especially during high-water years of 2021 and 2022. Our interpretation is that the new IBI is providing a more effective evaluation of the submergent zone, a weakness in the original IBI.

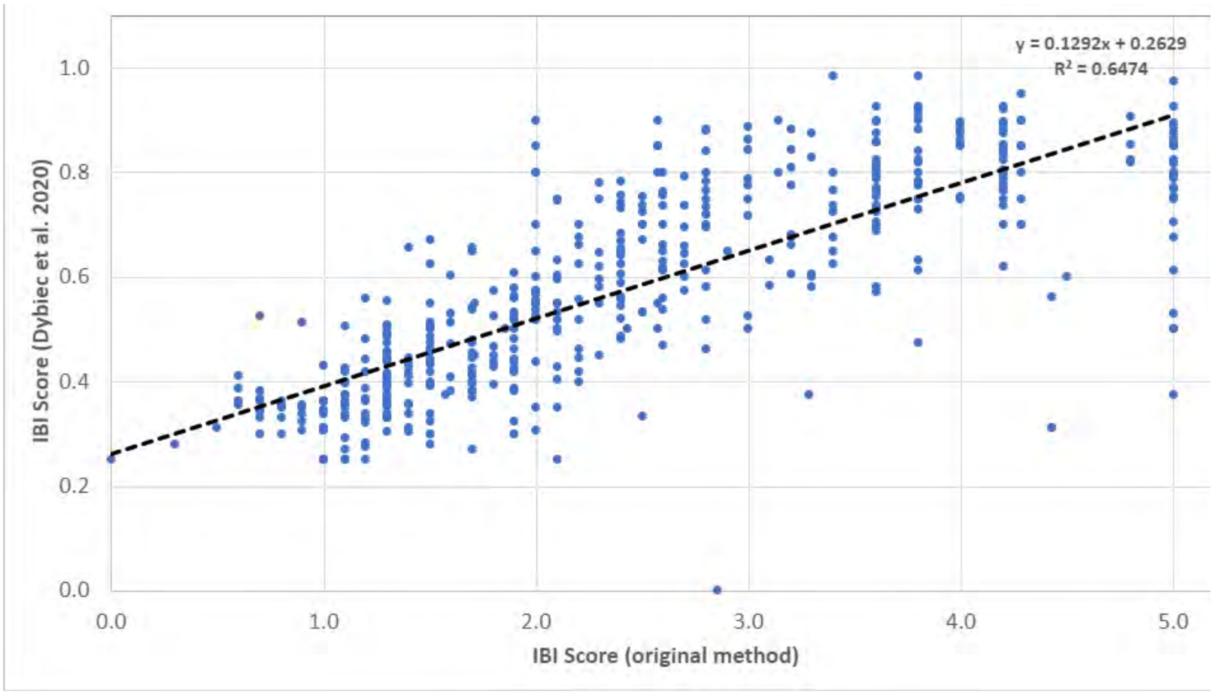


Figure 13. Comparison of original vs. revised vegetation IBI (2011-2022).

Using the new IBI, the site-wide scores appear to be slightly lower for the most degraded sites (old IBI scores <2) and slightly higher for the less degraded sites (old IBI scores >2). This is likely the result of adding metrics based on specific taxa, Carex spp. for the Wet Meadow, and Cyperaceae cover for the emergent zone, both taxonomic groups well represented in less degraded wetlands and often groups missing from highly degraded wetlands.

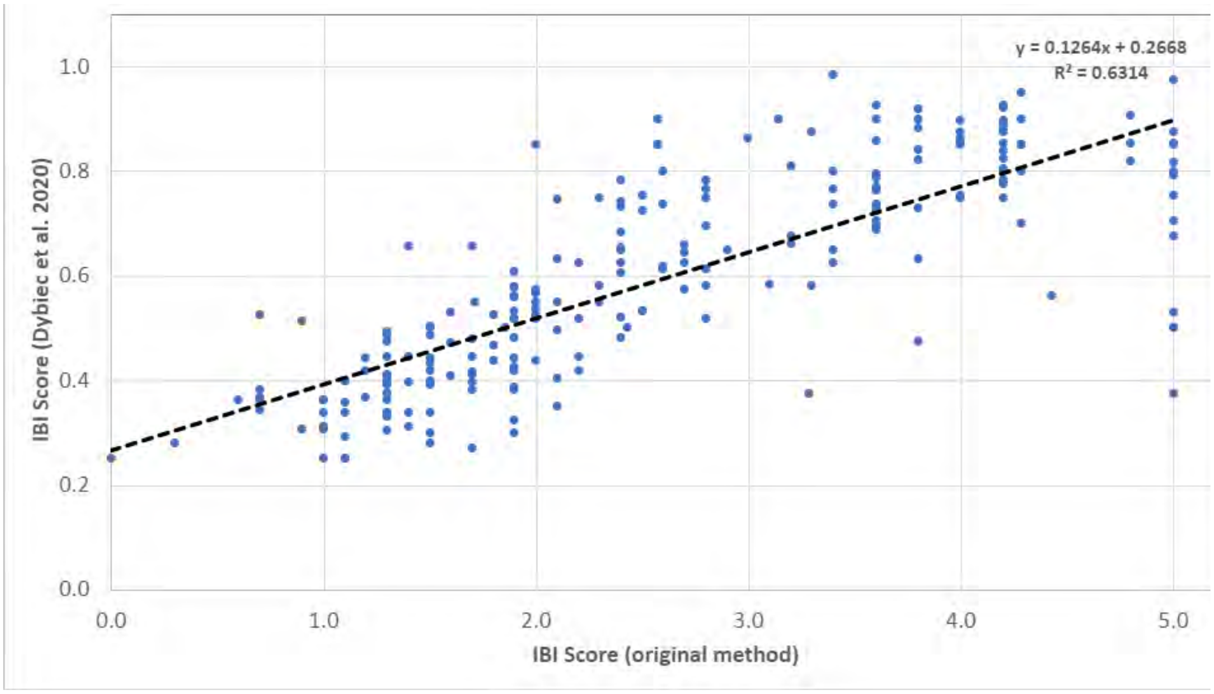


Figure 14. Comparison of original vs. revised vegetation IBI (2021-2022 data only).

Lake-wide comparison of the old and new IBIs produce similar results. The order of lake-wide quality remains the same, with Lake Superior having the highest IBI scores, followed in order by Lake Huron, Lake Michigan, Lake Ontario, and Lake Erie.

The map (Figure 15) shows the distribution of Great Lakes coastal wetland vegetation index scores across the basin. Note that there are long stretches of Great Lakes coastline that do not have coastal wetlands due to topography and geology. Sites with low FQI scores are concentrated in the southern Great Lakes, where there are large amounts of both agriculture and urban development, and where water levels may be more tightly regulated (e.g., Lake Ontario), while sites with high FQI scores are concentrated in the northern Great Lakes. Even in the north, an urban area like Duluth, MN may have high quality wetlands in protected sites and lower quality degraded wetlands in the lower reaches of estuaries (drowned river mouths) where there are legacy effects from the pre-Clean Water Act era, along with nutrient enrichment or heavy siltation from industrial development and/or sewage effluent. Benchmark sites in need of restoration will also have lower condition scores.

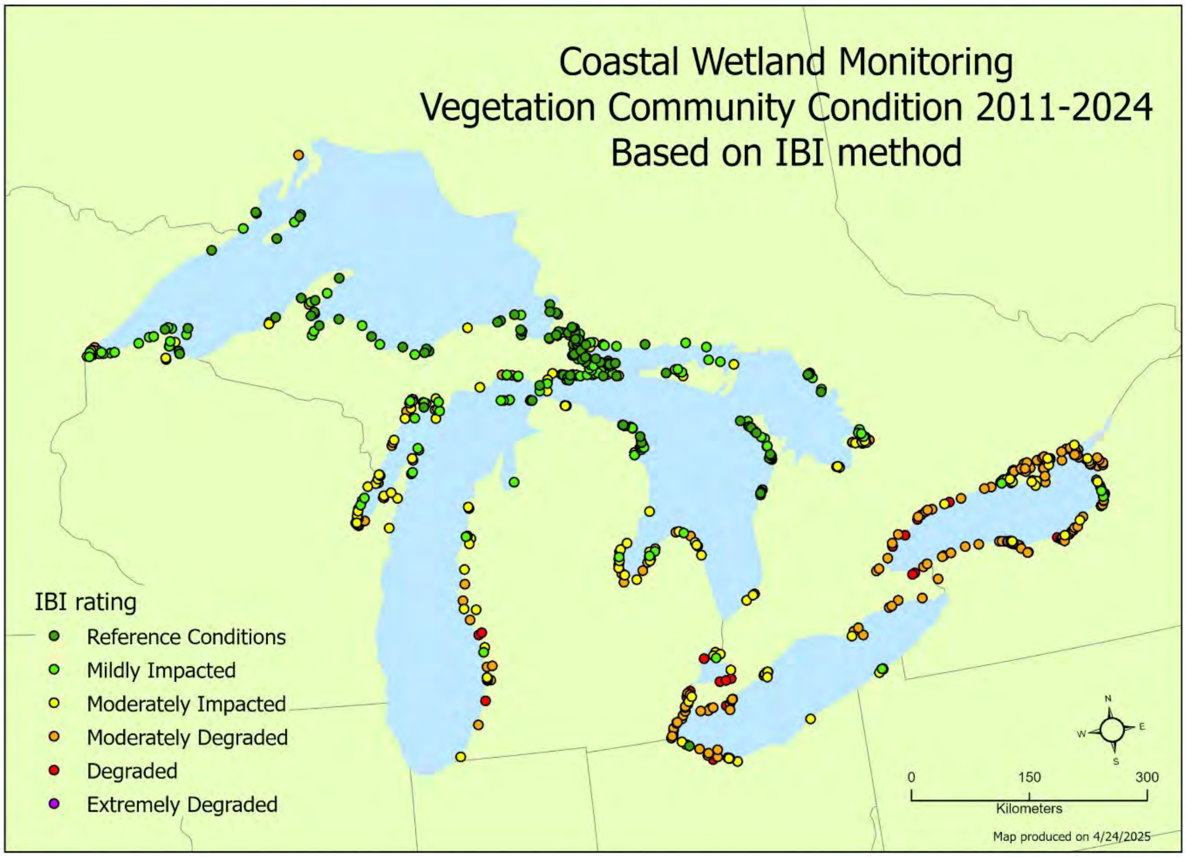


Figure 15. Condition of coastal wetland vegetation at sites across the Great Lakes. Circle color indicates vegetation community quality. Map shows IBI for the most recent year sampled for each site. IBI newly updated for 2024; see text for description.

Another of the IBIs that was developed by the Great Lakes Coastal Wetlands Consortium uses the aquatic macroinvertebrates found in several of the most common vegetation types in Great Lakes coastal wetlands: sparse bulrush (*Schoenoplectus*), dense bulrush (*Schoenoplectus*), and wet meadow (multi-species) zones (Figure 16). In 2019 we had a major shift in the taxonomy of some invertebrates (primarily snails and mollusks) used in the calculation of some indicator metrics due to taxonomic updates and revisions. Thus, the invertebrate IBI map (Figure 16) in this report should not be compared to the maps shown in previous reports. However, this IBI has been calculated for all sites with appropriate zones and invertebrate data for all years.

The lack of sites on lakes Erie and Ontario and southern Lake Michigan is due to either a lack of wetlands (southern Lake Michigan) or because these areas do not contain any of the three specific vegetation zones that GLCWC used to develop and test the invertebrate IBI. Many areas contain dense cattail stands (e.g., southern Green Bay, much of Lake Ontario), for which we do not yet have a published macroinvertebrate IBI. We are developing IBIs for additional vegetation zones to cover these sites, but these IBIs have not yet been validated so they are not included here.

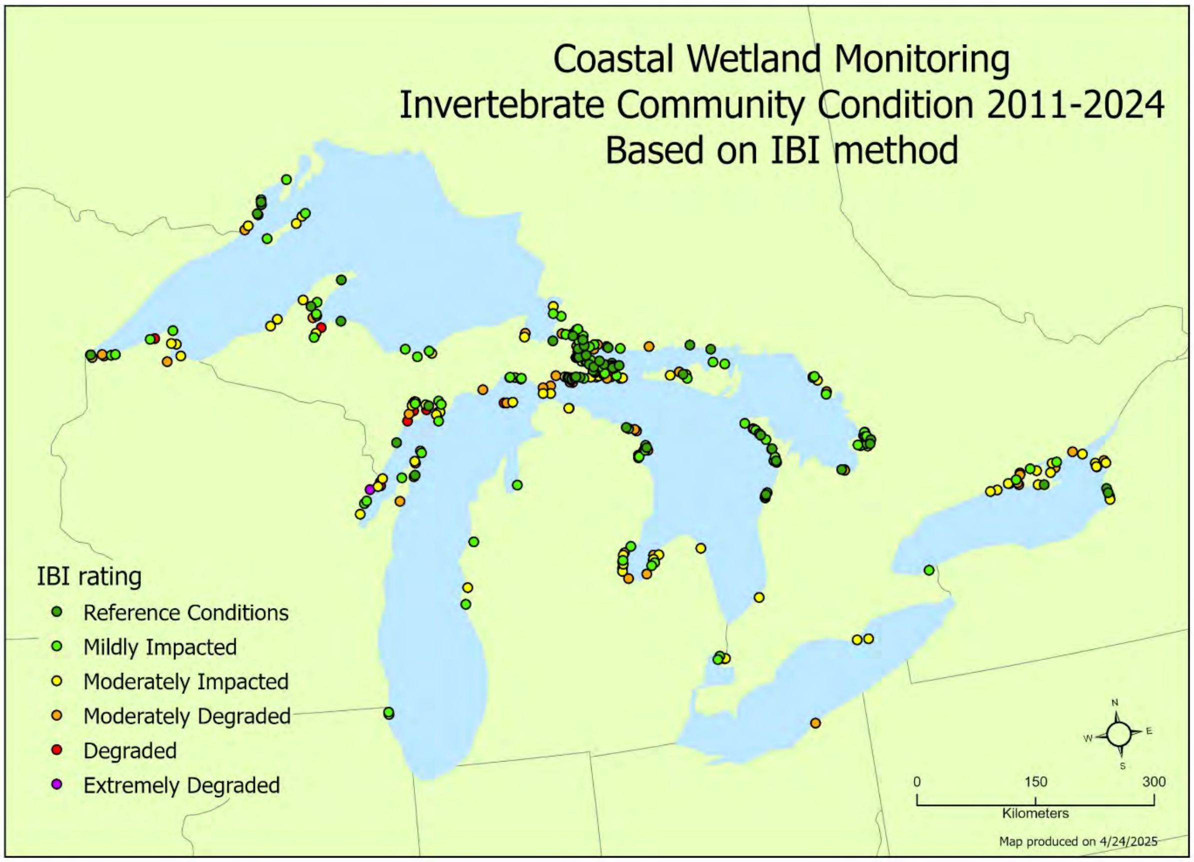


Figure 16. Condition of coastal wetland macroinvertebrate communties at sites with bulrush or wet meadow zones. Map shows IBI for the most recent year sampled for each site.

Our fish IBI scores for wetland sites now contain bulrush, cattail, lily, or SAV zones (Figure 17). Because of the prevalence of these vegetation types in wetlands throughout the Great Lakes basin, this indicator provides more site scores than the macroinvertebrate indicator. Because these are updated and adjusted indicators, the map image in this report should not be compared to fish IBI map images in previous reports. However, all sites reporting fish data from zones applicable to the new fish IBIs are shown here, regardless of the year they were sampled.

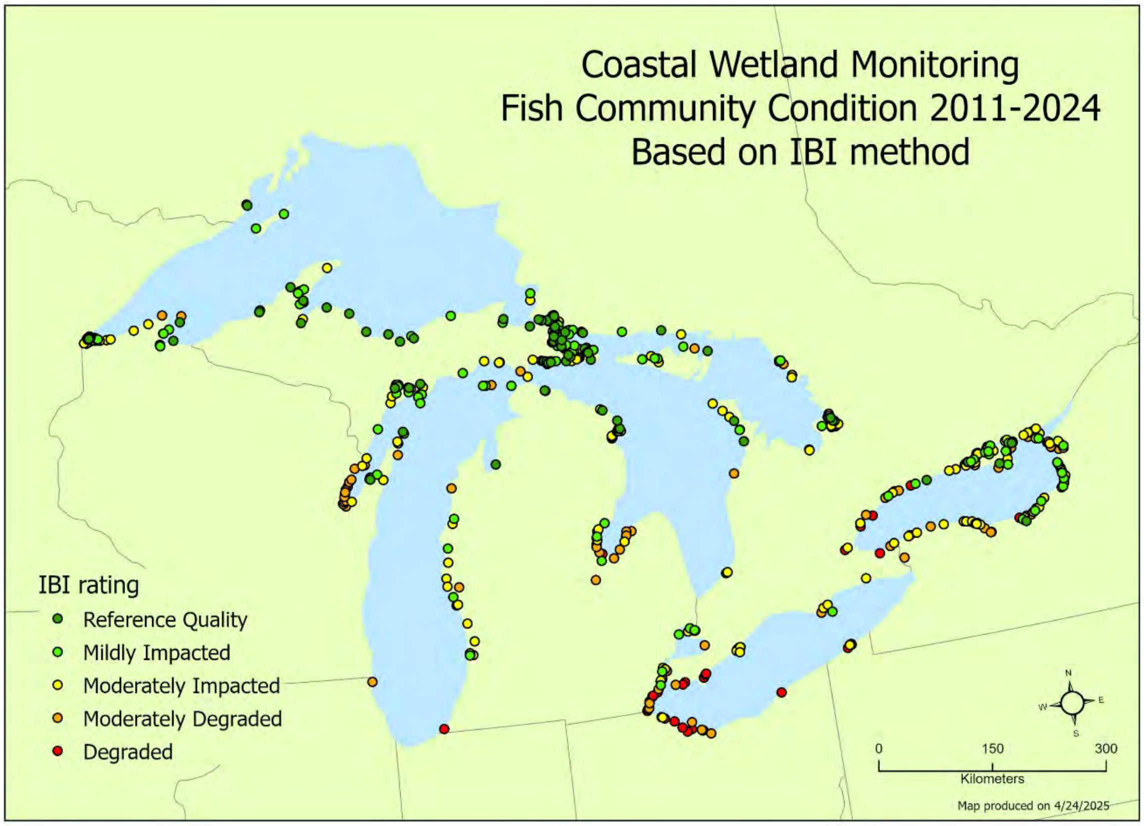


Figure 17. Condition of coastal wetland fish communties at sites with bulrush, cattail, lily, or submerged aquatic vegetation zones. Map shows IBI for the most recent year sampled for each site.

To develop the most recent fish IBI, fish community metrics were evaluated against numerous indices of anthropogenic disturbance derived from measurements of water quality and surrounding land cover. Disturbance indices included individual land cover and water quality variables, principal components combining land cover and water quality variables, a previously published landscape-based index (SumRel; Danz *et al*. 2005), and a rank-based index combining land cover and water quality variables (SumRank; Uzarski *et al*. 2005). Multiple disturbance indices were used to ensure that IBI metrics captured various dimensions of human disturbances.

We divided fish, water quality, and land cover data (2011-2015 data) into separate “development” and “testing” sets for metric identification/calibration and final IBI testing, respectively. Metric identification and IBI development generally followed previously established methods (e.g., Karr *et al*. 1981, USEPA 2002, Lyons 2012) in which 1) a large set of candidate metrics was calculated; 2) metrics were tested for response to anthropogenic disturbance or habitat quality; 3) metrics were screened for responses to anomalous catches of certain taxa, for adequate range of responses, and for highly redundant metrics; 4) scoring schemes were devised for each of the final metrics; 5) the final set of metrics was optimized to improve the fit of the IBI to anthropogenic disturbance gradients; and 6) the final IBI was validated against an independent data set.

Final IBIs were composed of 10-11 fish assemblage metrics for each of four vegetation types (bulrush [*Schoenoplectus* spp.], cattail [*Typha* spp.], water lily [*Brassenia, Nuphar, Nymphaea* spp.], and submersed aquatic vegetation [SAV, primarily *Myriophyllum* or *Ceratophyllum* spp.]). Scores of all IBIs correlated well with values of anthropogenic disturbance indices using the development and testing data sets. Correlations of IBIs to disturbance scores were also consistent among each of the five years. A manuscript describing development and testing of this IBI has been published (Cooper *et al.* 2018).

In 2024 we began using a new method for calculating the condition of Great Lakes coastal wetlands based on birds and anurans. The new method, called the Index of Biotic Condition (Howe *et al*. 2023), is qualitatively like our previous metric (Index of Ecological Condition) but is much simpler to calculate and therefore invites broader applications by state and local conservation agencies. We have back-calculated all point indices (IBC values), so our trend estimates are truly “apples-to-apples” comparisons. The IBC and IEC are highly correlated, and both are scaled to a range of 0 (poorest possible condition) to 10 (ideal condition). The Index of Biotic Condition (IBC), however, is more stable when few species are present and is more highly correlated with species richness. The IBC reaches a maximum value only when a full complement of indicator species is present at a site, generally leading to lower absolute values. In other words, using this method, biotic condition at Great Lakes wetlands based on birds (Figure 18) looks quite different than did these condition maps in previous reports.

Unlike the IEC method, the highest IBC value is achieved by an “ideal” species assemblage, which might not occur in the sampled data set (i.e., in any Great Lakes coastal wetland). The IBC and IEC use the same maximum likelihood method to quantify the sensitivity (biotic response) of species to an explicit reference gradient defined by wetland size and the “human footprint” in the surrounding landscape and watershed. Unlike the IEC, the IBC assigns “weights” to different species based on parameters of the biotic response functions. These weights are applied to the simple arithmetic formula reflecting the number and environmental sensitivity (“quality”) of species present.

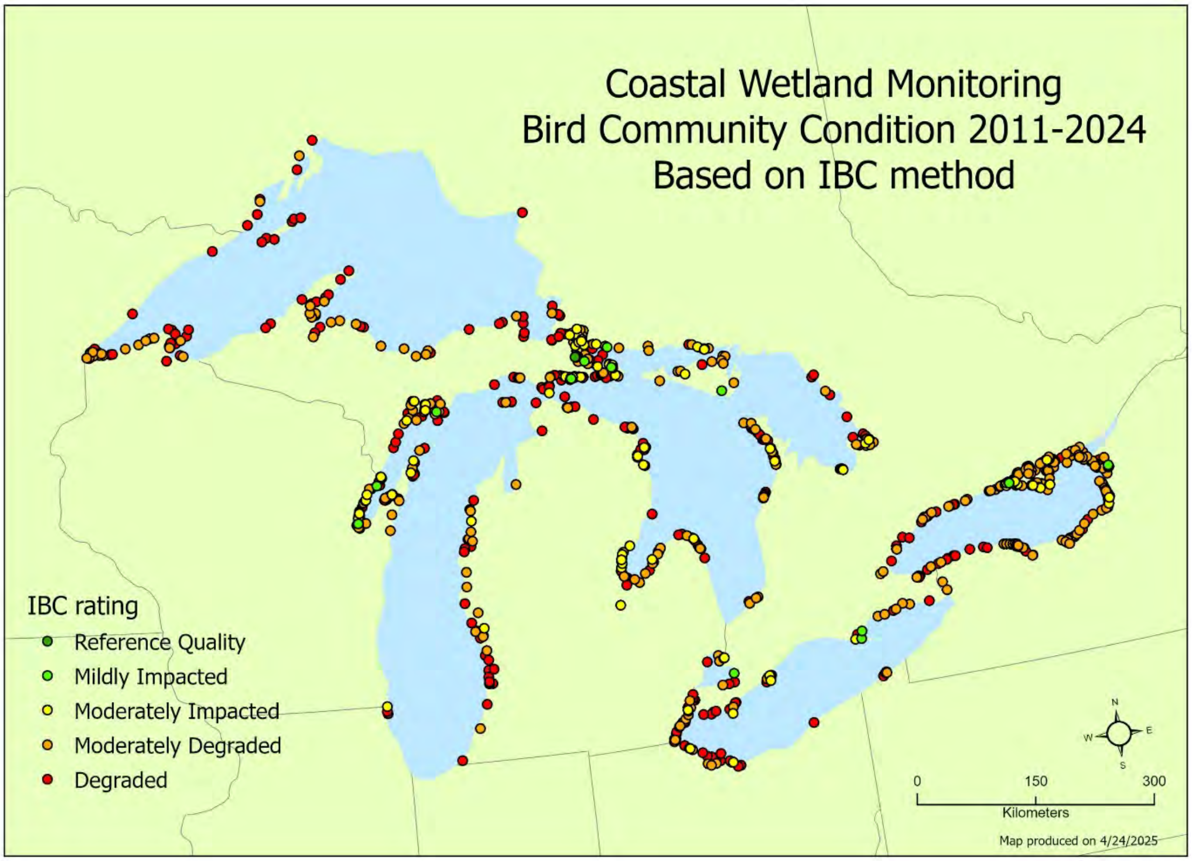


Figure 18. Condition of coastal wetland bird communties showing condition based on the most recent year each site was sampled.

Coastal Wetland Monitoring field teams have recorded 13 species of anurans (2 toads and 11 frogs) since 2011, but 4 of these (northern [Blanchard's] cricket frog, *Acris crepitans*; Fowler's toad, *Anaxyrus fowleri*; mink frog, *Lithobates septentrionalis*; and pickerel frog, *Lithobates palustris*) are seldom observed. Cope's gray treefrog (*Dryophytes chrysoscelis*) and eastern gray treefrog (*Dryophytes versicolor*) are sibling species that are difficult to differentiate in the field, so we combined records into a single taxon. We also did not separate geographically distinct species of chorus frogs, *Pseudacris*. IEC calculations for anurans therefore were based on 8 taxa (American toad or Fowler's Toad, *Anaxyrus spp*.; gray treefrogs, *Dryophytes spp*.; bullfrog, *Lithobates catesbeianus*; northern leopard frog, *Lithobates pipiens*; green frog, *Lithobates clamitans*; wood frog, *Lithobates sylvaticus*; chorus frogs, *Pseudacris spp*., and spring peeper, *Pseudacris crucifer*). A ninth category combines other less-common species such as pickerel frog and mink frog (*Lithobates spp*.). Wetland condition based on anuran communities as calculated by the new IBC method is shown in Figure 19.

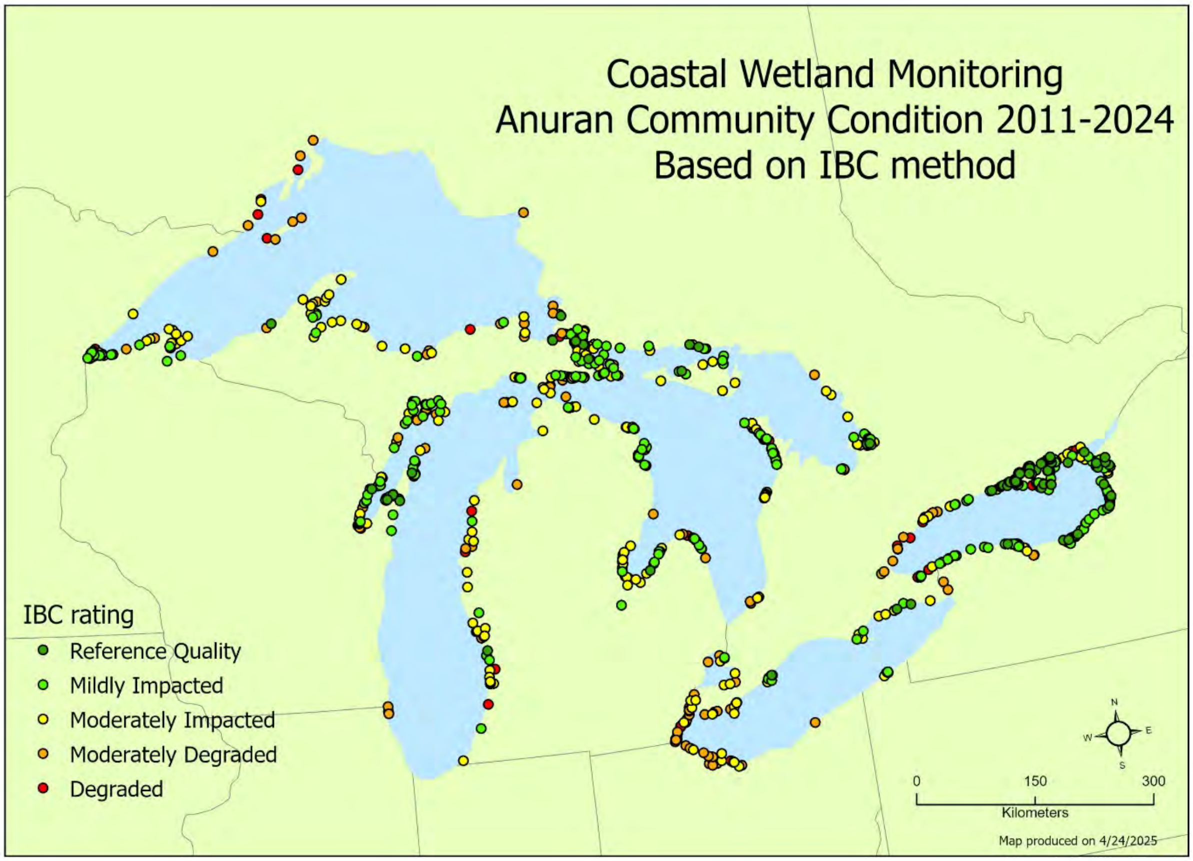


Figure 19. Condition of coastal wetland calling anuran communities based on the IBC method and using data from the most recent visit to each wetland.

Finally, we have developed a water quality and land use indicator (Harrison et al. 2019). This indicator is based on landscape stressor data and water quality data collected from each aquatic plant morphotype (Figure 20).

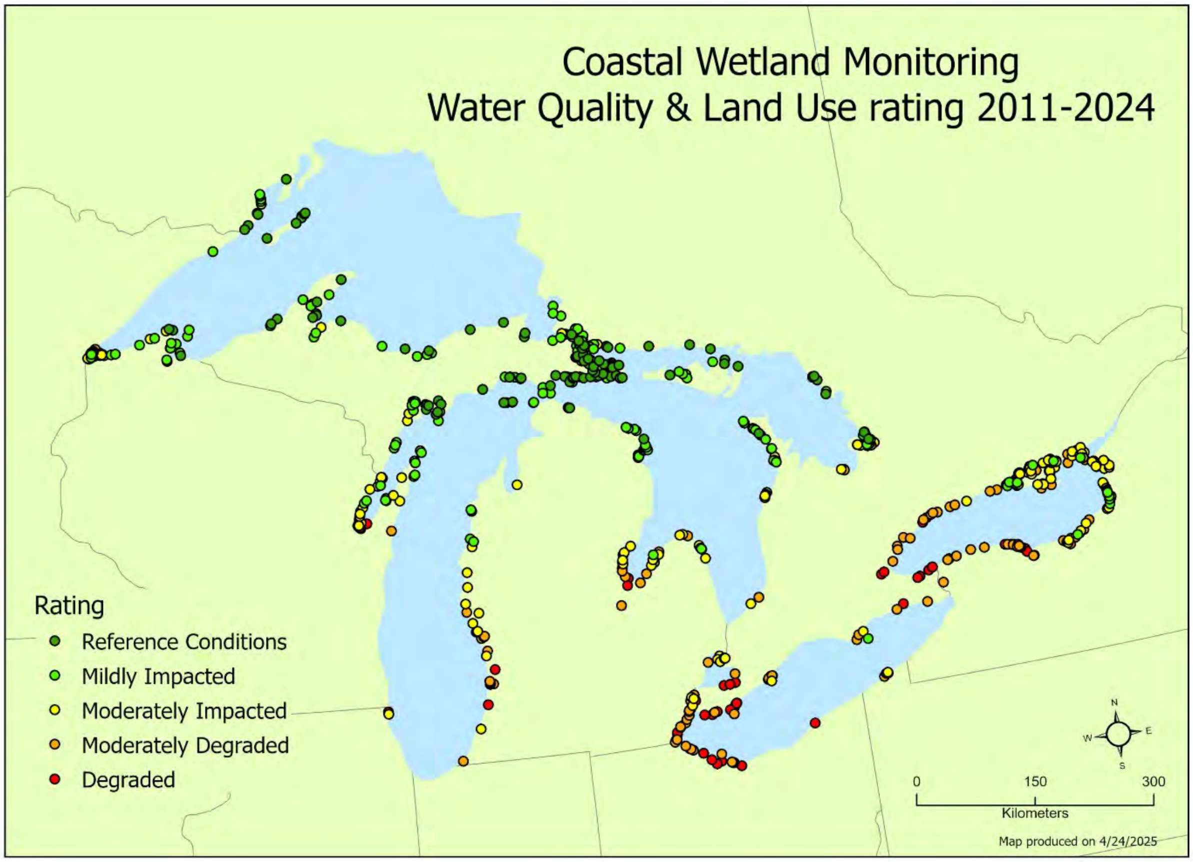


Figure 20. Disturbance gradient (SumRank) indicator. This indicator is based on landscape stressor data, site-based stressor data, and site water quality data.

PUBLIC ACCESS WEBSITE

The Coastal Wetlands Monitoring Program (CWMP) website provides efficient access to program information and summary results for coastal managers, agency personnel, and the interested public (Figure 21). As previously noted, the CWMP website was redeveloped and upgraded by LimnoTech and transitioned from an NRRI server to a permanent web hosting environment at Central Michigan University in spring 2016. The official launch of the new CWMP website occurred on April 26, 2016, including the public components of the website and data management tools for CWMP principal investigators and collaborators. Since that time, coastal managers and agency personnel have used the website's account management system to request and obtain accounts that provide access to the wetland site mapping tool, which includes reporting of Index of Biotic Integrity (IBI) scores. CWMP researchers have also obtained user accounts that provide access to data upload, entry, editing, download, and mapping tools. LimnoTech is providing ongoing maintenance and support for the website, including modifying and enhancing the site as required to meet CWMP and GLNPO needs, as well as other end user needs.

Figure 21. Front page of the Great Lakes Coastal Wetland Monitoring public website, www.greatlakeswetlands.org.

The CWMP website provides a suite of interrelated webpages and associated tools that allow varying levels of access to results generated by the CWMP, depending on the user's data needs and affiliation. Webpages available on the site allow potential users to request an account and for site administrators to approve and manage access levels for individual accounts. Specific levels of access for the website are as follows:

- **Public** – this level of access does not require a user account and includes access to a basic version of the wetland mapping tool, as well as links to CWMP documents and contact information;

- **<u>Site metrics (level 1)</u>** – provides access to index of biological integrity (IBI) scores by wetland site via the coastal wetland mapping tool;
- **<u>Agency/manager-basic (level 2)</u>** - access to IBI scores and full species lists by wetland site via mapping tool;
- **<u>CWMP scientists (level 4)</u>** - access to data entry/editing tools (+ Level 3 capabilities); and
- **<u>Admin</u>** - access to all information and data included on the website plus administrative tools. A small team of CWMP principal investigators have been given “Admin” access and will handle approval of account requests and assignment of an access level (1-4).

The following sub-sections briefly describe the general site pages that are made available to all users (“Public” level) and the coastal wetland mapping tool features available to “Level 1” and “Level 2” users. User requests for CWMP datasets are handled through a formal process which involves the requestor submitting a letter detailing the request and providing assurances regarding maintaining the publication rights of the CWMP team. Additional pages and tools available to “Level 4”, and “Admin” users for exporting raw monitoring data, entering and editing raw data, and performing administrative tasks are not documented in detail in this report.

COASTAL WETLAND MAPPING TOOL

The enhanced CWMP website provides a new and updated version of the coastal wetland site mapping tool described in previous reports (http://www.greatlakeswetlands.org/Map). The basic version of the mapping tool, which is available at the “Public” access level, provides the following features and capabilities (Figure 22):

- Map navigation tools (panning, general zooming, zooming to a specific site etc.);
- Basemap layer control (selection of aerial vs. “ocean” basemaps);
- Display of centroids and polygons representing coastal wetlands that have been monitored thus far under the CWMP;
- Capability to style/symbolize wetland centroids based on: 1) geomorphic type (default view; Figure 23), or 2) year sampled (Figure 24); and
- Reporting of basic site attributes (site name, geomorphic type, latitude, longitude, and sampling years) and general monitoring observations for the site (e.g., hydrology, habitat, disturbances).

In addition to the features made available at the “Public” access level, users with “Level 1” (*Site Metrics*) access to the website can currently obtain information regarding IBI scores for vegetation, invertebrates, and fish; *Index of Ecological Condition* (IEC) scores for anurans and birds; and a *Water Quality and Land Use Index*.

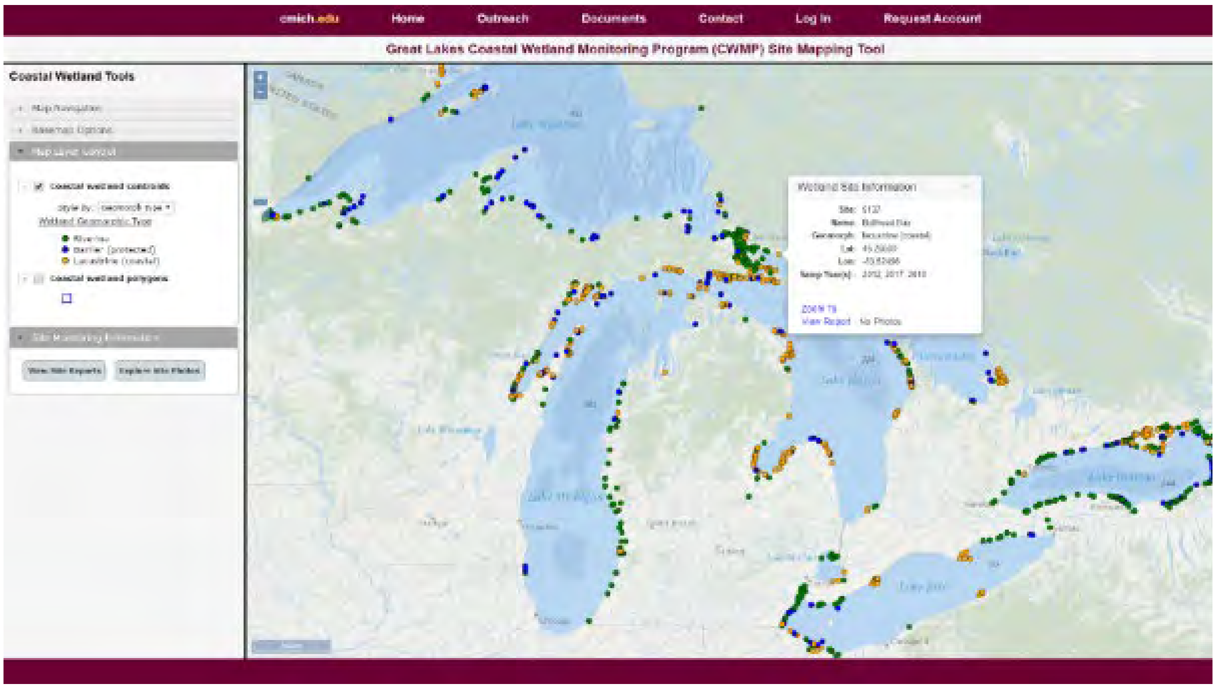


Figure 22. Coastal Wetland Mapping Tool – Public Version (geomorphic type view).

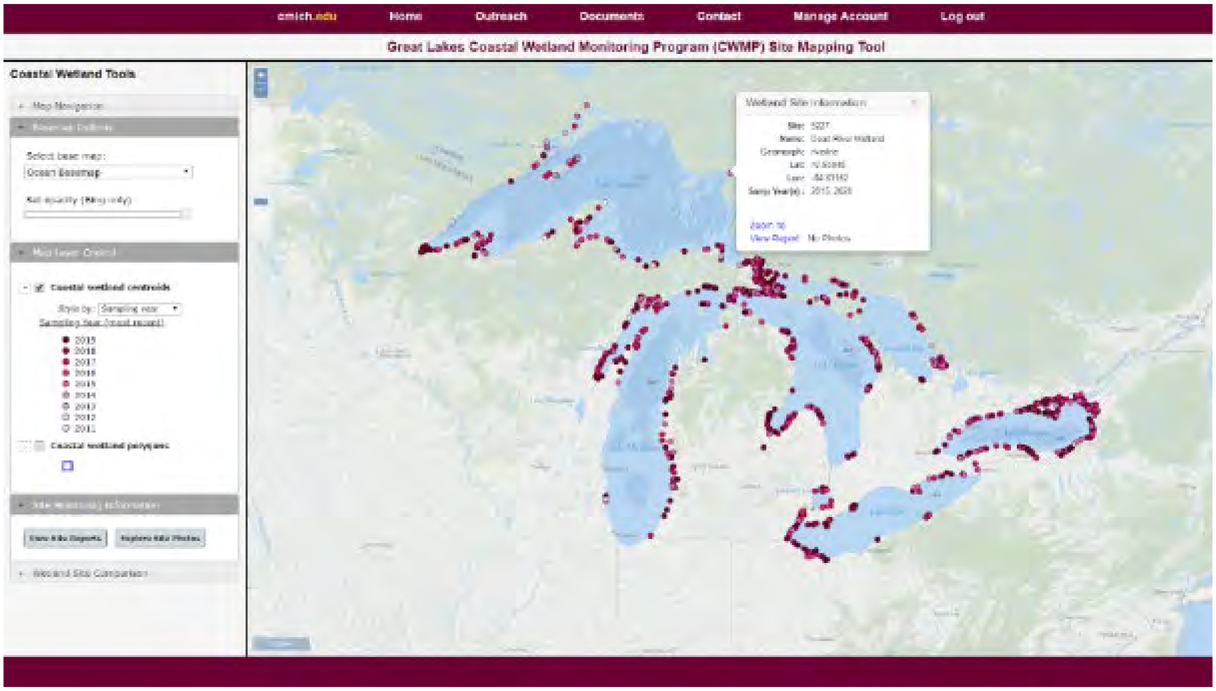


Figure 23. Coastal Wetland Mapping Tool – Public Version (sampling year view)

Wetland centroids can be symbolized based on IBI scores for a specific biological community, as well as based on geomorphic type and year sampled. For example, vegetation IBI scores calculated for individual sites can be displayed by selecting the “Vegetation IBI” option available in the “Style by:” pull-down menu (Figure 24). In addition, the actual IBI scores can be viewed by clicking on an individual wetland centroid.

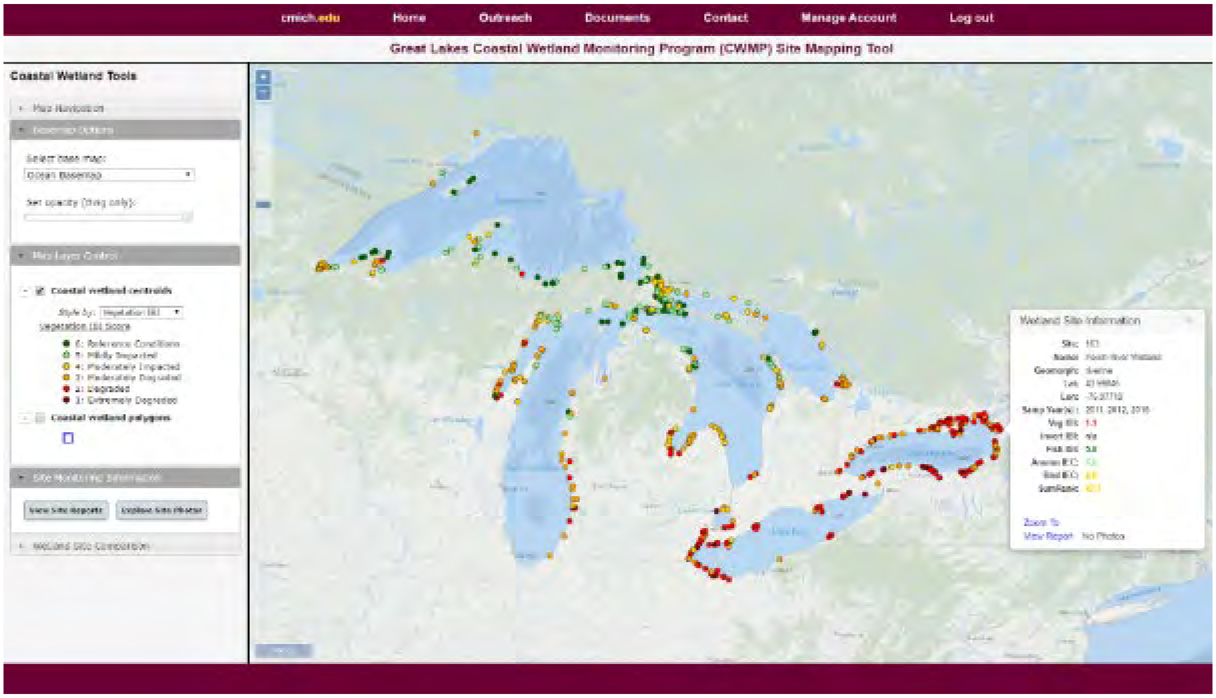


Figure 24. Coastal Wetland Mapping Tool with IBI scores displayed.

Users with “Level 2” (Agency/Manager (basic)) access to the website are provided with the same visualization options described above for the “Public” and “Level 1” access levels, but also have the capability of viewing a complete listing of species observed at individual wetland sites. Species lists can be generated by clicking on the “Species List” link provided at the bottom of the “pop-up” summary of site attributes (Figure 25), and the information can then be viewed and copied and pasted to another document, if desired.

“Level 1” and “Level 2” users may also access the following tools that are available in the site mapping tool:

- **Wetland Site Report** – a tool that provides monitoring design information, monitoring observations, and the entire matrix of IBI/IEC/SumRank scores on an individual site basis.
- **Wetland Site Photos** – a photo viewer that allows users to review CWMP-approved digital photos taken during site sampling events.
- **Wetland Site Comparison** – a tool that allows users to select a geographic area of interest on the map and then generate a matrix comparing characteristics and IBI/IEC/SumRank scores across the selected sites.

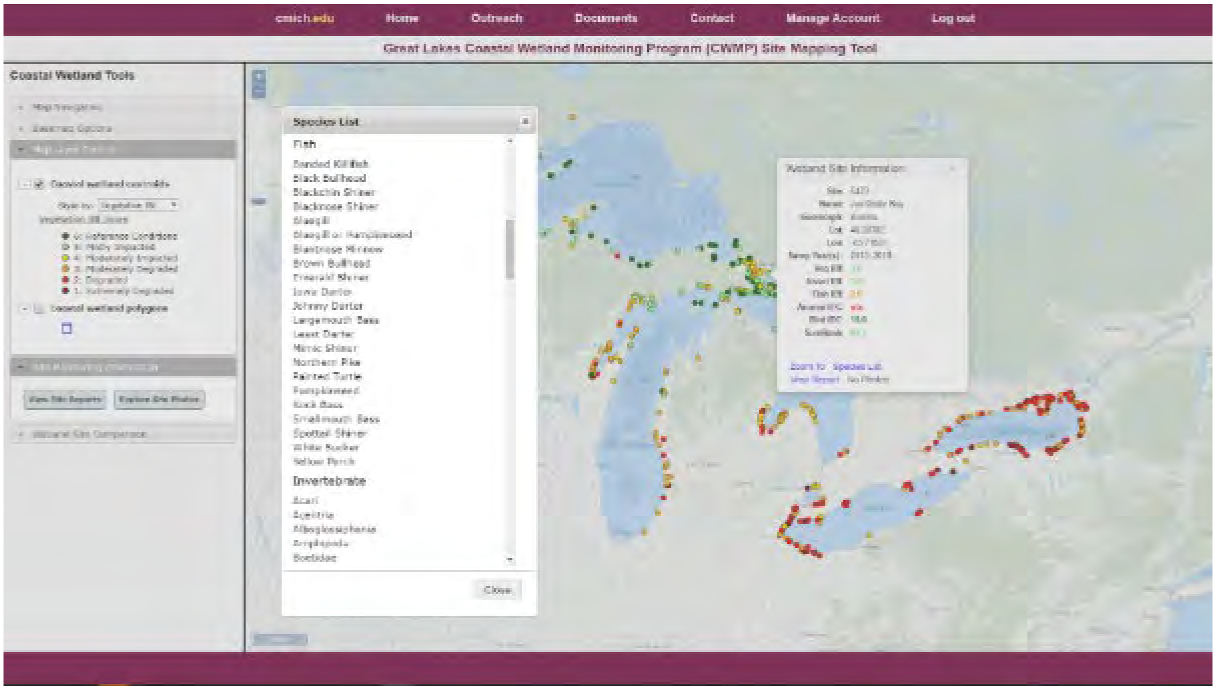


Figure 25. Coastal Wetland Mapping Tool with wetland macrophyte IBI scores and species list displayed.

OUTREACH TO MANAGERS

There have been many improvements to the website which assist external users with accessing and understanding the results, in particular the site reports and photos. Michigan Department of Environment, Great Lakes and Energy (EGLE) and Central Michigan University hosted a workshop at the Michigan Wetlands Association annual meeting in Kalamazoo on September 12, 2023. The workshop focused on data collection methodology, data access, and data applications and was attended by 22 wetland management professionals.

In 2021, EGLE hired a new Wetland Monitoring and Coastal Wetland Analyst to fill the vacancy left by Anne Garwood. In transitioning into the position, Katie Fairchild met with many of the partners of the GLCWMP. Training included virtual meetings, introduction to the website and Coastal Wetlands Decision Support Tool, and a 2-day GLCWMP field training hosted by CMU. Katie will be leading the outreach efforts for EGLE going forward, including meeting planning, webinar scheduling and facilitation, and convening PIs and restoration partners to encourage application of the monitoring data in wetland restoration projects.

EGLE has also been encouraging restoration practitioners to use the GLCWMP data in project planning, goal setting, and development of adaptive management plans through Michigan's interagency Voluntary Wetland Restoration (VWR) Program. In the past year there have been a few VWR projects undergoing regulatory review by EGLE where we requested that the practitioners identify if/how the GLCWMP data were used in planning or design of the project, and whether or not the project would be monitored as a benchmark site. Although there is still some uncertainty in how practitioners can or should use these data in project planning, there is momentum in the VWR Program to increase awareness and application of these results.

In 2019, a one-hour documentary on the CLCWMP was release on PBS. The documentary aired across the U.S. "Linking Land and Lakes: Protecting the Great Lakes' Coastal Wetlands" chronicled the work of all 15 universities and government agencies documenting our scientists collecting data to help restore and protect these ecosystems. The WCMU production team traveled the entire Great Lakes basin over 18 months covering 5,000 miles in Michigan, Wisconsin, Indiana, Illinois, New York, Ohio, Pennsylvania, and Ontario, Canada. More than 40 coastal wetland scientists shared their expertise in the documentary. This documentary aired on 275 PBS stations in 46 states, the Virgin Islands, and Washington D.C. beginning in July of 2020. It can be viewed at https://www.pbs.org/video/linking-land-and-lakes-hdo22u/

TEAM REPORTS

WESTERN BASIN BIRD/ANURAN TEAM AT THE NATURAL RESOURCES RESEARCH INSTITUTE, UNIVERSITY OF MINNESOTA DULUTH

Team Members

Dr. Annie Bracey (PI, team lead – Bird & Anuran Surveys) –permanent/year-round (returning)
Dr. Alexis Grinde (Avian Ecology Lab Director) – permanent/year-round (returning)
Josh Bednar (field tech – Anuran & Bird Surveys) – permanent/year-round (returning)
Amanda Tveite (field tech – Anuran & Bird Surveys) – Graduate Student (new)
Isabel Dunn (field tech – Anuran & Bird Surveys) – Graduate Student (new)
Josh Kolasch (field tech - Anuran & Bird Surveys) - Graduate Student (returning)

Training

Training for anuran surveys was held remotely in April 2025 and for bird surveys on 20 -28 May 2025. During the 2025 field season, three individuals conducted the anuran and bird surveys, the person who did the first round of anuran surveys has conducted surveys for this project since 2012. The other two individuals who surveyed anurans & birds on this project were new employees both of whom received a week of survey training and field safety. Training involved instructing individuals on how to conduct standardized field surveys, on basic travel procedures, and on appropriate field safety measures. Individuals were trained to proficiently complete field sheets. Rules for site verification, safety issues including caution regarding insects (e.g., Lyme's disease), GPS and compass use, boat safety, working near traffic or roadways, and record keeping were also included in field training to insure that the guidelines in the QAPP were being followed.

All individuals involved in conducting the surveys had previously taken and passed each of the following tests on 1) anuran calls, 2) bird vocalization, and 3) bird visual identification via an on-line testing system established at the University of Wisconsin, Green Bay – see http://www.birdercertification.org/GreatLakesCoastal. Training documents, including SOPs and QAQC measures , specifically related to sampling procedures are available on the program website – see https://www.greatlakeswetlands.org/Sampling-protocols.vbhtml. Training documents related to field safety were provided by NRRI and were reviewed with the PI at the time of training.

Challenges and Lessons Learned

There were no significant challenges that our team encountered this field season. Travel to and from Canada was allowed, so there were no issues with border crossing which we had experienced during Covid travel restrictions. Our primary challenge was site accessibility, whether sites were too far from one another to justify surveying (e.g., a single site >2+ hrs drive from all other sites) or island sites where access is challenging or restricted to daylight use (e.g. ferry service).

Site Visit List

In 2025, 47 wetland sites, located in the U.S. and Canada, were selected to be surveyed for birds and anurans by the western basin bird and anuran team. Although all of these sites had been surveyed at least once during the 2011-2024 project period, by at least one taxonomic group, we still needed to determine accessibility and site conditions, which may have changed during this time (e.g., changes in property ownership or water levels). A total of 13 sites were marked as 'could not access site' and two sites were listed as 'could not sample'. The majority of these situations were associated with not being able to contact land ownership or due to travel safety issues or lack of roads. Three sites were listed as visit rejects because there was poor access by road or new 'no trespassing signs' and gated off and nine sites were listed as 'web rejects' as they did not meet sampling criteria or were clearly not accessible.

A total of 20 wetlands were sampled in 2025 for anurans and 24 sites were sampled for birds by the western basin bird and anuran team. These sites were located along the south shore of Lake Superior in Minnesota, Wisconsin, and in the upper peninsula of Michigan and on the eastern shoreline in Canada and along northern Lake Huron. Of these sites, seven were designated as benchmark sites, many located within the St. Louis River in the Duluth-Superior Harbor. Three sites were designated a panel re-sample sites. The remaining sites surveyed were regular panel-year sites. Anuran surveys began April 05 and bird surveys began May,28 2025. Anuran and bird sampling were both completed by July 03, 2025.

Panel Survey Results

The data collected in 2025 by the western basin bird and anuran team were entered and error checked into the online data entry system and completed in September 2025.

Anurans: In 2025, eight species of anurans were recorded throughout our study sites, with 426 individuals and 83 full choruses counted (Table 1). The average number of species detected per wetland was four, with a minimum of two and a maximum of seven. Spring peepers were the most abundant species detected in all wetlands sampled, accounting for 41% of the anuran observations and the majority of full chorus observations (Table 16). There were also large numbers of Green frog and Gray treefrog detections (Table 16). There were 14 Chorus Frog detections, which was higher than the previous two years. There were 22 Mink Frog detections which was similar to 2024.

Table 16**.** List of anurans recorded during 2054 surveys. The number of individuals counted and the number of full choruses observed (i.e., number of individuals cannot be estimated) are provided for each species.

Species	**Number of Individuals**	**Number of Observations (Full Chorus)**
American toad (*Anaxyrus americanus*)	69	2
Blanchard's cricket frog (*Acris blanchardi*)	0	0
Bullfrog (*Lithobates catesbeianus)*	0	0
Chorus frog (western/ boreal – ***Pseudoacris triseriata & P.maculatas***)	14	0
Green frog (*Lithobates clamitans*)	33	0
Gray treefrog (***Hyla versicolor***)	54	12
Mink frog (*Lithobates septentrionalis*)	22	0
Northern leopard frog (***Lithobates pipiens***)	40	4
Spring peeper (***Pseudoacris crucifer***)	175	61
Wood frog (***Lithobates sylvatica***)	19	4
Total	**426**	**83**

Birds: Birds were surveyed twice at each site between May 28 and July 03, 2025. A total of 90 identifiable species observations and 3,092 individual birds were recorded. The five most abundant species observed accounted for approximately 47% of all observations. These species, in order of decreasing abundance, were Ring-billed Gull, Red-winged Blackbird, Canada Goose, Yellow Warbler, and Song Sparrow.

Interesting bird observations: In the Western Great Lakes region there have been many observations of birds of special concern in the vicinity of the wetlands or using the wetland complexes in 2025 (Table 17). There were relatively low numbers of detections for both Virginia and Sora rails which seem to be consistent with lower observations in recent years.

Figure 26. NRRI field crew conducting bird training day in the St. Louis River Estuary, Duluth, MN.

Table 17. List of birds of special interest recorded during 2025 surveys. The number of individuals observed is listed for each species.

Species	Number of Individuals
Sandhill Crane (*Grus canadensis*)	25
Pied-billed Grebe (*Podiymbus podiceps*)	0
American Bittern (*Botaurus lentiginosus*)	0
Virginia Rail (*Rallus limicola*)	1
Bald Eagle (*Haliaeetus leucocephalus*)	14
Common Loon (*Gavia immer*)	11
Sora Rail (*Porzana carolina*)	2
Great Blue Heron (*Ardea herodias*)	5
Green Heron (*Butorides virescens*)	0
Belted Kingfisher (*Megaceryle alcyon*)	5

Wetland Condition Observations and Results

The western basin bird and anuran team does not have any noteworthy observations to report regarding wetland condition of sites sampled in 2025.

Data Processing

All bird, anuran, and point-count level vegetation surveys have been electronically scanned and digitally stored as .pdfs at NRRI. Data entry and QAQC were completed by the end of September 2025. All of the GPS coordinates associated with 2025 field sampling have been uploaded to the CWMP database. The physical data sheets from the point-count level vegetation surveys will be mailed to Doug Tozer at Bird Studies Canada for processing by November 2025.

Mid-season QC Check Findings

In-person mid-season QC checks were conducted to ensure protocols were being followed. The surveyors also reported to the PI daily during fieldwork. Surveyors also took pictures of sites where habitat was suspected to be inappropriate. These photos were then sent to the PI to verify whether the sites in question met sampling criteria or not. Surveyors also described general field conditions and any issues associated with accessing sites. Data sheets were scanned and sent to the PI periodically throughout the field season to identify any potential issues with an individual's data collection methods. Surveyors were able to effectively communicate with the PI throughout the field season and therefore there were no QC issues that arose or needed to be addressed.

Additional Funding and Projects

Nothing to report

Other Collaboration Activities

Nothing to report

Other Data Requests

No data requests have occurred since the previous semi-annual report.

Related Student Research

Isabel Dunn, a graduate student in the Water Resources Program at U of MN-Duluth will be using the coastal wetland monitoring program bird data for her master's thesis which will look at species functional traits, community composition, and associated habitat characteristics as it related to remediation and restoration activities in AOC sites across the Great Lakes region.

WESTERN BASIN FISH, INVERTEBRATE AND WATER QUALITY TEAM AT THE NATURAL RESOURCES RESEARCH INSTITUTE, UNIVERSITY OF MINNESOTA DULUTH

Team Members

- Dr. Valerie Brady, PI, aquatic invertebrate ecologist, QC manager (since 2011)
- Dr. Chris Filstrup, co-PI, limnologist (since 2019)
- Kristi Nixon, GIS specialist (since 2016)
- Kari Pierce, crew leader, fish, invertebrate, and water quality sampling (since 2014)
- Bob Hell, aquatic invertebrate taxonomist (since 2011)
- Holly Wellard Kelly, aquatic invertebrate taxonomist (since 2015)
- Dr. Amber Ulseth, aquatic ecosystem ecologist (since 2024)
- Paul Jeffrey, permanent field and lab crew member (since 2022)
- Brennan Pederson, permanent field and lab crew member (since 2023)
- Three summer field techs, all returning from summers 2023 and 2024

Training

The NRRI fish/invert/WQ team held in-person safety and classroom project training from June 3-6, 2025. Classroom training was attended by all NRRI fish/invert/WQ staff (9 participants). Classroom training material was presented by permanent staff who have been working on the Coastal Wetland Monitoring Program for >5 years. Topics covered were: field safety from environmental hazards, safe boating practices, approved scientific collection permits and responsibilities of the field teams to give prior notification to local fisheries managers and conservation officers before collecting fish from a wetland, Coastal Wetland Monitoring Program overview and introduction to Standard Operating Procedures and datasheets, GPS use and annual QC check, uploading GPS files to the program website, fish collection methods and identification, proper euthanasia and preservation methods for retained fish, water quality data and sample collection, post-collection processing of water samples (filtration and titration), daily calibration of water quality multiparameter instruments, invertebrate collection and field picking of samples, vegetation identification and habitat quadrats. After classroom safety and method training was completed, we provided hands-on training for new summer technicians during their first site visit in Green Bay, WI (June 20–23, 2024). The hands-on field safety and method training in Green Bay, WI was led by experienced crew chief Bob Hell and crew leader Holly Wellard Kelly who have worked on CWMP for more than 10 years. During hands-on training the experienced NRRI crew chiefs guided summer technicians (n=3) on fish identification (with real fish rather than pictures), how to determine vegetation zones, vegetation identification, setting and pulling fyke nets, and which invertebrates to pick from trays (e.g., don't pick terrestrial insects, spiders, or large zooplankton).

Challenges and Lessons Learned

The 2025 field season was, for the most part, a normal season. We only had to drop three sites upon visiting them as they did not meet project protocols due to low water levels or lack of vegetation. Most sites appear to be recovering from past low water years, although some look different than they have historically because vegetation zones have changed in size or presence.

This season, our primary boat had some maintenance challenges, with a replacement of the lower unit and persistent failure of the trim/tilt motor. While the lower unit was successfully replaced, reoccurring failures with the motor's trim/tilt persisted after its initial service and the boat is now scheduled for a follow up repair.

One positive lesson learned this season was that we can transport a trailered boat on the ferry that goes to Washington Island from the Door Peninsula. This discovery allowed us to sample our Washington Island/Detroit Island site on a windy day this year, eliminating dependency on calm weather, and will give us more flexibility to sample Washington Island sites in the future.

Site Visit List

The NRRI fish/invert/WQ team was originally assigned 28 sites in 2025. We dropped two indigenous native nation sites (Red Cliff Nation and Bad River Nation) because we were not able to obtain access permissions. PI Valerie Brady then added two more sites (n=28). Mud Lake in Duluth, MN was added as a Benchmark site as restoration is set to occur here next year and Hurkett Cove near Thunder Bay, ON was added after we received a request to sample this site from Jessie McFadden with the Lakehead Region Conservation Authority. Three sites were dropped upon visiting the sites due to not meeting sampling protocols. Therefore, 25 sites were sampled in total. There were 18 regular sites, 4 resample sites, 3 pre-sample sites, and 5 benchmark sites of the 30 total sites:

- 1079 (Hog Island Area Wetland): BENCHMARK; sampled fish, inverts, and water quality.
- 1201 (Clough Island Wetland #3): BENCHMARK; sampled fish, inverts, and water quality.
- 7063 (Spirit Lake): BENCHMARK; sampled fish, inverts, and water quality.
- 7064 (Mud Lake): BENCHMARK; sampled fish, inverts, and water quality. PI Valerie Brady added this site to this year as it was requested for pre-restoration sampling. Restoration planned for 2026.
- 1194 (Gouge Park Pickle Ponds): BENCHMARK; sampled fish, inverts, and water quality.

- 1069 (Lost Creek Wetland): regular panel re-sample site, sampled fish, inverts, and water quality.
- 1436 (Little Sturgeon Bay Wetland #2): regular panel re-sample site, did not sample due to no sampleable vegetation zones present.
- 1068 (Bark Bay Wetland): regular panel re-sample site; sampled inverts and water quality.
- 1114 (Paradise Beach Wetland #1): regular panel re-sample site; sampled inverts and water quality.
- 5173 (Chippewa Marsh): regular panel pre-sample site; sampled fish, inverts, and water quality.
- 1188 (Pikes Creek Wetland): regular panel pre-sample site; sampled inverts and water quality.
- 5673 (Nipigon River Marshes): regular panel pre-sample site; sampled fish, inverts, and water quality.
- 1680 (Rowleys Bay Area Wetland): regular panel site; sampled fish, inverts, and water quality.
- 1486 (Portage Marsh): regular panel site; sampled fish, inverts, and water quality.
- 1701 (Peshtigo Point Wetland): regular panel site; sampled inverts and water quality.
- 1402 (Detroit Island Wetland): regular panel site; sampled inverts and water quality.
- 1379 (Kewaunee River Wetland #2): regular panel site; did not sample due to very shallow water levels and no sampleable vegetation zones present.
- 1720 (Little Bay de Noc Wetland): regular panel site; sampled fish, inverts, and water quality.
- 974 (Sand Point Wetland): regular panel site; sampled inverts and water quality.
- 5209 (Cranberry Bay): regular panel site; sampled fish, inverts, and water quality.
- 1449 (Peters Marsh): regular panel site; sampled fish, inverts, and water quality.
- 1196 (St. Louis Bay Area Wetland #2): regular panel site; sampled fish, inverts, and water quality.
- 1492 (Mino-kwe Point Wetland): regular panel site; sampled fish, inverts, and water quality.
- 1702 (Little River Wetland): regular panel site; did not sample due to very shallow water levels and no sampleable vegetation zones present.
- 1727 (Schaawe Lake Area Wetland #1): regular panel site; sampled fish, inverts, and water quality.
- 1035 (Chequamegon Wetland #2): regular panel site; did not sample due to not being able to get access permissions from the Band River Tribal Nation.
- 1459 (Little Tail Point Wetland #1): regular panel site; sampled fish, inverts, and water quality.

- 1513 (Ogontz Bay Wetland #2): regular panel site; sampled fish, inverts, and water quality.
- 1189 (Red Cliffs Bay Wetland): regular panel site; did not sample due to not being able to get access permission from the Red Cliff Tribal Nation.
- 5445 (Hurkett Cove): regular panel site; sampled fish, inverts, and water quality.

Panel Survey Results

Regular Panel Sites:

1069 – First sampled on 7-19-2014 by NRRI team. We re-sampled this site this year with the last visit on 7-26-2025 and sampled SAV for fish, invertebrates, and water quality, as well as Lily for invertebrates and water quality. Crew leader Brennan Pederson noted that the entrance to the site was almost covered by a sand bar this year, with water levels at the mouth of Lost Creek being 0.5 m or less. The crew was not able to get our big Jon boat into the site like we did in 2024 and had to use hand-carry boats instead. Nets at this site (n=3) captured Pumpkinseed, Northern Pike, Bluntnose Minnow, Golden Shiner, Bluegill, Black Bullhead, Rock Bass, Yellow Perch, Spottail Shiner, Blacknose Shiner, and Brown Bullhead. There were 8 Painted Turtles, 1 Common Snapping Turtle, and 10 Native Crayfish as bycatch in fyke nets.

1436 – First sampled on 6-30-2014 by NRRI team. We re-sampled this site this year with the last visit on 6-21-2025. During this year's visit crew leader Paul Jeffrey noted that the wetland at this site no longer exists and that there was no sampleable vegetation present. The crew did not sample this site this year. When this site was visited in 2024, it was also not sampled due to lack of vegetation along with very shallow water depths.

1068 – First sampled on 7-18-2014 by NRRI team. We re-sampled this site this year with the last visit on 7-24-2025 and sampled SAV for invertebrates and water quality. Crew leader Brennan Pederson noted that the bottom substrate at this site was very mucky with no discernible bottom and that water levels were deep, therefore no fyke nets were set at this site. The crew that visited this site in 2024 reached the same conclusion.

1114 – First sampled on 8-5-2024 by NRRI team. We re-sampled this site this year with the last visit on 7-29-2025 and sampled SAV for invertebrates and water quality. Crew leader Bob Hell noted that this site was a hike-in only site as there is no boat access from the lake and it is a 15 minute hike down the beach from the only parking spot. He also noted that the SAV patches sampled were too small to set fyke nets. When the crew visited this site in 2024 this was also the same conclusion that was reached.

5173 – First sampled on 8-15-2013 by NRRI team. This site has not been sampled since 2013 because we were unable to access it in 2020 when the Canadian Border was closed due to COVID-19. The site is also located on Fort Williams First Nation Reservation and special permission is required prior to sampling. This visit started on 8-12-2025 and we sampled SAV and Lily zones for water quality, invertebrates, and fish. The site was accessed by foot from Chippewa Park and RV campground as no suitable boat launches were available within a reasonable boating distance and shallow water limited accessibility. Small hand launched boats were used in 2013 but not necessary for this visit as sampleable zones were within walking distance from shore. Crew leader Brennan Pederson noted that the campground employees were very kind and accommodating for the crew's request for access. Nets at this site (n=6) captured Yellow Perch, Central Mudminnow, and Northern Pike. Invasive fish captured were Eurasian Ruffe (n=2). 5 Native Crayfish, 1 Leopard Frog and 3 Painted Turtles were captured as bycatch in the fyke nets.

1188 – First sampled on 7-31-2015 by NRRI team. The site was sampled this year on 7-25-2025. A SAV zone was sampled for invertebrates and water quality, no nets were set due to limited size of SAV patches. Fish have only been sampled at this location once in 2016. Crew leader Brennan Pederson noted that there is limited vegetation and 75% of the site is sand beach. There is also a marina located within this site polygon and locals mentioned that dredging of the channel occurs every year.

5673 – First sampled on 8-16-2013 by NRRI team. This site has not been sampled since 2013 because we were unable to access it in 2020 when the Canadian Border was closed due to COVID-19. We sampled this year on 8-8-2025 for fish, water quality, and invertebrates in an Outer/Sparse Bulrush zone, as well as water quality and invertebrates in a Typha zone. Nets at this site (n=3) captured White sucker, Mottled Sculpin, Spottail Shiner, Trout Perch, Yellow Perch, and Brook Stickleback. Invasive fish captured were Threespine Stickleback (n=255). 9 Native Crayfish and 1 Painted Turtle were also captured as bycatch in the fyke nets.

1680 – First sampled on 6-27-2015 by NRRI team. This site has not been sampled since 2015 because complications due to COVID-19 prevented the site visit in 2020. This year on 6-21-2025 we sampled Outer/Sparse Bulrush for water quality, invertebrates, and fish. The site is managed by The Nature Conservancy (TNC) and a special permit/permission is required prior to sampling. Crew leader Paul Jeffrey noted that there is an active eagle's nest near the site and TNC requested us to keep 660’ distance from it while sampling. Nets at this site (n=3) captured Rock Bass, Brown Bullhead, and Smallmouth Bass. Invasive fish captured were Threespine Stickleback (n=1), Round Goby (n=165) and Alewife (n=21). 7 Native Crayfish were also captured as bycatch in the fyke nets.

1486 – First sampled on 7-18-2015 by NRRI team. The site was sampled this year on 7-11-2025. SAV, Typha, and Outer/Sparse Bulrush were all sampled for water quality, invertebrates, and fish. The site is accessible by boat but crew leader Paul Jeffrey noted that there is a large sand flat in front of the site that is 1 meter or less in depth, so caution is needed when approaching the site. Nets at this site (n=9) captured Bowfin, Rock Bass, Yellow Perch, Largemouth Bass, Emerald Shiner, YOY Gar species, Northern Pike, Golden Shiner, Pumpkinseed Sunfish, Bluegill, Common Shiner, Smallmouth Bass, and Green Sunfish. Round Goby (n=7) was the only invasive fish captured at this site. 5 Painted Turtles and 2 tadpoles were also captured as bycatch in the fyke nets.

1701 – First sampled on 7-22-2015 by NRRI team. The site was sampled this year on 6-24-2025. SAV was sampled for water quality and invertebrates. Crew leader Paul Jeffrey noted that there is a large sand flat 1 meter deep or less that extends out from the site approximately 200 to 300 meters but is accessible by boat. During site visit, overnight strong storms and wind deposited sand on the western side of Lake Michigan. The site has limited vegetation presumably due to exposure to the open water of Lake Michigan.

1402 – First sampled on 6-25-2015 by NRRI team. This site has not been sampled since 2015 as complications due to COVID-19 prevented the site visit in 2020. We sampled this site on 6-22-2025. This site is located on Washington Island, just off of the tip of the Door County Peninsula. A ferry was taken to the island that allowed both truck and boat trailer combinations on board for a fee of $111.00. There is a free boat launch right next to the ferry drop off which was used for this visit. Otherwise it's a several mile boat ride across open water from the mainland to reach this location. Outer/Sparse Bulrush was sampled for water quality and invertebrates. Due to the logistical constraints and cost of visiting this site via ferry, no fyke nets were set during this visit. The sampleable vegetation at this site has also shifted from the original visit in 2015 and it now lies just outside of the polygon drawn for this site. Field crew leader Holly Wellard-Kelly noted the vegetation shift and requested a new polygon be drawn for this site that extends to include the area of sampleable Bulrush. Egrets, Eastern Newts (n=50 or more) and Sandhill Cranes spotted while sampling at this location.

1379 – First sampled on 6-28-2015 by NRRI team. This site has not been sampled since 2015 as complications due to COVID-19 prevented the site visit in 2020. We visited this site on 6-21-2025. No sampleable zones were identified while scouting this location, the water levels were too low. Crew leaders Bob Hell and Holly Wellard-Kelly noted that Typha was abundant but too narrow and shallow to sample for fish or bugs. Some SAV present but not enough to sample. Water was slightly turbid and the presence of carp may impact the growth of SAV. US Fish and

Wildlife officials were present at the boat launch and they commented that the water has been low.

1720 – First sampled on 7-16-2015 by NRRI team. We sampled this site on 7-12-2025. Lily, Outer/Sparse Bulrush and Typha were all sampled for water quality, invertebrates, and fish. Nets at this site (n=9) captured Northern Pike, YOY Bullhead species, Yellow Perch, Largemouth Bass, Johnny Darter, Smallmouth Bass, Emerald Shiner, Pumpkinseed, Bluegill, YOY Lepomis species, Rock Bass, Brown Bullhead, Smallmouth Bass, Golden Shiner, White Sucker, Blackchin Shiner, Iowa Darter, and Bowfin. Invasive fish captured included Common Carp (n=2) and Round Goby (n=1). 29 Painted Turtles and 1 Native Crayfish were also captured as bycatch in the fyke nets.

974 – First sampled on 7-29-2015 by NRRI team. This year the site was sampled on 7-21-2025 for water quality and invertebrates in an SAV zone. This site is located on Keweenaw Bay Indian Community land. Special permission prior to sampling is required. Erin Johnston was our contact and was very helpful and informative during our visit. Wild Rice has been seeded and growing since the most recent visit in 2021 and these areas were avoided during our visit. Sampling was done from an inflatable raft using oars as no motors are allowed at this location. There is a small dirt canoe launch that was used for accessing the site. SAV patches without Wild Rice were sampled from the raft and no fyke nets were set to avoid disturbing potential Wild Rice seed beds.

5209 – First sampled 8-10-2016 by Environment Canada team. The site was sampled this year on 8-10-2025 by the NRRI team. The site was accessed via boat from a primitive concrete launch. Typha, Outer/Sparse Bulrush and Arrowhead were all sampled for water quality, invertebrates, and fish. Crew leader Brennan Pederson noted strong onshore wind and seiche during this visit. Nets at this site (n=9) captured Yellow Perch, Northern Pike, Smallmouth Bass, White Sucker, Emerald Shiner, Logperch, Johnny Darter, Central Mudminnow, Blacknose Shiner, Silver Redhorse, and Walleye. Invasive fish sampled were Eurasian Ruffe (n=269) and Common Carp (n=17). 20 Native Crayfish were captured in the nets as bycatch.

1449 – First sampled 6-25-2015 by NRRI team. We sampled this year on 6-21-2025 and accessed the site via boat from the Deerfield/Lineville road launch. The site is in a shallow area protected by an artificial barrier from the open water portion of Green Bay. Field crew leader Bob Hell noted very strong onshore winds creating turbid water and limiting access to potential zones. Typha and SAV were sampled for water quality, invertebrates, and fish. Nets at this site (n=6) captured Banded Killifish, Hybrid Gar, Golden Shiner, Pumpkinseed, Yellow Perch, Bluegill, White Sucker, Bowfin, Largemouth Bass, Northern Pike, Freshwater Drum, Channel Catfish, Emerald Shiner, Walleye, Black Bullhead, and Bigmouth Buffalo. Invasive fish sampled include Common Carp (n=11), Alewife (n=1), Round Goby (n=2), Gizzard Shad (n=18), and White Perch (n=50). 1 Painted Turtle, 1 Native Crayfish, and 1 Bullfrog were captured as bycatch.

1196 – First sampled 8-12-2015 by NRRI team. We sampled this year on 9-3-2025 and accessed the site via boat from Billings Park boat launch in Superior WI. SAV was sampled for water quality, invertebrates, and fish while Lily was sampled for water quality and invertebrates. Typha also present but low water levels limited sampleable areas within the vegetation. Crew leader Bob Hell noted that the SAV zone was on the margin of the wetland polygon drawn for this site. Commercial refuse (iron scraps) located along train tracks/riprap portion of the site. Nets set at this site (n=3). One did not fish properly as something chewed a large hole in the cod end of the net under the water line, fish captured in this net were not included in the results. Fish captured here were Black Crappie, Yellow Perch, YOY Lepomis species, Tadpole Madtom, Pumpkinseed, Rock Bass, Walleye, Silver Redhorse, Yellow Bullhead, Spottail Shiner, Johnny Darter, and Brook Silverside. Invasive fish sampled were Eurasian Ruffe (n=4), Round Goby (n=24) and Tubenose Goby (n=7). 2 Painted Turtles captured as bycatch in the fyke nets.

1492 – First sampled on 7-26-2015 by NRRI team. We re-sampled this year on 7-14-25 and 7-18-2025. Sampling was broken into two visits due to boat motor issues on 7-14. Typha, Phragmites, and Outer/Sparse Bulrush were all sampled for water quality, invertebrates, and fish. There is a large sand flat 1m or less deep present for about 150m out from the vegetation zones. Nets set at this site (n=9) captured Common Shiner, Banded Killifish, Rock Bass, Yellow Perch, Smallmouth Bass, Golden Shiner, YOY Gar Species, Black Bullhead, Spottail Shiner, White Sucker, and Bowfin. Invasive fish captured were Round Goby (n=81). 6 Painted turtles captured as bycatch in the fyke nets.

Figure 27. An invasive White Perch (Morone americana) captured in the St. Louis River Estuary near Spirit Lake in Duluth, MN. Though not necessarily rare, it is uncommon for the NRRI team to capture an adult of this species in this location.

1702 – First sampled on 7-20-2015 by NRRI team. This year we were not able to sample this site due to large amounts of sand piled up on the western side of the bay making access to the site difficult. We think this was from storms with high winds pushing sand onshore. The water levels in the site were 0.5 m or less and therefore the entire site was not sampleable or navigable.

1727 – First sampled on 7-17-2015 by NRRI team. Last visit on 7-19-2025 and sampled Typha and Outer/Sparse Bulrush for fish, invertebrates, and water quality. Crew leader Bob Hell noted that there were some small patches of Phragmites present at this site, but not large enough to sample. Nets at this site (n=6) captured Rock Bass, Yellow Perch, Largemouth Bass, Smallmouth Bass, White Sucker, Brown Bullhead, Common Shiner, Bluegill, Pumpkinseed, Bowfin, Bluntnose Minnow, and Black Bullhead. Invasive fish captured were Round Goby (n=35). There were 5 Painted Turtles as bycatch in fyke nets.

1035 – First sampled on 8-10-2015 by NRRI team. This site is on Bad River Band of Lake Superior Chippewa land. We were not able to obtain necessary permissions to sample this site this year.

1459 – First sampled on 6-26-2015 by NRRI team. Last visit on 6-22-2025 and sampled SAV and Typha for fish, invertebrates, water quality. Nets at this site (n=6) captured Bowfin, Yellow Perch, Pumpkinseed, Black Bullhead, Bluegill, Banded Killifish, Brown Bullhead, Hybrid Gar, Golden Shiner, Green Sunfish, White Sucker, Largemouth Bass, Blacknose Shiner, Walleye, and Yellow Bullhead. Invasive fish captured were Common Carp (n=15). There were 13 Painted Turtles, 2 Native Crayfish, and 3 Common Snapping Turtles captured as bycatch in the fyke nets.

1513 – First sampled on 7-15-2015 by NRRI team. Last visit on 7-17-2025 and sampled SAV and Sparse/Outer Bulrush for fish, invertebrates, and water quality. Crew leader Bob Hell noted that there were low water levels this year leaving parts of the shoreline with little vegetation. Also noted was that there was sampleable Typha present, but just outside the site borders into an adjacent site. Nets at this site (n=6) captured Longnose Gar, Yellow Perch, Pumpkinseed, Bluegill, Smallmouth Bass, Banded Killifish, Common Shiner, Black Bullhead, Johnny Darter, Golden Shiner, Bowfin, Rock Bass, Blacknose Shiner, Brown Bullhead, Blackchin Shiner, Bluntnose Minnow, Spottail Shiner, and White Sucker. Invasive fish captured were Round Goby (n=118). There were 4 Painted Turtles, 2 Native Crayfish, and 1 Common Snapping Turtle captured as bycatch in the fyke nets.

1189 – This site has never been sampled by the fish/bug NRRI team in the past, but has been sampled by the bird/amphibian NRRI team. This site is on the Red Cliff Band of Lake Superior Chippewa land. We were not able to obtain necessary permissions to sample this site this year.

<u>Benchmark sites</u>

1079 – First sampled on 8-6-2015 by NRRI team. Last visit on 9-10-2025 and sampled Lily for fish, invertebrates, and water quality, as well as Typha for invertebrates and water quality. Crew leader Kari Pierce noted that large logs inundated the Typha zone, which became dry quickly, preventing the crew from setting nets. Nets at this site (n=3) captured Black Crappie, Rock Bass, Yellow Perch, Bluegill, Pumpkinseed, Black Bullhead, Golden Shiner, Tadpole Madtom, Spottail Shiner, and Johnny Darter. Invasive fish captured were Tubenose Goby (n=44) and YOY Common Carp (n=2). Invasive Crayfish captured were Rusty Crayfish (n=1). There were 11 Painted Turtles as bycatch in fyke nets.

1201 – First sampled on 8-22-2013 by NRRI team. Last visit on 9-2-2025 and sampled SAV for fish, invertebrates, and water quality, as well as Typha and Dense Bulrush for invertebrates and water quality. Crew leader Bob Hell noted that the Typha zone was too narrow and shallow, and the Dense Bulrush was too narrow to set fyke nets. Nets at this site (n=3) captured Yellow Bullhead, Black Crappie, Yellow Perch, Bluegill, Pumpkinseed, Johnny Darter, Walleye, Largemouth Bass, Golden Shiner, White Sucker, Silver Redhorse, and Tadpole Madtom. Invasive fish captured were Round Goby (n=18), Tubenose Goby (n=6), Common Carp (n=2), and Eurasian Ruffe (n=2). There were 8 Painted Turtles as bycatch in fyke nets.

7063 – First sampled on 8-17-2015 by NRRI team. Last visit on 8-26-2025 and sampled SAV and Lily for fish, invertebrates, and water quality. Crew leader Bob Hell noted a large SAV patch within Spirit Lake proper that was about 1-2 m deep and therefore not suitable for setting fyke nets. The crew did however find suitable SAV depths closer to "Kilchlis Meadows" which are small shallow areas/islands separating the main boating channel from Spirit Lake. The Lily zone sampled was on the East side of the meadows just outside of the polygon, PI Valerie Brady approved sampling this zone. Nets at this site (n=6) captured Rock Bass, Pumpkinseed, Black Crappie, Logperch, Yellow Perch, White Sucker, Golden Shiner, Spottail Shiner, Bluegill, Johnny Darter, Tadpole Madtom, Silver Redhorse, Walleye, Smallmouth Bass, and Shorthead Redhorse. Invasive fish captured were Tubenose Goby (n=25), Eurasian Ruffe (n=6), Round Goby (n=99), Common Carp (n=2), and White Perch (n=2). There was 1 Painted Turtle as bycatch in fyke nets.

7064 – First sampled on 8-18-2015 by NRRI team. Last visit on 8-25-2025 and sampled SAV for fish, invertebrates, and water quality, as well as Typha and Lily for invertebrates and water quality. Crew leader Kari Pierce noted the Typha zone became dry only about 1 m into the zone and therefore was not wide enough to fit fyke nets. Also noted was that the Lily zone patches were not large enough to fit fyke nets. Nets at this site (n=3) captured White Sucker, Brown Bullhead, Rock Bass, Pumpkinseed, Black Crappie, Yellow Perch, Bluegill, Spottail Shiner, Tadpole Madtom, Johnny Darter, Silver Redhorse, Black Bullhead, Golden Shiner, and Northern Pike. Invasive fish captured were Tubenose Goby (n=19), and Common Carp YOY (n=1). There was 1 Painted Turtle as bycatch in fyke nets.

1194 – First sampled on 8-18-2016 by NRRI team. Last visit on 9-8-2025 and sampled SAV for fish, invertebrates, and water quality. Crew leader Bob Hell noted recent restoration that occurred in either 2023 or 2024 has opened this site up to the main portion of the estuary by adding two navigable connections that were not at this site previously. It also appears that this site was dredged during the restoration creating much deeper depths as well as removal of a thin band of Typha that was the location of previous sampling efforts by the NRRI team. Nets at this site (n=3) captured Black Bullhead, Pumpkinseed, Spottail Shiner, Bluegill, Johnny Darter, Fathead Minnow, Tadpole Madtom, Brook Stickleback, Rock Bass, Smallmouth Bass, Yellow Bullhead, Northern Pike, Yellow Perch, Golden Shiner, Black Crappie, and Logperch. Invasive fish captured were Common Carp (n=3), Round Goby (n=17), and Tubenose Goby (n=4). There were 13 Painted Turtles as bycatch in fyke nets.

Figure 28. A rare catch of a "Mirror Carp", a mutation of Common Carp (*Cyprinus carpio*), that leaves the fish with little or no scales. The NRRI team captured this fish near Escanaba, MI (CWMP Site 1720).

Extra Sites and Data

5445 – This site has never been sampled by the fish/bug NRRI team in the past, but has been sampled by the bird/amphibian NRRI team. Jessie McFadden with Lakehead Region Conservation Authority requested that we sample this site since we were already in the area and because it is of interest to many Canadian agencies. PI Valerie Brady added this site for us to sample in response to that request. We were told that there is invasive cattail at this site that was planned to be removed and Wild Rice seeding occurs at this site. We visited this site on 8-11-2025 and sampled Typha for fish, invertebrates, and water quality, as well as Sparse/Outer Bulrush and SAV for invertebrates and water quality. Crew Leader Brennan Pederson noted that the boat launch used for this site, which is near to the site, was very popular with recreationalists at the time of the visit. Nets at this site (n=3) captured Northern Pike, Yellow Perch, Smallmouth Bass, and Blacknose Shiner. Invasive fish captured were Common Carp YOY (n=1) and Eurasian Ruffe (n=1). There were 3 Painted Turtles and 15 Native Crayfish captured as bycatch in the fyke nets.

Extra Data: There was no extra data collected this year.

Wetland Condition Observations and Results

This summer it appeared that some of the water levels were higher than last year, especially in Lake Michigan, as we were able to sample more sites and zones. However, in Lake Michigan near Green Bay, WI it appeared that some of the wetlands had not yet recovered from the low water years and had little vegetation. Some of the sites on the western side of Lake Michigan had accumulated sand, making them very shallow. The sites sampled near Escanaba, MI were mostly multiple zone sites with water depths ideal for setting fyke nets. The Lake Superior sites were also mostly multiple zone sites with average water depths and ample vegetation.

Data Processing

As of September 2025, the NRRI fish/invert/WQ team has stored invertebrate samples from 25 sites (49 zones x 3 = 147 samples) and will start processing them in 6-8 weeks. Staff have digitized field datasheets and begun entering field data into the CWMP database.

Mid-season QC Check Findings

Primary long-time crew leaders Kari Pierce, Bob Hell, and Holly Wellard-Kelly administered mid-season QC check of fish identification with crew members. In 2025, the NRRI fish/invert/WQ team surveyed sites as one 3-person crew or two 4-person crews. New crew members were always working directly with experienced crew members, so the training and evaluation of new crew members was continuous. No issues were noted.

Audit and QC Report and Findings

None. QC of invertebrate samples between team labs has not occurred yet.

Additional Funding and Projects

None.

Other Collaboration Activities

PI Brady continues to collaborate with MPCA, MNDNR, and WDNR on restoration planning and evaluation for sites in the St. Louis River Estuary.

Other Data Requests

None.

Related Student Research

None.

Team Name: Western Basin Vegetation Team at University of Wisconsin-Superior

Team Members

- Dr. Nicholas Danz, PI, wetland plant ecologist (15 years since 2011)
- Ryne Rutherford, co-crew leader, botanist (12 years since 2014)
- August Camp, botanist (3 years since 2023)

Training

This year long-time crew-leader Rutherford took on surveying all the sites in the western basin team and was assisted by botanist August Camp in these efforts. Rutherford and Camp surveyed all sites together. Rutherford provided training to Camp consistent with the project SOP. In all field work, Rutherford and Camp were paired to ensure sampling protocols were followed correctly, and to assist identifying vegetation to species level.

Challenges and Lessons Learned

The field season was routine this past year, with water levels about average allowing sites to be easily accessible and no problems encountered during field surveys.

Site Visit List

The UWS vegetation team visited 26 sites in 2025.

site	name	site	name
974	Sand Point Wetland	1459	Little Tail Point Wetland #1
1068	Bark Bay Wetland	1486	Portage Marsh
1069	Lost Creek Wetland	1492	Squaw Point Wetland
1079	BENCHMARK:Hog Island Area Wetland	1513	Ogontz Bay Wetland #2
1114	Paradise Beach Wetland #1	1680	Rowleys Bay Area Wetland
1188	Pikes Creek Wetland	1701	Peshtigo Point Wetland
1194	BENCHMARK:Gouge Park Pickle Ponds	1702	Little River Wetland
1196	St. Louis Bay Area Wetland #2	1720	Little Bay de Noc Wetland
1201	Clough Island Wetland #3	1727	Schaawe Lake Area Wetland #1
1379	Kewaunee River Wetland #2	5173	Chippewa Marsh
1402	Detroit Island Wetland	5673	Nipigon River Marshes
1436	Little Sturgeon Bay Wetland #2	7063	BENCHMARK:Spirit Lake

1449	Peters Marsh	7064	BENCHMARK: Mud Lake

Panel Survey Results

N/A

Extra Sites and Data

N/A

Wetland Condition Observations and Results

Anecdotally, we observed apparent lower species richness this year in wet meadow and emergent zones across Lake Michigan wetlands. We hypothesize this may be due to a decline in ruderal, or disturbance-prone species, as water levels have stabilized over the past several years as well as the failure of some species to recover from previous high water levels. We did not observe this same pattern across Lake Superior wetlands. We will complete data analysis in the coming year to test these patterns. We did not find any notable rare species this field season. Notably, we observed *Ranunculus reptans* for this first time on the project, in Nipigon, ONT.

Data Processing

All vegetation data have been entered into the CWM database. QC checks were completed by Ryne Rutherford in Fall 2025.

Mid-season QC Check Findings

Nothing to report.

Audit and QC Report and Findings

Our team continued to prioritize efforts to import GPS coordinates into the database and input our vegetation data immediately following the end of field sampling. Currently, we are completing QA/QC fixes from prior years of the projects and intend for that work to be completed soon.

Additional Funding and Projects

In addition to CWM work in 2025, we surveyed over 200 points in the St. Louis River Estuary for aquatic macrophytes for the Minnesota Pollution Control Agency (MPCA). The MPCA is currently developing a comprehensive, long-term plan to delist the St. Louis River Area of Concern (AOC) through restoration efforts under a grant from USEPA and other project partners. The monitoring and assessment of aquatic macrophytes and soil at several sites in the estuary at various pre- and post-restoration stages will be used in the AOC delisting process. We will continue to collaborate with MCPA through the coming year and plan to use some historical CWM data to help with the efforts to develop indicators of vegetation quality.

Other Collaboration Activities

We continue to collaborate with former project lead Dr. Jeremy Hartsock to summarize patterns of coastal wetlands and aquatic vegetation in the St. Louis River estuary.

Other Data Requests

N/A

Related Student Research

N/A

US CENTRAL BASIN BIRD & ANURAN TEAM AT THE COFRIN CENTER FOR BIODIVERSITY, UNIVERSITY OF WISCONSIN-GREEN BAY

Team Members

- Erin Giese, PI, bird/anuran ecologist (since 2011)
- Dr. Robert Howe, project advisor, bird/anuran ecologist, retired (since 2011)
- Three full-time summer field techs (new)
- One full-time summer field techs (since 2023)
- Two part-time summer field techs (one since 2023, one new)

Training

Between February and May 2025, nine trainings with summer field technicians were led by Erin Giese and conducted at UW-Green Bay either in person or online. Our three new field technicians passed the online bird/anuran identification tests and became certified to conduct bird and anuran surveys.

Challenges and Lessons Learned

This year was not a particularly challenging year in terms of access since Great Lakes water levels continue to drop; however, we were assigned several sites located on inaccessible private property or sites that were impossible to access due to private roads, unimproved roads, or distant, remote islands. We were able to access 6 points via kayak and 3 points via motorized boat.

Site Visit List

Our team was assigned 44 total wetland sites: 11 in Wisconsin and 33 in Michigan. Of our 44 assigned sites, there were 2 pre-sample ("P") sites, 3 re-sample ("R") sites, and 2 benchmark ("B") sites. We surveyed 33 sites and dropped the remaining ones that were not accessible (e.g., private property, lack of roads).

Panel Survey Results

Our first anuran surveys of the 2025 season took place on April 16, 2025 at sites 1444 and 1449 in Green Bay, Wisconsin. Our last surveys occurred in the eastern Upper Peninsula of Michigan on July 1, 2025 at sites 630, 658, and 700. Cumulatively across all sites and samples, we recorded seven anuran species: American toad, spring peeper, gray treefrog, green frog, northern leopard frog, wood frog, and bullfrog, which are each relatively common and expected species in Great Lakes coastal wetlands. We did not detect any uncommon, unusual, or listed anuran species, and we did not detect chorus frog, which we last recorded by our team in 2021. At 8 of our 114 total anuran point count surveys (114 = 38 point count locations × 3 rounds), we did not detect any anurans calling.

Our first bird surveys of the 2025 season took place on May 27, 2025 at sites 1379, 1428, 1459, 1680, 1701, and 1702 in Marinette, Suamico, Kewaunee, Sturgeon Bay, and Baileys Harbor, WI. Our last surveys occurred in the eastern Upper Peninsula of Michigan on July 8, 2025 at sites 658, 700, 718, 719, 781, and 857. Cumulatively across all sites and samples, we recorded 115 bird species, including many target, marsh-obligate bird species: rails (Virginia Rail and Sora), American Coot, Common Gallinule, bitterns (American and Least Bitterns), wrens (Marsh and Sedge), Pied-billed Grebe, terns (Black and Forster's Terns), Swamp Sparrow, Yellow-headed Blackbird, Blue-winged Teal, Sandhill Crane, Eared Grebe, and Black-necked Stilt. While not listed species, both Eared Grebe and Black-necked Stilts are rare visitors to Wisconsin and Michigan.

- Listed Bird Species:
    - American Bittern: Imperiled–Vulnerable in Wisconsin (S2S3B) during breeding
        - Sites 630, 1459, 1486
    - Black Tern: Endangered in the state of Wisconsin, threatened in the state of Michigan

        - Sites 794, 1459, 1513
    - Caspian Tern: Endangered in the state of Wisconsin, threatened in the state of Michigan
        - Sites 718, 721, 726, 781, 1379, 1444, 1449, 1459, 1460, 1701, 1702
    - Common Gallinule: Threatened in the state of Michigan
        - Site 1459
    - Common Loon: Threatened in the state of Michigan
        - Sites 781, 794, 857, 904, 1701
    - Common Tern: U.S. Species of Concern, endangered in the state of Wisconsin, threatened in the state of Michigan
        - Sites 614, 794, 833, 1449, 1459, 1460, 1513, 1720
    - Forster's Tern: Endangered in the state of Wisconsin, threatened in the state of Michigan
        - Site 1449
    - Great Egret: Threatened in the state of Wisconsin
        - Sites 616, 1444, 1449, 1459, 1492, 1513, 1702, 1720
    - Least Bittern: Imperiled–Vulnerable in Wisconsin (S2S3B) during breeding, threatened in the state of Michigan
        - Sites 1428, 1680
    - Purple Martin: Imperiled–Vulnerable in Wisconsin (S2S3B) during breeding
        - Sites 1428, 1436, 1449, 1459, 1460, 1701
    - Red-necked Grebe: Endangered in the state of Wisconsin
        - Site 1720
    - Yellow-headed Blackbird: Critically Imperiled–Imperiled in Wisconsin (S1S2B) during breeding
        - Sites 1444, 1449, 1459
- Invasive Bird Species:
    - European Starling: sites 630, 781, 857, 1379, 1444, 1459, 1460, 1486, 1513, 1701, 1720
    - House Sparrow: sites 1379, 1449
    - Mute Swan: sites 630, 718, 833

Extra Sites and Data

Like we have done for the last several years, we collected local habitat variables at every point count location following methods outlined by Birds Canada. These data are not entered into the online CWMP DMS. Instead, hard copies are mailed to Dr. Doug Tozer with Birds Canada who then scans the data forms and conducts OCR so they may be automatically and digitally entered into a database.

Wetland Condition Observations and Results

Unlike 2018–2022, our team hardly had any issues pertaining to high water levels this season since Great Lakes levels have been dropping over the last few years. No wetland points that our team sampled was described as "drowned" (i.e., did not have any emergent plants within 100 m). In terms of wetland quality, sites 794, 1459, and 1513 produced high quality bird species, such as American Bittern, Virginia Rail, Pied-billed Grebe, American Coot, Common Gallinule, and Black Tern. Many of these sites consisted of few invasive plant species and instead contained native sedges, grasses, rushes, bulrushes, and cattails. Site 794 contains some of the highest quality coastal wetlands in the Laurentian Great Lakes system. This wetland is part of the Munuscong River complex near the rivermouth in the far eastern UP and are breeding hotspots for Black Terns, Pied-billed Grebes, and other bird species that use coastal marshes.

Data Processing

Summer anuran and bird field technicians have completed double data entry for all 2025 anuran and bird point counts and conducted QA/QC such that all double entries match.

Mid-season QC Check Findings

We were fortunate to have two returning field crew members, who helped with project continuity and expertise: Haley Spargur, our Field Crew Leader and anuran expert, and bird expert Sarah Baughman. Giese also regularly checked bird and anuran observations reported by all team members and addressed any issues as needed. However, because two of our team's bird technicians were new to marsh bird surveys, Giese spent >40 hours training them on bird visual and auditory identification and anuran auditory identification both online and in the field. Both Giese and Baughman accompanied our new bird experts while Spargur accompanied our new anuran experts for multiple surveys to ensure data were collected correctly and accurately.

Audit and QC Report and Findings

Summer anuran and bird field technicians have completed double data entry for all 2025 anuran and bird point counts and conducted QA/QC such that all double entries match.

Additional Funding and Projects

Nothing to report.

Other Collaboration Activities

In collaboration with Wisconsin Department of Natural Resources (WDNR) and U.S. Fish and Wildlife Service, UW-Green Bay's Cofrin Center for Biodiversity (Giese, Howe, and others) developed metrics to evaluate the condition of fish and wildlife habitats and populations within the Lower Green Bay Fox River Area of Concern (AOC). A few AOC priority population groups utilize the metric Index of Ecological Condition (IEC), originally developed by Howe, Gerald Niemi, and other CWMP/Great Lakes Environmental Indicator (GLEI) collaborators. Recently developed IECs utilize CWMP data and are being used to evaluate fish and wildlife population groups, such as breeding marshbirds and anurans. Over the last few years, WDNR has been working with St. Norbert College on developing an online R Shiny App that converts each metric value (based on collected field data) to a condition score ranging from 0 (poor condition) to 10 (best condition).

Giese was awarded separate GLRI funding to monitor site 1444, locally called Ken Euers Nature Area, to evaluate wildlife responses to recent restoration efforts. Student field technicians monitored breeding marshbirds and anurans using CWMP protocols and breeding coastal birds, coastal wetland mustelids, muskrats, and Mallards using other methods. WDNR will evaluate each of these wildlife groups using a series of metrics made by Giese, Howe, and others. Breeding marshbirds and anurans will be evaluated using CWMP-developed IECs.

Other Data Requests

Species lists were provided to the Wisconsin Department of Natural Resources in agreement for allowing our team to survey on State Natural Areas.

Related Student Research

UW-Green Bay graduate student Whitney Tank continues to work with Erin Giese and Dr. Dhanamalee Bandara on developing statistical models of habitat associations with marsh-obligate breeding bird species using CWMP data. They are using local habitat point count data collected for this project to develop these bird-habitat associations, which could be used for informing land management decisions and their effects on breeding marshbirds. They are currently drafting a manuscript for publication in *Ecosphere*, which will include multiple CWMP PIs as co-authors.

US CENTRAL BASIN, CENTRAL MICHIGAN UNIVERSITY (CMU), BIRD/ANURAN TEAM

Team Members

- Thomas Gehring, PI, wildlife biologist (since 2011)
- Bridget Wheelock, full time technician, team lead (since 2013)
- Mary Benjamin, survey lead/lab coordinator, graduate student (since 2023)
- Brendan Jankowski, survey lead, undergraduate, prior survey lead and field tech (since 2023)
- Samuel Rimatzki, survey lead (new 2025)

- Audrey George, field technician (new 2025)
- Cole Zumbrunnen, field technician (new 2025)

Training

Brendan Jankowski and Samuel Rimatzki completed the anuran ID certification (audio) prior to 19 April 2025, and the bird ID certification (audio and visual) prior to 20 May 2025. A one-hour training was held on 20 March 2025 with Brendan Jankowski, Cole Zumbrunnen and CMU PI to review anuran, bird, and habitat assessment survey protocols and new audio equipment function. A one-hour training was held on 29 April 2025 with Samuel Rimatzki, Audrey George and CMU PI to review anuran, bird, and habitat assessment survey protocols and new audio equipment function prior to sampling done by this team. New technician job responsibility and equipment function training occurred prior to their first field day.

Challenges and Lessons Learned

No major challenges.

Site Visit List

The CMU bird/anuran team was assigned 34 sites, and 29 sites were sampled. We web-rejected one benchmark site (7061) due to the inability to access the site due to boating restrictions. We did not sample four sites (445, 486, 572 (resample), 696) after visiting due to lack of wetlands meeting the protocol requirements of emergent wetland vegetation with <50% woody vegetation at the roadside and low water levels. We surveyed 24 regularly scheduled bird/anuran 2025 sites (450, 453, 491, 495, 510, 524, 539, 545, 682, 1276, 1301, 1305, 1310, 1311, 1582, 1601, 1640, 1653, 1858, 1867, 1869, 1889, 1918, 1919), 3 resample bird/anuran 2025 sites (426, 1279, 1915), and two benchmark sites (515, 1598).

Panel Survey Results

Anurans: First sample date – 19 April 2025; Last sample date 2 July 2025

Table 18. Anurans – 8 species	
Common Name	**Taxa Name**
American Toad	*Anaxyrus americanus*
Bullfrog	*Lithobates catesbeiana*
Chorus Frog (Western/Boreal)	*Pseudacris triseriata/Pseudacris maculata*
Gray Treefrog	*Hyla versicolor*
Green Frog	*Lithobates clamitans*

Northern Leopard Frog	*Lithobates pipiens*
Pickerel Frog	*Lithobates palustris*
Spring Peeper	*Pseudacris crucifer*

Birds: First sample date – 20 May 2025; Last sample date 7 July 2025

Table 19. Birds - 105+ species	
Common Name	**Code**
Alder Flycatcher	ALFL
American Crow	AMCR
American Goldfinch	AMGO
American Kestrel	AMKE
American Redstart	AMRE
American Robin	AMRO
American White Pelican	AWPE
Bald Eagle	BAEA
Baltimore Oriole	BAOR
Bank Swallow	BANS
Barn Swallow	BARS
Barred Owl	BADO
Belted Kingfisher	BEKI
Black-and-white Warbler	BAWW
Black-capped Chickadee	BCCH
Black-crowned Night Heron	BCNH
Black-throated Green Warbler	BTNW
Blackpoll Warbler	BLPW
Blue Jay	BLJA
Blue-gray Gnatcatcher	BGGN
Blue-winged Warbler	BWWA
Brown Thrasher	BRTH
Brown-headed Cowbird	BHCO
Canada Goose	CANG
Carolina Wren	CARW
Caspian Tern	CATE
Cedar Waxwing	CEDW

Chestnut-sided Warbler	CSWA
Chipping Sparrow	CHSP
Common Gallinule	COGA
Common Grackle	COGR
Common Merganser	COME
Common Nighthawk	CONI
Common Raven	CORA
Common Tern	COTE
Common Yellowthroat	COYE
Cooper’s Hawk	COHA
Double-crested Cormorant	DCCO
Downy Woodpecker	DOWO
Eastern Bluebird	EABL
Eastern Kingbird	EAKI
Eastern Phoebe	EAPH
Eastern Wood-Pewee	EAWP
European Starling	EUST
Field Sparrow	FISP
Forster's Tern	FOTE
Glossy Ibis	GLIB
Gray Catbird	GRCA
Great Blue Heron	GBHE
Great Crested Flycatcher	GCFL
Great Egret	GREG
Greater Yellowlegs	GRYE
Green Heron	GRHE
Hermit Thrush	HETH
House Finch	HOFI
House Sparrow	HOSP
Indigo Bunting	INBU
Killdeer	KILL
Least Bittern	LEBI
Least Flycatcher	LEFL
Mallard	MALL
Marsh Wren	MAWR

Mourning Dove	MODO
Mute Swan	MUSW
N. Rough-winged Swallow	NRWS
Nashville Warbler	NAWA
Northern Cardinal	NOCA
Northern Flicker	NOFL
Northern Mockingbird	NOMO
Northern House Wren	NHWR
Orchard Oriole	OROR
Osprey	OSPR
Ovenbird	OVEN
Pied-billed Grebe	PBGR
Purple Finch	PUFI
Purple Martin	PUMA
Red-bellied Woodpecker	RBWO
Red-eyed Vireo	REVI
Red-headed Woodpecker	RHWO
Red-tailed Hawk	RTHA
Red-winged Blackbird	RWBL
Ring-billed Gull	RBGU
Rose-breasted Grosbeak	RBGR
Sandhill Crane	SACR
Sedge Wren	SEWR
Song Sparrow	SOSP
Sora	SORA
Spotted Sandpiper	SPSA
Swamp Sparrow	SWSP
Tennessee Warbler	TEWA
Tree Swallow	TRES
Trumpeter Swan	TRUS
Tufted Titmouse	TUTI
Turkey Vulture	TUVU
Unidentified blackbird	UBLB
Unidentified duck	UDUC
Unidentified Flycatcher	UFLY

Unidentified gull	UGUL
Unidentified large bird	ULBD
Unidentified medium bird	UMBD
Unidentified Raptor	URAP
Unidentified shorebird	USHO
Unidentified small bird	USBD
Unidentified sparrow	USPA
Unidentified swallow	USWA
Unidentified Tern	UTER
Unidentified woodpecker	UWPR
Unknown swan	USWN
Veery	VEER
Virginia Rail	VIRA
Warbling Vireo	WAVI
White-breasted Nuthatch	WBNU
White-throated Sparrow	WTSP
Willow Flycatcher	WIFL
Wilson's Snipe	WISN
Wood Duck	WODU
Wood Thrush	WOTH
Yellow Warbler	YEWA
Yellow-billed Cuckoo	YBCU

Extra Sites and Data

None.

Wetland Condition Observations and Results

Water levels were noticeably lower for multiple points this year compared to the 2024 survey year. Benchmark points such as 515 and 1915 appeared to have substantially lowered water levels which seem to have impacted emergent vegetation growth as well as biodiversity. Focal species such as the Least Bittern and American Bittern were less frequent whether due to activity at time of survey or in relation to water levels and wetland productivity, but this would need to be further researched to determine the connection. Similarly, shorebirds other than Killdeer were sparse or absent from many of the coastal wetland survey sites.

Data Processing

All 2025 data (species surveys, habitat assessments, GPS coordinates, audio recordings) have been double entered, backed up, and sent to respective parties.

Mid-season QC Check Findings

On 14 June 2025, mid-year QC checks were completed for each team lead/data collector (Brendan Jankowski, Samuel Rimatzki) at two sites each for anurans and birds this year. Data collectors were 100% proficient in the performance criteria including: 1) correct location of sampling points; 2) accuracy of species-level identification; 3) accuracy of abundance category estimates; 4) correct criteria and techniques used for identification of rare species; and 5) correct use of field survey forms.

Audit and QC Report and Findings

All 2025 data have been QA'd with no flags. All GPS coordinates are confirmed or excellent. All data 2016-present have been QA'd in the Data Verification interface.

Additional Funding and Projects

N/A

Other Collaboration Activities

N/A

Other Data Requests

Data have been requested and sent to two landowner organizations. This includes data collected at two sites. Point five of site 1869 went to Green Creek Hunt Club. Site 515 data went to the Michigan DNR for the Fish Point State Game Area.

Related Student Research

Kylie McElrath defended her M.S. thesis examining the factors influencing muskrat abundance in Great Lakes coastal wetlands and changes in muskrat spatial distribution patterns over time.

Megan Bos is currently writing her M.S. thesis examining the influence of muskrat houses on water chemistry and plant communities in Great Lakes coastal wetlands. Megan is planning to defend her thesis in December 2025.

Megan Casler is currently writing her M.S. thesis examining multi-season occupancy modeling of Rallidae species using basin-wide bird, invertebrate, and vegetation data from the years 2011-2022.

Mary Benjamin is currently writing her M.S. thesis examining the use of passive recording for secretive marsh bird detection.

US CENTRAL BASIN FISH, INVERTEBRATE AND WATER QUALITY TEAM

Team Members

The US Central Basin Fish, Invertebrate and Water Quality Team consists of PIs and members from the following universities:

Central Michigan University (CMU) crew:

- Dr. Donald G. Uzarski, PI (since 2011)
- Bridget Wheelock, Uzarski lab supervisor and crew leader (since 2018)
- Molly Gordon, lead invertebrate taxonomist (since 2011)
- Matthew Sand, lead water quality technician (since 2020), Uzarski lab supervisor (since 2023)
- Howard Mitchell, crew leader (new 2025), summer field technician (since 2024), water quality technician (since 2024), graduate student (new 2025)
- Taylor Dick, summer field technician (new 2025), graduate student (new 2025)
- Jacob LeCaptain, summer field technician (new 2025), student lab technician (since 2024)
- Zoe Moore, summer field technician (new 2025), student lab technician (new 2025)

Grand Valley State University (GVSU) crew:

- Dr. Carl Ruetz III, PI (since 2011)
- Dr. Matthew Cooper, PI (2011)
- Emily Eberly, crew leader (since 2025), graduate student technician (since 2024)
- John Gargasz, graduate student technician (since 2024)
- Ruby Johnson, summer technician (new 2025)
- Eleanor Newcomb, summer technician (new 2025)
- Brenden Reid, summer technician (new 2025)

University of Notre Dame (UND) crew:

- Dr. Gary Lamberti, PI (since 2011)
- Sarah Klepinger, crew leader (since 2018)
- Caitlynn Day, technician (since 2024)
- Elizabeth Sicking (new 2025)

Lake Superior State University (LSSU) crew:

- Dr. Ashley Moerke, PI (since 2011)
- Connor Arnold, crew leader (since 2024), crew member (since 2023)

- Sam Rimatzki, summer technician (since 2024)
- Donnovan Stone, summer technician (new 2025)
- Anthony Savoie, summer technician (new 2025)
- Nikki Perigo, research technician (since 2024)

Training

Central Michigan University hosted the Central Basin training at site 515 in Saginaw Bay on 16 June 2025 and 17 June 2025, attended by GVSU and LSSU. The training was led by Bridget Wheelock who has been a part of the CWMP since 2012. The topics covered included water quality collection, *in* situ data collection, GPS navigation, vegetation zone selection, invertebrate sampling and picking, fyke net setting/retrieval, and fish handling/identification. Teams conducted additional water quality processing training and certification on their own to familiarize themselves with their equipment.

Additional training for the CMU crew was completed at Littlefield Lake in Isabella County, MI on 12 June 2025 as well as in Mount Pleasant from 19 May 2025 to 13 June 2025. The topics covered included lab and field safety, boater safety, IACUC, water quality collection, titration, filtering, *in situ* data collection, water quality sonde troubleshooting, GPS navigation, invertebrate sampling and picking, fyke net setting/retrieval/repair, fish identification, boat operation, and trailering.

University of Notre Dame training occurred on June 16th, 2025 at North Chain Lake in South Bend, IN. Proper technique for water and macroinvertebrate collection was demonstrated and practiced, as well as how to set a fyke net and launch a boat.

Fish ID training was provided for the LSSU crew by lead technician (Arnold) and certified by LSSU PI (A. Moerke) at the Barch Center for Freshwater Research and Education using the centers preserved specimens. All three crew members identified at least 95% of fish correctly. GPS training also occurred before field season began. Initial field training was provided by LSSU PI (Moerke) and crew chief (Arnold) at Ashmun Bay where the crew went through equipment deployment and sample collection process, and then reviewed lab protocols with the water quality lab manager. Mid-season checks were provided by Arnold to ensure protocols were being followed.

Challenges and Lessons Learned

CMU encountered challenges finding inundated vegetation zones again this year as water levels were still low. Multiple sites visited this summer were too shallow to sample, completely dry or had no vegetation.

One of the main challenges faced by the GVSU crew this season was navigating around rocky shallow waters, as the water levels this year were low on Lakes Michigan and Huron. Multiple sites lacked proper inundated vegetation zones or had water too shallow to conduct fish sampling.

The season went smoothly with one exception. On June 26th, we were sampling near Douglas, MI (site 1653). Overnight, two of our nets were sabotaged. The poles holding cod ends of each net had been removed, which allowed the cod end to collapse. Two turtles in net #1 could not access the surface and drowned. After this incident, we updated our net tags to make them more visible and started zip-tying the cod end to the pole to discourage any similar attempts.

Site Visit List

The US Central Basin was assigned 48 sites (17 CMU, 11 GVSU, 9 LSSU, 7 UND), three of which were web rejected and one that was a benchmark that wasn't going to be sampled. Four sites were benchmarks (515, 616, 1598 and 7061), six sites were re-sample sites (426, 572, 719, 857, 1279 and 1915) and four sites were pre-sample sites (630, 827, 833 and 1305). Sites 515 and 7061 were benchmarked because they represent low (515) and high (616, 7061) extremes, respectively, along the disturbance gradient and have long term data sets. Site 1598 is close to the line 5 oil pipeline in the Mackinac Straits and was requested as a benchmark to gather historical data in the event of an oil spill.

CMU sampled eight sites, could not sample six sites due to low water levels or lack of vegetation, did not sample benchmark site 7061, visit rejected one site (627), and could not access one site (753). Within the eight sites, 12 zones were sampled for water quality and macroinvertebrates and 11 zones were sampled for fish.

GVSU was assigned 11 sites to sample for the 2025 season. Of those sites, GVSU sampled eight, rejected two, and could not sample one site. The two rejected sites (452 and 572) were both due to lack of inundated wetland vegetation, and the one unsamplable site (1310) was due to lack of safe access and low water levels. Of the eight sites that were sampled, three sites were sampled for water quality and macroinvertebrates only but not sampled for fish (1279, 450, and 539). Site 1279 has no motorboat access so sampling was conducted from a canoe where fish sampling gear was not transportable. Sites 450 and 539 were too shallow to sample for fish (less than 20 cm deep) and too shallow for boat access, so gear was hiked in by the crew on foot. The other five sampled sites included fish, water quality, and macroinvertebrate sampling.

UND was assigned seven sites to access for 2025. Four sites were along the Detroit River (426, 1915, 1918 and 1919). Two more were sampled along the Kalamazoo River near Saugatuck, MI

(1653 and 1656). One more was on Saginaw Bay (510). Within these seven sites, 13 zones were sampled for water and macroinvertebrates, and six of those zones were also sampled for fish.

Panel Survey Results

Sampling started on 16 June 2025 and the last site was sampled on 14 August 2025. The following tables list zones sampled for each site, non-native species by site, and reptile and amphibian species captured in fyke nets, respectively.

Table 20. Vegetation Zones by Site

Site	Vegetation Zones
424	SAV
	Phragmites
426	*Phragmites*
450	Spikerush
508	*Phragmites*
	Typha
	SAV
510	*Phragmites*
515	Dense Bulrush
	Typha
524	SAV
539	SAV
630	Dense Bulrush
	Lily
	Typha
651	Dense Bulrush
700	Dense Bulrush
719	SAV
726	SAV
781	Dense Bulrush
	Typha
805	Dense Bulrush
811	Lily
	Sparse Bulrush
827	Dense Bulrush

	Lily
	Sparse Bulrush
833	Dense Bulrush
	SAV
	Sparse Bulrush
	Typha
857	Dense Bulrush
873	Sparse Bulrush
1279	Lily
1305	Lily
1598	Sparse Bulrush
	Typha
1653	Lily
	SAV
1656	PSP
	Typha
1915	Lily
	Typha
1918	Lily
	Phragmites
	Typha
1919	Lily
	Phragmites
5046	Lily
	SAV
5757	SAV

Table 21. Non-native Species by Site

Site	Common Name	Taxa Name
424	Goldfish (YOY)	*Carassius auratus*
426	Common Carp	*Cyprinus carpio*
508	Common Carp (YOY)	*Cyprinus carpio*
510	Round Goby	*Neogobius melanostomus*
515	Round Goby	*Neogobius melanostomus*
630	Round Goby	*Neogobius melanostomus*

700	Round Goby	*Neogobius melanostomus*
719	Round Goby	*Neogobius melanostomus*
726	Round Goby	*Neogobius melanostomus*
827	Eurasian Ruffe	*Gymnocephalus cernua*
1305	Common Carp (YOY)	*Cyprinus carpio*
1598	Freshwater Tubenose Goby	*Proterorhinus semilunaris*
	Round Goby	*Neogobius melanostomus*
1653	Common Carp	*Cyprinus carpio*
1918	Common Carp	*Cyprinus carpio*
1919	Common Carp	*Cyprinus carpio*
	Round Goby	*Neogobius melanostomus*

Table 22. Reptile and Amphibian Species Captured in Fyke Nets

Site	**Common Name**	**Taxa Name**
424	Northern (Common) Map Turtle	*Graptemys geographica*
426	Northern (Common) Map Turtle	*Graptemys geographica*
	Painted Turtle	*Chrysemys picta*
508	Painted Turtle	*Chrysemys picta*
510	Common Snapping Turtle	*Chelydra serpentina*
	Painted Turtle	*Chrysemys picta*
515	Painted Turtle	*Chrysemys picta*
524	Painted Turtle	*Chrysemys picta*
630	Painted Turtle	*Chrysemys picta*
726	Painted Turtle	*Chrysemys picta*
781	Painted Turtle	*Chrysemys picta*
805	Painted Turtle	*Chrysemys picta*
811	Painted Turtle	*Chrysemys picta*
827	Painted Turtle	*Chrysemys picta*
833	Painted Turtle	*Chrysemys picta*
857	Painted Turtle	*Chrysemys picta*
1305	Common Snapping Turtle	*Chelydra serpentina*
	Painted Turtle	*Chrysemys picta*

	Northern (Common) Map Turtle	*Graptemys geographica*
1653	Common Snapping Turtle	*Chelydra serpentina*
	Northern (Common) Map Turtle	*Graptemys geographica*
1918	Northern Leopard Frog	*Lithobates pipiens*
1919	Common Snapping Turtle	*Chelydra serpentina*
	Northern (Common) Map Turtle	*Graptemys geographica*
	Painted Turtle	*Chrysemys picta*
5046	Painted Turtle	*Chrysemys picta*
5757	Painted Turtle	*Chrysemys picta*

Extra Sites and Data

Sites 515 and 7061 were benchmarked by Dr. Don Uzarski and site 616 by Dr. Dennis Albert because they represent high (515) and low (616 and 7061) extremes along the disturbance gradient and have long term data sets. These data will be used for developing and improving our indices of biotic integrity and indices of environmental condition. Site 1598 is close to the line 5 oil pipeline in the Mackinac Straits and was requested by Dr. Don Uzarski as a benchmark to gather historical data in the event of an oil spill.

Wetland Condition Observations and Results

Water levels were low again this year, resulting in many vegetation zones being absent, dry or too shallow to sample for the CMU team.

For the GVSU team water levels were low to the point where some sites no longer had wetland vegetation or could not be sampled for fish. Some GVSU sites were inaccessible by boat due to low water levels, so GVSU crew hiked with gear on foot from nearby public land access (sites 450 and 539). Site 1310 was inaccessible because wetland sediment surrounding the shallow water was extremely thick and deep so wading was unsafe. Wetland sediment throughout our sites ranged from deep organic materials to gravel bottoms, influencing a wide array of sampling experiences. Site 1279 in Bar Lake, Manistee had much more water lily growth covering the lake in early July 2025 compared to early June of 2024. A local resident that lives on the lake has been tracking the date of first lily emergence since 2022 and noted that it establishes growth earlier in the summer each year.

Data Processing

CMU has finished entering site, habitat, fyke, and all other *in situ* data. All data currently entered have been QC'd. All CMU macroinvertebrates have been initially identified. Initial identification of GVSU macroinvertebrates is underway along with QC of CMU macroinvertebrates. Water quality analyses of CMU, GVSU and LSSU filtered and raw water samples is underway. Fourteen chlorophyll-*a* samples were mailed to UND on 24 September 2025 for processing and received on 25 September 2025 in good condition.

Thirteen chlorophyll-*a* samples were mailed from GVSU to the Lamberti Lab at the University of Notre Dame on 15 September 2025 for processing. The Chlorophyll-*a* samples were received by the lab on 16 September 2025. Six macroinvertebrate samples were given to Bridget Wheelock from GVSU on 17 June 2025 at the wetlands training site 515. Thirty additional macroinvertebrate samples were delivered to Central Michigan University by Emily Eberly on 12 September 2025, along with 39 water samples (raw, filtered nutrients, and dissolved filtered ions).

UND has begun entering all 2025 field data into the CWMP database. Macroinvertebrate identification is about 60% complete. UND is still awaiting chlorophyll-*a* samples from most teams, and these will likely be analyzed in December.

The LSSU team has completed data entry from the field season and all data have been QC'd. Water samples from LSSU will be shipped to CMU and the LSSU chlorophyll-*a* samples will be shipped to Notre Dame by the end of September. Macroinvertebrate ID has not been completed yet for summer 2025 samples, but identification will begin in November and be led by Silas Dunn, who has been identifying LSSU samples for the past several years.

Figure 1: Water lilies at site 1279 in Bar Lake, Manistee on June 4, 2024 (left) and July 10, 2025 (right).

Mid-season QC Check Findings

Bridget Wheelock provided the mid-season QC check for the CMU crew and observed sampling in accordance with the SOP at sites 781 and 857 the week of 4 August 2025 with no issues reported. The crew correctly determined if sites and vegetation zones were sampleable, located sampling points, collected data and identified fish species.

The mid-season QC check did not occur this season. Crew leader Emily Eberly was with the GVSU field crew during all stages of sampling and observed that sampling occurred in accordance with the SOP. Any fish specimens that could not be identified with 100% certainty were brought back to the lab at AWRI and keyed-out by Dr. Ruetz and Emily Eberly to ensure proper fish identification at all sites.

The mid-season check was conducted on 26 June 2025 and 27 June 2025 by UND’s PI, Gary Lamberti. He was largely satisfied with the crew’s performance and made positive comments on their efficiency.

Research technician Connor Arnold provided the mid-season QC and observed that sampling occurred in accordance with the SOPs.

Audit and QC Report and Findings

Most field data have been entered into the database and QC'd; the rest will be completed before the 2026 spring report.

Additional Funding and Projects

None.

Other Collaboration Activities

None.

Other Data Requests

None

Related Student Research

Incoming CMU graduate student and crew leader Howard Mitchell is planning to look at the relationship between large storm events and nutrient loading in Great Lakes coastal wetlands. Incoming CMU graduate student and crew member Taylor Dick is planning on looking at changes in zooplankton communities between seasons in Great Lakes coastal wetlands.

Emily Eberly, a GVSU graduate student under the advising of Dr. Matt Cooper, is using GLCWMP data for her thesis analyzing the influences of each indicator to develop a multi-indicator assessment of wetland health. She presented preliminary data as poster presentations at the IAGLR and Michigan AFS annual conferences in 2025.

Eberly, E. A., Brady, V. J., Lamberti, G. A., Ruetz III, C. R., Uzarski, D. G., & Cooper, M. J., (2025, February 19-21). *Fish Assemblages in Lake Michigan Coastal Wetlands* [Poster presentation]. Michigan Chapter of the American Fisheries Society 2025 Annual Meeting, Marquette, MI, United States.

Eberly, E. A., Brady, V. J., Ruetz III, C. R., Uzarski, D. G., & Cooper, M. J., (2025, June 2-5). *Multi-Indicator Assessment of Great Lakes Coastal Wetlands* [Poster presentation]. IAGLR's 68th Annual Conference on Great Lakes Research, Milwaukee, WI, United States.

US CENTRAL BASIN VEGETATION TEAM

Team Members

- Dr. Dennis Albert, PI, wetland vegetation ecologist/botanist (since 2011)

- Matthew Sand, CMU lab manager, wetland plants and water chemistry (since 2017)
- Kim Schraitle, CMU lab manager, wetland plants (since 2022)
- Katlyn Groulx, CMU summer field technician (since 2023)
- Olivia Klein, CMU summer field technician (since 2024)
- Linsey Ward, CMU summer field technician (new)

Training

Matthew Sand (6 years of crew leader experience) refreshed Katlyn Groulx (2 years of crew leader experience) and Kimberly Schraitle (2 years of crew leader experience) the week of June 16th – June 18th, 2025, as well as refreshed/trained the two technicians in Mount Pleasant wetlands. This included SOP training and sampling logistics as a crew leader. Topics covered included identification of common Michigan coastal wetland macrophytes, proper use of GPS for taking waypoints, using a compass to set transect bearings, estimation of percent cover, collection of plants for expert ID, and completion of datasheets.

Matthew Sand refreshed/trained Katlyn Groulx, Kimberly Schraitle, and the two summer field technicians on in-situ vegetation protocols at Saginaw Bay River (524). They also calibrated individual percent cover estimates.

On June 19th, 2025, the crews met with Dr. Dennis Albert via Webex to discuss the upcoming sample year and ask questions about macrophyte identification and sampling protocols. Following the meeting, crew members were tested on a subset of specimens covered in training PowerPoints and collected from Mount Pleasant wetlands. Crew leaders, Katlyn Groulx, Matthew Sand, and Kimberly Schraitle all correctly identified at least 90% of the specimens.

Challenges and Lessons Learned

Due to water levels dropping from the previous high-water years in 2020 and 2021, the patterns of vegetation zonation continue to be in-flux within the wet meadow, emergent, and submergent vegetation zones. This made it difficult to judge the start waypoint in a few wetlands. Some start waypoints had originally been located at small tree lines that are now standing dead. In these cases, the start waypoint was pushed back to a well-developed tree line. When samplers were unclear on how to treat zones, they consulted one of the more experienced crew leaders, Matthew Sand, for confirmation and added information about zonation in the notes section of the datasheets.

At some sites, crews experienced difficult or dangerous sampling conditions due to the drop in the water levels. At Singapore Area Wetland (1656), the water level decline made the creek a muddy river through which the canoe had to be dragged. The upper emergent zones were dangerous to sample due to thick, deep muck, and the meadow was inaccessible (Figure 1).

Figure 32. Decreased water levels caused thick muck to form in the upper emergent area of Singapore Area Wetland (1656), making it impossible to sample.

Both vegetation crews experienced sampling delays due to poor air quality from Canada wildfire smoke. Crews had to leave McKay Bay Area Wetland (719) and Sugar Island Wetland #4 (811) due to experiencing symptoms from poor air quality. Both crews were able to return to their respective wetlands and continue sampling once air quality conditions had improved.

Site Visit List

The Central Basin vegetation crews sampled 43 sites: 30 panel sites from 2025, 6 resampled panel sites from 2024, 3 benchmark sites, and 4 pre-sample panel sites from 2026.

Batchawana River 1 (5046) was the only Canadian panel site sampled by the Central Basin crew, with all others being in the United States.

The benchmark site Indian Harbor Wetland (7061) was dropped from the 2025 sampling list due to time and travel costs.

Panel Survey Results

In the US Central Basin, the first day of vegetation sampling took place on June 18th, 2025, and the last day of sampling took place on September 16th, 2025. Sampling was conducted in order from southern sites (Lake Erie and southeast Lake Michigan) to northern sites (Lake Superior) to sample vegetation when plants were identifiable and fertile.

Most anthropogenically disturbed sites (e.g., East Saginaw Bay Coastal Wetland #15 [508], Swan Creek Wetland [1915]) lacked the presence of wet meadow zones due to invasive *Typha* and *Phragmites* and generally had fewer species observations. Two island sites, Marquette Island Wetland #6 (627) and Lime Island Wetland #1 (873) had very diverse wet meadow zones, but sparse or no emergent vegetation and almost no submergent vegetation due to wave energy.

We noted several rare species at new sites. *Iris lacustris* (Dwarf Lake Iris) was observed near the sample transects at Whitefish Bay Area Wetland (539) and Thompsons Harbor Wetland #1 (572) but did not fall within any quadrats (Figure 2). This species is well established in this area of the state, but its continued presence is still noteworthy. *Subularia aquatica* (water awlwort) was found at Oak Ridge (805). This species is known to be present in Chippewa and Keweenaw Counties, but its presence is again noteworthy.

Two other species that are not regularly collected were collected multiple times on the St. Mary's River and in the Les Cheneaux area: *Isoetes echinospora* and *Myriophyllum tenellum*. Both are associated with soft water and slightly acidic habitats, although some of the sites where we found *M. tenellum* were nutrient-rich sites with calcareous substrates.

Extra Sites and Data

Benchmark site East Saginaw Bay Coastal Wetland #5 (515) was sampled on July 7th, 2025. This site was selected as a benchmark to track long-term trends at a site that was highly degraded throughout earlier long-term sampling. The herbicidal treatment of invasive *Phragmites australis* last season as well as noted burning and mowing this sampling season led to high levels of rack that needed to be maneuvered over (Figure 3). Though treated, the *Phragmites australis* persisted to the tree line.

Figure 33. *Iris lacustris* at Whitefish Bay Area Wetland (539).

Mackinac Creek Wetland (616) was sampled on July 15th and July 16th, 2025. This is a high-quality site that has a long history of sampling prior to the beginning of the GLRI, as well as having been regularly sampled as part of GLRI.

Point St. Ignace Wetland (1598) was sampled on July 16th, 2025 to track the potential environmental changes in the Straits of Mackinac. The only notable change that was observed is that there are less separated patches of *Typha angustifolia* and *Phragmites australis*.

Figure 3: Comparison between invasive *Phragmites australis* at East Saginaw Bay Coastal Wetland #5 (515B) in 2024 (top) and 2025 (bottom).

Wetland Condition Observations and Results

The most visible trend noted by sampling crews is that the vegetation zonation was impacted by receding water levels. In many sites, the remains of dead woody plants or *Typha sp.* persist in the wet meadow and upper emergent zones. Some sites, however, appear to be establishing more distinct zonation following the years of fluctuating water levels. Across the Central Basin, crews encountered small emergent species such as *Carex viridula*, *Eriocaulon aquaticum*, and *Eleocharis acicularis* where the waterlines had receded, indicating the establishment of new emergent zone boundaries. This was seen as far south as Whiskey Harbor Wetland (450) and continued north to Lake Nicolet East Shore Wetland #2 (7036) (Figure 4).

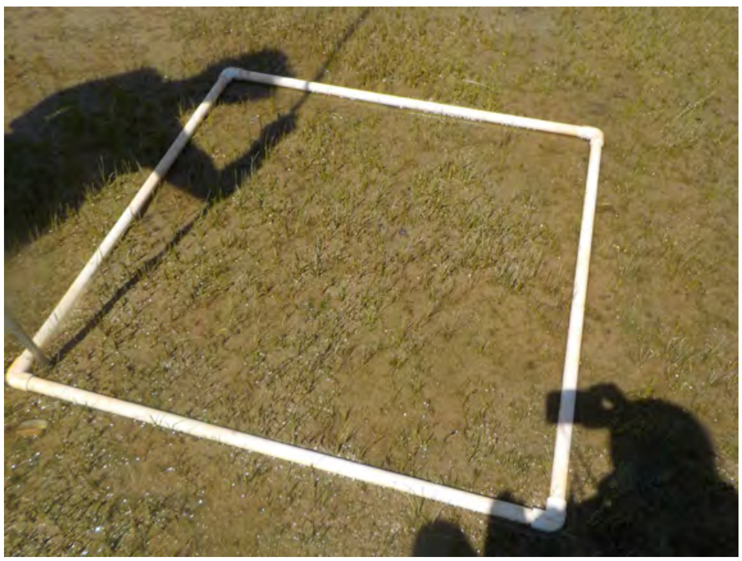


Figure 4: Small emergent plants (*Eriocaulon aquaticum* and *Eleocharis acicularis*) at Lake Nicolet East Shore Wetland #2 (7036).

Data Processing

Dr. Dennis Albert has finished the last of the plant identifications, and data entry will begin in October 2025. All data should be entered and quality-checked by spring of 2026.

Mid-season QC Check Findings

Matthew Sand completed mid-season QC checks at Potagannissing River Mouth Wetland (781) with Kimberly Schraitle's crew on August 5th and Big Shoal Cove Area Wetland #1 (753) with Katlyn Groulx's crew on August 6th. Matthew Sand quality-checked Kimberly's and Katlyn's sampling protocols by observing transect set ups, quadrat locations, percent cover estimates, and plant identification. No corrections were needed for either sampling crew.

Audit and QC Report and Findings

A CMU technician will begin entering 2025 vegetation data to GreatLakesWetlands.org in October. When the entry is completed, data will be quality-checked by Katlyn Groulx, Matthew Sand, or Kimberly Schraitle. Finally, data will be reviewed by Dr. Dennis Albert. Any data entry issues will be noted in the Spring 2026 report.

Additional Funding and Projects

None

Other Collaboration Activities

There are no external collaboration activities to report for the 2025 field season.

Other Data Requests

Site lists of species encountered/observed in 2025 will be sent to outside entities as was agreed upon to access their conservancies and properties for site sampling. Data will be sent to the Detroit River International Wildlife Refuge for Swan Creek Wetland (1915); the University of Michigan for Sugar Island Wetland #4 (811); Bay Mills Indian Community for Lake Nicolet East Shore Wetland #2 (7036); the Little Traverse Conservancy for the Mackinac Creek Wetland (616), Seymour Point Wetland (651), and Marquette Island #6 (627); and the Michigan Nature Association for Whiskey Harbor Wetland (450) and East Saginaw Bay Wetland #10 (510). A data-sharing agreement was also signed with the Sault Ste. Marie Tribe of Chippewa Indians for Rabbit Back Peak Area Wetland #2 (696). Two wetlands, Rockwood Road Wetland (1918) and Cherry Isle Wetland (1919), were sampled in Lake Erie Metropark, and a sampling progress update will be submitted to the Huron-Clinton Metroparks by the end of the calendar year.

Related Student Research

Central Basin vegetation data from 2025 is not currently being used for any student research.

CANADIAN CENTRAL/EASTERN BASIN BIRD/ANURAN TEAM AT BIRDS CANADA, PORT ROWAN/LONG POINT, ONTARIO

Team Members

- Dr. Doug Tozer, PI, waterbird and anuran ecologist (since 2011)
- Jeremy Bensette, bird and anuran field crew (since 2014)
- Tim Arthur, bird and anuran field crew (since 2017)
- Tyler Hoar, bird and anuran contractor (since 2011)
- Nadine Litwin, bird and anuran contractor (since 2011)

Training

All 4 field crew members / contractors received training refreshers via Zoom or phone in early April 2025. Topics included site selection procedures and station placement guidelines; specifics of anuran and bird survey field protocols; what's involved with reporting; safety procedures; overview of data entry; and GPS procedures. All members previously showed comprehension of the topics through written and practical in-person tests and successfully completed the online anuran and bird identification tests.

Challenges and Lessons Learned

Field work in 2025 went smoothly with no noteworthy challenges. With all team members having 9-15 years of experience working on the project, we are now a "well-oiled machine."

Site Visit List

We considered 59 sites for sampling in 2025, which consisted of 1 benchmark site, 6 resample sites, 6 pre-sample sites, and 46 panel sites. We surveyed 42 of the 59 sites for anurans and/or birds. We were unable to survey 17 of the sites due to issues with obtaining landowner access or safety, or both.

Panel Survey Results

Sampling for anurans occurred from 5 April until 5 July 2025 and sampling for birds occurred from 20 May to 4 July 2025. Of note were 116 point occurrences of 9 Ontario bird species at risk or of conservation concern (Table 23).

Table 23. Ontario bird species at risk or of conservation concern observed at sites in 2024.

		No. Occurrences	
Species	**ON-ESA/SARA Status***	**2024 (*n* = 42 sites)**	**2025 (*n* = 42 sites)**
Bald Eagle	Special concern	20	18
Bank Swallow	Threatened	20	13
Barn Swallow	Threatened	43	48
Black Tern	Special concern	12	3
Chimney Swift	Threatened	6	6
Common Nighthawk	Threatened	2	6
Eastern Meadowlark	Threatened	–	3
Least Bittern	Threatened	28	18
Red-headed Woodpecker	Endangered	2	1
Total		133	116

*Status is the assessment of greatest concern based on Ontario's Endangered Species Act (ON-ESA) or Canada's Species at Risk Act (SARA).

Also of note were 13 occurrences of Chorus Frog, some populations of which are listed as threatened in Canada (we logged 10 occurrences in 2024).

Extra Sites and Data

We sampled 1 benchmark site in 2025: Hillman Marsh (5422) in Lake Erie.

We collected additional habitat data at each bird and anuran sample point following a slightly modified version of Birds Canada's Great Lakes Marsh Monitoring Program habitat sampling protocol. These data are being collected to augment species-habitat relationship models, especially for certain marsh bird species, some of which are strongly influenced by local vegetation characteristics (i.e., within a few hundred meters of the sampling point), and are stored in an Access database on Birds Canada's secure servers in Port Rowan, Ontario.

Wetland Condition Observations and Results

We sensed that the abundance of secretive marsh birds started to decline in 2025 compared to our observations over previous years. We suspect this is because lake levels also started to decrease in 2025 relative to recent levels. Our observations are reflected in the relationship between lake levels and the number of secretive marsh bird detections over the years, with higher lake levels generally yielding higher abundance of secretive marsh birds (see figure at the end of this section). Our observations are also reflected in the results reported by Homan et al. (2021) and Tozer et al. (2024), who used CWMP bird data from throughout the Great Lakes across several years to show that higher lake levels generally yield higher wetland bird occurrence and abundance.

Hohman et al. (2021): https://doi.org/10.1016/j.jglr.2021.01.006
Tozer et al. (2024): https://doi.org/10.1093/ornithapp/duad062

Data Processing

All of our data have been entered into and checked in the CWMP database.

Mid-season QC Check Findings

Mid-season checks were performed in June; no issues were identified.

Audit and QC Report and Findings

No issues to report.

Additional Funding and Projects

We received additional funding to augment the bird and anuran team's capacity to complete a 10-year trend analysis for birds, as well as for anurans, using all of the CWMP data from Canada and the US. These projects are described further in the next section.

Other Collaboration Activities

The CWMP bird and anuran team has been collaborating with Danielle Ethier, Bird Population Scientist at Birds Canada in Port Rowan, Ontario, to calculate bird and frog trends in coastal wetlands throughout Canada and the US based on CWMP data. The bird paper has now been published: https://doi.org/10.1093/ornithapp/duad062. The frog paper has also now been published: https://doi.org/10.1002/ecs2.70248.

The CWMP bird and anuran team is now collaborating again with Danielle to answer a timely question of conservation interest for Great Lakes wetland managers regarding invasive Mute Swans. The project will use CWMP data and other datasets to test the "marshbird exclusion hypothesis," which predicts that species richness and abundance of marshbirds decrease in the presence of the swans due to the aggressive territorial behavior of the swans. While negative broad-scale impacts of Mute Swans on marshbirds may exist, clear evidence is lacking. This paper will help fill this knowledge gap. We also plan to test the marshbird exclusion hypothesis for Trumpeter Swans, if sample sizes are large enough to do so.

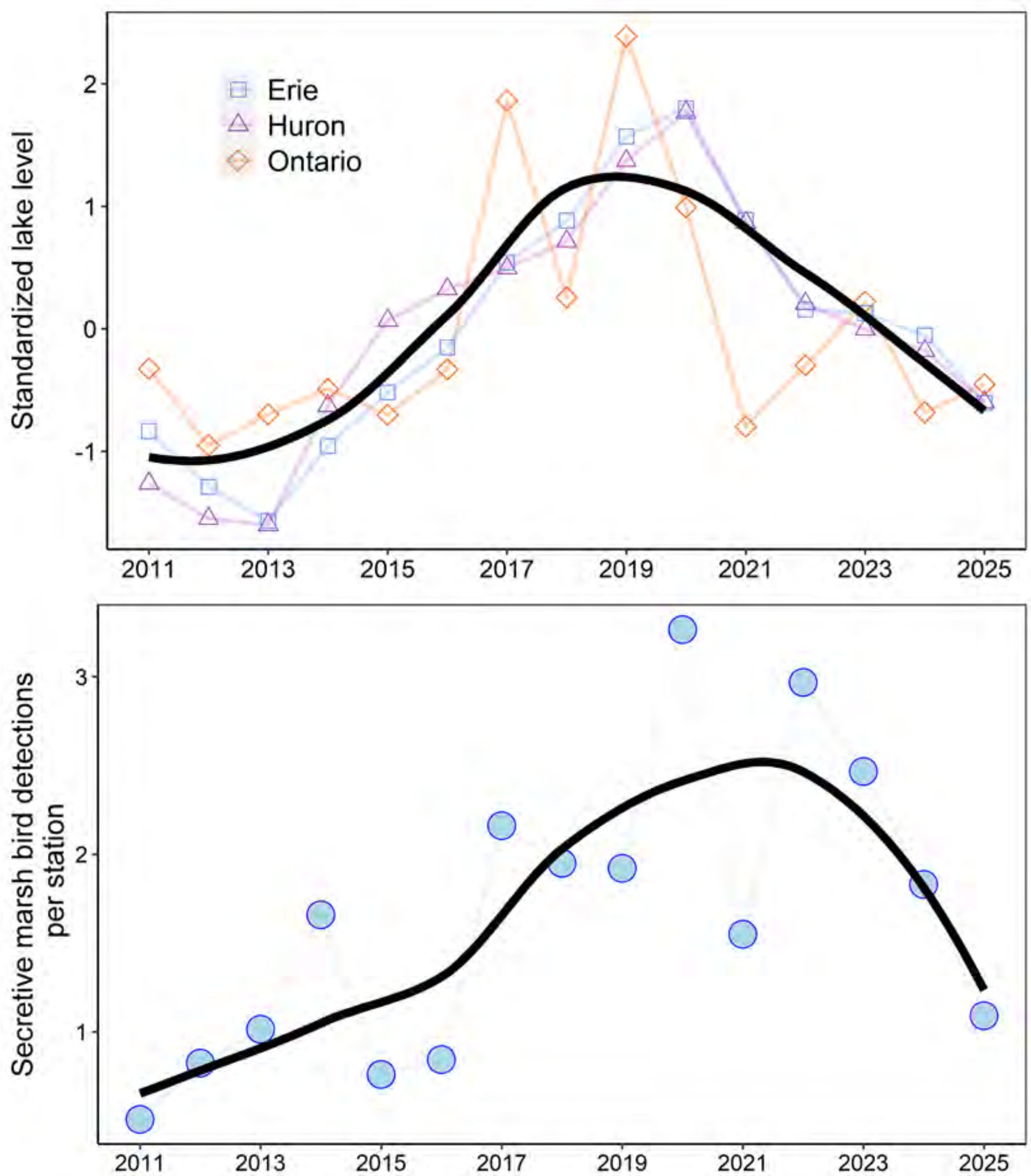
The CWMP bird and anuran team is collaborating with the other CWMP teams on a book entitled “Limnology of Coastal Wetlands Associated with Large Freshwater Lakes.” We are co-authoring the “Wildlife” chapter in the book, which will include various information based on CWMP data. The draft abstract for the chapter is included at the end of this section.

Other Data Requests

Nothing to report, but see student project descriptions.

Related Student Research

We continue to provide advice and guidance to Megan Casler, an MSc student at Central Michigan University, under the supervision of Tom Gehring. Megan plans to use CWMP data to test whether and how much the addition of invertebrate and water quality covariates improve bird habitat relationship models based on vegetation and land cover covariates.



Above: Higher lake levels on lakes Huron, Erie, and Ontario generally yield higher numbers of detections of secretive marsh birds of conservation concern (American Bittern, American Coot, Common Gallinule, Least Bittern, Pied-billed Grebe, Sora, Virginia Rail) by the Canadian Central/Eastern basin bird survey team. This is because rising and higher lake levels inundate emergent vegetation and break up dense stands of emergent vegetation, which is preferred by most of these species. Standardized lake levels were calculated by subtracting the long-term mean for each lake from the annual mean for each lake and dividing by the standard deviation, given the reference value is the same for all lakes (International Great Lakes Datum 1985). Secretive marsh bird detections per station were calculated by summing the number of individuals observed on any of the visits to a station in each year, and dividing by the number of stations surveyed in each year.

CANADIAN CENTRAL BASIN FISH, INVERTEBRATE AND WATER QUALITY TEAM AT THE UNIVERSITY OF WINDSOR AND UNIVERSITY OF WISCONSIN RIVER FALLS

Team Members

- Dr. Jan Ciborowski (UW), PI, aquatic ecologist, (since 2011)
- Dr. Joseph Gathman (UWRF), co-PI, aquatic ecologist, team leader (since 2011)
- Li Wang (UW), GIS specialist, data/QC manager (since 2011)
- Michelle Dobrin (UW), lead invertebrate taxonomist (since 2011)
- Stephanie Johnson (UW), lab and field crew member (since 2016)
- Emilee Mancini (UW), lab and field crew member (since 2020)
- Julia Santin (UW), lab and field crew member (since 2023)

Training

All crew members were experienced workers on the project for multiple years. Refresher training for crew was carried out at University of Windsor in May under the supervision of Stephanie Johnson who had eight years of experience in field and laboratory operations for the CWM program. All field crew members reviewed updates to the QAPP and SOP documents, and received instruction in GPS use, assessment of whether sites met project criteria (open water connection to lake, presence of a wetland, safe access), identification of vegetation zones to be sampled, water quality sample collection, preprocessing and shipping to water quality labs, calibrating and reading field instruments and meters, setting, removing, cleaning and transporting fyke nets, and protocols for collecting and preserving macroinvertebrates. Crews received refresher training and review in field data and lab entry. All field personnel were given refreshers in basic fish identification. Field-crew members were certified for identifying common fishes and Species at Risk through the Royal Ontario Museum's course in fish identification in 2023 or earlier.

The crew leader in 2025 was co-PI Joseph Gathman who led the team in the field at most sites. Sampling operations were under his direct supervision, except at one site (led by Stephanie Johnson). Gathman also prescreened the suitability of sample sites, coordinated all logistics, secured accommodations, and obtained sampling permissions where necessary.

Challenges and Lessons Learned

2025 lake levels were somewhat lower than in 2024, continuing a general decline since the 2019-2020 peaks. According to the Great Lakes Water Level Dashboard managed by Great Lakes Environmental Research Laboratory (https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html), Lake Huron's 2025 midsummer lake-level peak was approximately 25 cm lower than in 2024 and 98 cm lower than the recent high level reached in 2020. Lake Erie's year-over-year change was less, but still greater than in the 2023-24 interval: it was 14 cm lower than in 2024, and 66 cm lower than the long-term peak reached in 2019.

As noted in 2024, lower lake levels left many zones (particularly wet meadows, but also many cattail zones) having little or no surface water, rendering them unsampleable for fish, invertebrates, and water quality.

Site Visit List

The UW team has capacity to sample 30 wetlands annually. We were initially assigned 30 candidate sites on Lakes Erie and Huron, but several of these sites were inaccessible. Instead, we sampled four wetlands on the Canadian shore of eastern Lake Ontario that had originally been assigned to the Canadian Wildlife Service team. These included site 5104 Blessington Creek Marsh 2, site 5358 Grafton Swamp, site 5922 South Bay Marsh 2, and site 6040 Wellers Bay Wetland 7.

Vegetation sampling for the UWindsor team began on June 16th, 2025, at Rondeau Bay on Lake Erie, and ended on September 17th, 2025, at Hillman Marsh, also on Lake Erie. A total of 30 sites were sampled, including 29 panel sites (including 4 resample sites) and one benchmark site (site 5422 Hillman Marsh). Of those 30 sites, 15 were located on Lake Huron, 11 sites were on Lake Erie, and 4 sites were on Lake Ontario.

All wetlands visited in 2025 were sampled for vegetation, but two were not sampled for invertebrates or water quality because one lacked flooded wetland vegetation and the other was inaccessible by boat or on foot (but was accessible by kayak for vegetation survey). Ten of the assigned wetlands were not sampled for fishes because declining lake levels left many higher-elevation plant zones with no standing water, or insufficient water depth or area to meet fish-sampling criteria. Meanwhile, many areas at lower elevations that had been vegetated in the low-water, early years of the CWM program had become de-vegetated during high-water years and still had not recovered by 2025.

Panel Survey Results

Fishes collected over the summer largely consisted of the usual species. We caught one fish Species-At-Risk (SAR) in Canada: one spotted gar (Lepisosteus oculatus), collected at site 5304, Flat Creek Wetland. Regarding non-native species, we caught relatively few common carp (Cyprinus carpio) or goldfish (Carassius auratus) compared to many previous years but found round gobies (Neogobius melanostomus) and tubenose gobies (Proterorhinus semilunaris) at several sites. Reptiles observed included many painted turtles (Chrysemys picta), a few snapping turtles (Chelydra serpentina), and several musk turtles (Sternotherus odoratus), plus one northern map turtle (Graptemys geographica). Northern water snakes (Nerodia sipedon) were observed at multiple sites. We observed empty mussel shells at several sites, likely resulting from predation but indicating possibly healthy populations there, and we collected one juvenile mussel in a sweep-net sample at Hillman Marsh (site 5422), tentatively identified as Toxoplasma parvum, known as the “lilliput”, which is listed as “Threatened” in Ontario.

As in 2024, as compared to many earlier years we had a number of samples with relatively few invertebrates, i.e., fewer samples had 150 individuals than is usually the case. This appeared to be a result of sparse vegetation at these sites. In the invertebrate samples processed so far, non-native invertebrates included zebra mussels (Dreissena polymorpha) in cattail stands at three Lake Erie wetlands and one Lake Ontario wetland, the amphipod Gammarus tigrinus in cattail stands at the same three Lake Erie wetlands where we collected zebra mussels, and the snail Bithynia tentaculata at ten Lake Erie and Lake Ontario wetlands. This snail species has become quite common, so it is likely to appear in some of the remaining samples as well.

Extra Sites and Data

We did not sample any extra sites in 2025.

Wetland Condition Observations and Results

As noted above, declining lake levels have left wet meadows - even many cattail zones - too shallow/unflooded to allow us to sample them for fishes or even invertebrates in two cases. Also, many previously devegetated areas had still not yet recovered the vegetation seen in pre-peak years, making them unsuitable for sampling.

Data Processing

All field-collected data - fishes, in situ water-quality, vegetation, and habitat - have been entered into the database. GPS waypoints and site photographs have been uploaded. Our laboratory water-quality analyses are performed off-site, at the National Laboratory for

Environmental Testing (NLET) in Burlington, Ontario. We have not yet received results of these tests from NLET but will enter them as soon as they are received. We have sent our chlorophyll-a samples to the Lamberti lab at the University of Notre Dame for analysis, and data will be entered once results are returned to us. Of 123 invertebrate samples collected, just over one-half have been processed, and the data from 48 of them have been entered.

Mid-season QC Check Findings

No difficulties or anomalies were observed during mid-season checks. Each crew member has multiple years of prior experience on our team and were always working under direct supervision of co-PI Joseph Gathman or experienced crew leader Stephanie Johnson.

Audit and QC Report and Findings

All data for fishes, in situ water-quality, and habitat data have been QC’ed. Lab water quality data will be entered and QC’ed upon reception of results. Invertebrate data will be QC’ed once all samples have been processed and their data entered into the database.

Additional Funding and Projects

None to report for 2025.

Other Collaboration Activities

Other Collaboration Activities

Hillman Marsh on the Canadian shore of western Lake Erie was designated as a benchmark site in 2024 and was also sampled this year. It is in Essex County, Ontario, and is managed by the Essex Region Conservation Authority (ERCA). It was once protected by a barrier beach but has been exposed to wave action since its breaching in 2018. Restoration efforts focus on stabilizing the barrier to protect marsh vegetation and wildlife habitat. Phase 1 (2024) included shoreline reinforcement and planting native vegetation to reduce erosion. Phase 2 will involve testing and refining the barrier design through engineering analyses and physical modeling. Future phases will stabilize the barrier beach and restore wetland vegetation. We will continue to collaborate with ERCA to monitor changes in Hillman Marsh resulting from their restoration work.

Other Data Requests

We have not received any requests in 2025.

Related Student Research

None.

CANADIAN CENTRAL BASIN VEGETATION TEAM AT THE UNIVERSITY OF WINDSOR AND UNIVERSITY OF WISCONSIN RIVER FALLS

Team Members

- Dr. Jan Ciborowski (UW), PI, aquatic ecologist (since 2011)
- Dr. Joseph Gathman (UWRF), co-PI, aquatic ecologist, team leader (since 2011)
- Carla Huebert (UW), crew leader, plant taxonomist (since 2013)
- Li Wang (UW), GIS specialist, data/QC manager (since 2011)

Training

The crew leader in 2025 was Carla Huebert who directly conducted all vegetation field sampling. Co-PI Joseph Gathman prescreened the suitability of sample sites, coordinated all logistics, secured accommodations, and obtained sampling permissions where necessary.

Carla Huebert has led the vegetation component of the project since 2013, so only a review and refresher of protocols was needed as outlined in the QAPP. The review included instruction in GPS use, assessment of whether sites met project criteria (open water connection to lake, presence of a wetland, safe access), and identification of vegetation zones to be sampled, Carla also received refresher training and review in field data and lab entry to become familiar with changes to the database.

Challenges and Lessons Learned

2025 lake levels were somewhat lower than in 2024, continuing a general decline since the 2019-2020 peaks. According to the Great Lakes Water Level Dashboard managed by Great Lakes Environmental Research Laboratory (https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html), Lake Huron's 2025 midsummer lake-level peak was approximately 25 cm lower than in 2024 and 98 cm lower than the recent high level reached in 2020. Lake Erie's year-over-year change was less, but still greater than in the 2023-24 interval: it was 14 cm lower than in 2024, and 66 cm lower than the long-term peak reached in 2019.

The recent high-water years (probably combined with emerald-ash-borer infestations) caused many trees at the upper wet-meadow edges to die off. This has allowed the meadows to expand upslope, creating much longer transects, thus more walking time. Further, like last year, the standing dead trees remain a potential hazard (falling limbs), which must be taken into account.

Site Visit List

The UW team has capacity to sample 30 wetlands annually. We were initially assigned 30 candidate sites on Lakes Erie and Huron, but several of these sites were inaccessible. Instead, we sampled four wetlands on the Canadian shore of eastern Lake Ontario that had originally been assigned to the Canadian Wildlife Service team. These included site 5104 Blessington Creek Marsh 2, site 5358 Grafton Swamp, site 5922 South Bay Marsh 2, and site 6040 Wellers Bay Wetland 7.

Vegetation sampling for the UWindsor team began on June 16th, 2025, at Rondeau Bay on Lake Erie, and ended on September 17th, 2025, at Hillman Marsh, also on Lake Erie. A total of 30 sites were sampled, including 29 panel sites (including 4 resample sites) and one benchmark site. Of those 30 sites, 15 were located on Lake Huron, 11 sites were on Lake Erie, and 4 sites were on Lake Ontario.

Panel Survey Results

Water levels continued their downward trend in 2025 in the basin areas sampled by the team, and as a result, created even larger wet meadow zones with more newly exposed shoreline. An interesting phenomenon within several Lake Huron wet meadow zones was noted in 2025: now that water levels have been on the decline for four years, the upper wet-meadow zone has had time to re-establish and mature with the drier conditions, while a new lower, recently exposed wet meadow zone has formed, as water levels continued to lower in 2025. This has resulted in two entirely different plant communities within the same zone.

Characteristic sedge-meadow vegetation in the upper wet-meadow zone consisted of the usual dominant sedges and grass species (*Carex stricta, C. lacustris, C. lasiocarpa, Calamagrostis canadensis*). In addition to these common sedges and grasses, several other less-dominant species (but nonetheless consistently present) were surveyed in the upper meadow zone, including goldenrods (*Solidago sp.),* asters (*Symphyotrichum sp.),* boneset (*Eupatorium perfoliatum*), Joe-Pye weed (*Eutrochium maculatum*), and swamp milkweed (*Asclepias incarnata*).

While there was also a wide variety of lower wet-meadow vegetation, several uncommon plants that have been rarely or never seen in previous years were found in several of these lower meadow zones, including: autumn sedge (*Fimbristylis autumnalis*), umbrella sedge (*Cyperus diandrus*), brown-fruited rush (*Juncus pelocarpus*), and pipewort (*Eriocaulon aquaticum*). The lower wet meadow zone was characterized as having low growing, sparser vegetation, with minimal detritus or standing dead stems. Figure 1 (below) illustrates the stark contrast between the upper wet meadow and lower wet meadow.

One of our Lake Huron sites, Sadler Creek Wetland 5 (5848) located in Ontario's Bruce Peninsula, included a large, rare coastal fen. This site has been sampled several times since 2011, but each survey year has picked up different unique plants growing there. While typical carnivorous vegetation associated with a fen community was sampled there again this year, such as pitcher plant (*Sarracenia purpurea*), linear-leaved sundew *(Drosera linearis*), and horned bladderwort (*Utricularia cornuta*), several new and rare plants were also encountered, including fen orchid (*Liparis loeselii*), tuberous Indian plantain (*Arnoglossum plantagineum*), and white camas (*Anticlea elegans* ssp. *glauca*).

Figure 1. Highlighting the stark contrast between the upper, established wet-meadow zone (upper portion of photo beneath tree line), and the new, recently exposed wet meadow zone (middle and lower portions of photo). Old Fort St. Joe, St. Joseph Island (site #5702), Lake Huron.

Two sites sampled in 2025 within Canada's Lake Erie western basin were Wheatley East Two Creeks (6054), and Cedar Creek (5164). These were both noteworthy sites for vegetation due to both sites containing wet meadow zones, which is rather uncommon in Canada's western-basin wetlands, most of which have been overtaken by near monocultures of the nonnative *Phragmites australis*, known as "common reed" or simply "phragmites".

Many of the Canadian Lake Erie western-basin sites are of the riverine type. These wetlands are characterized as having wide but shallow creeks with raised, high-and-dry creek banks precluding the establishment of wetland vegetation. In the few areas where a wet meadow was historically present, invasive phragmites had overtaken the zone, leaving very little trace of any meadow that would have existed there previously. Now that Phragmites control measures have been intermittently used at several sites, some of these wet meadows have begun to rebound. Of the four wet-meadow zones that were found during sampling at Wheatley East and Cedar Creek (two at each site), several seldom-seen plants were found at both sites, including crested sedge (*Carex cristatella*), Torrey's rush (*Juncus torreyi*) and monkeyflower (*Mimulus ringens*). Indian tobacco (*Lobelia inflata*) was also observed in several quadrats in the Cedar Creek wet meadow.

<u>Invasive species:</u>

European Water Clover (*Marsilea quadrifolia*): The floating-leaved European water clover (*Marsilea quadrifolia*, Figure 2), was found for the first time at Nanticoke Creek Mouth (site 5667), in Lake Erie's eastern basin. It was in a shallow, quiet creek, and was observed to have also taken on a terrestrial form growing onto the organic mud banks along the creek.

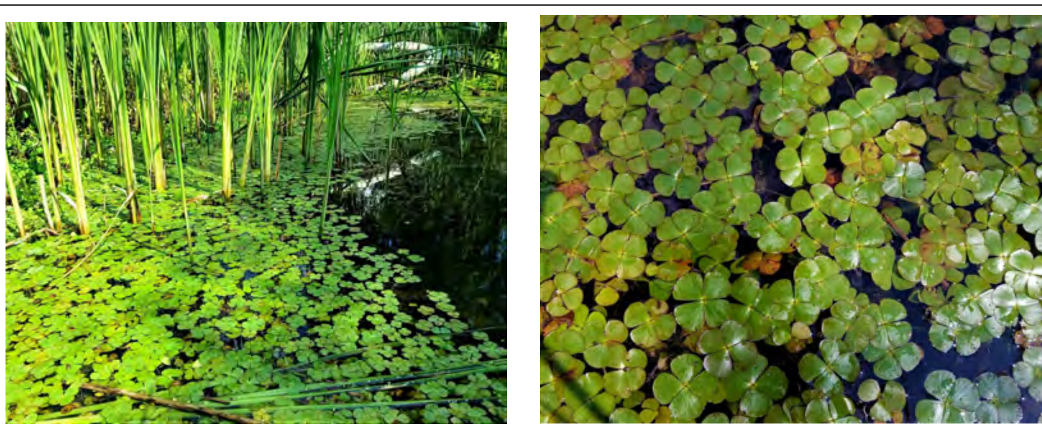


Figure 2. New floating-leaf invasive European water clover (*Marsilea quadrifolia*), found for the first time by the UWIN crew at Nanticoke Creek Mouth (5667), eastern Lake Erie.

Common Hemp Nettle (*Galeopsis tetrahit*): Common hemp nettle was found for the first time for the UWIN team at two sites in Lake Huron's north channel: Findlay Point Wetland (site 5280) and Desbarats Wetland (site 5234). Both sites have been sampled numerous times, as both have been resample sites in previous years, as well as having been on the regular five year sampling circuit, and prior to 2025 this species had never been observed at these or any other sites. While common hemp nettle is not a new nonnative to the Great Lakes region as a whole, it is new to our sampling area, and should be monitored in future years, as it has the potential to take over wet meadow communities where it becomes established.

Hydrilla (*Hydrilla verticillata*): The highly invasive submergent Hydrilla was found in late 2024 at one of our Lake Erie western basin sites, Hillman Marsh (site 5422). It was discovered by another Ontario research team in a closed wetland cell, directly adjacent to the open area of the wetland where our sampling takes place. Remediation efforts by the local conservation authority and other organizations is currently underway, and while it was not found during our 2025 survey in the open, connected part of the wetland, the infestation is still not under control in the nearby closed cell. In 2024 Hillman Marsh became a benchmark site for our team to monitor the changes in the wetland as work began to reconstruct the large barrier beach that had been eroded away during the high-water years. Now, in addition to that, we will continue to monitor the site for any signs that Hydrilla has migrated into the open, connected portion of the wetland (Figure 3).

Figure 3. Newly posted signs at boat launch advising boaters of best practices

<u>Species at risk:</u>

Dwarf Lake Iris (*Iris lacustris*): Dwarf lake-iris was found at one of our sites on Lake Huron south of the Bruce Peninsula, Baie du Dore 2 (site 5016). This was the first time this species has been recorded there for CWMP. (Federal COSEWIC Status: Special Concern)

Swamp Rose Mallow (*Hibiscus moscheutos*): Swamp rose mallow was surveyed at two of our Lake Erie sites: Rondeau Bay Wetland 1 (site 5821) and Cedar Creek (site 5164). This was the first time this species has been recorded at either site. (Federal COSEWIC Status: Special Concern).

Extra Sites and Data

We did not sample any extra sites in 2025.

Data Processing

All vegetation data and GPS waypoints have been entered into the database.

Mid-season QC Check Findings

No difficulties or anomalies were observed during mid-season checks, which were self-administered, because field crew leaders have at least 14 years experience with the CWM teams.

Audit and QC Report and Findings

QC will be carried out in October.

Additional Funding and Projects

None to report for 2025.

Other Collaboration Activities

In 2024 Hillman Marsh became a benchmark site for our team to monitor the changes in the wetland as work began to reconstruct the large barrier beach that had been eroded away during the high-water years. Now, in addition to that, we will continue to monitor the site for any signs that Hydrilla has migrated into the open, connected portion of the wetland (Figure 3).

Other Data Requests

No data requests were received in 2025.

Related Student Research

No additional projects to report.

CANADIAN EASTERN BASIN FISH, INVERTEBRATE AND WATER QUALITY TEAM AT CANADIAN WILDLIFE SERVICE

Team Members

- Joe Fiorino, PI, wetland ecologist (since 2016)
- Ian Smith, crew leader, fish sampling, GIS tech (since 2014)
- Hayley Rogers, team leader, vegetation sampling (since 2017)
- Patrick Rivers, team leader, WQ/invert sampling (intermittent since 2014)
- Albert Garofalo, field crew member, vegetation sampling (intermittent since 2018)
- Marissa Zago, field crew member, vegetation/fish/WQ/invert sampling (intermittent since 2018)
- Kayla Alipanah, summer student field tech, WQ/invert/fish/vegetation sampling (new 2025)
- Breanna Pevec, summer student field tech, WQ/invert/fish/vegetation sampling (new 2025)

Training

Environment and Climate Change Canada – Canadian Wildlife Service (ECCC-CWS) field crew members were trained by Joe Fiorino, Ian Smith, and Hayley Rogers. The sampling protocol, use of technical equipment, occupational health and safety, and field-based decision-making were covered in detail over multiple days; staff were assessed in the field and lab for proper sample collection, data recording, GPS use, water processing, equipment calibration, and lab sample preparation and storage. A practice session at a nearby wetland and in our lab facility was conducted in July 2025 to provide hands-on training to new staff. An experienced staff member was paired with new personnel to reinforce project protocols and ensure high data quality. A mid field-season check was conducted in mid-August. No problems were identified.

Challenges and Lessons Learned

None

Site Visit List

As in previous years, the number of sites originally assigned to our group (21) exceeded the capacity of the ECCC-CWS field crew, so two sites were given to SUNY-Brockport (5005, 5196) and five sites were given to University of Windsor (5104, 5358, 5922, 6039, 6040).

Eleven sites were sampled. We were unable to secure permission to sample one site (5306) and two sites were “web rejects” (5090, 5857). Vegetation sampling was conducted at all 11 sites, water quality and invert sampling was conducted at 10 sites (all except 6002), and fish sampling was conducted at seven sites (all except 5312, 5536, 5558, 6002). Turtle Creek (6002) could not be sampled for fish, invertebrates, or water quality because there was very limited flooded wetland area (only a small creek, <1m wide) and accessibility was limited. Fish sampling could not be conducted at Four Mile Creek Estuary (5312) because the site could only be accessed by canoe from a steep bank (and there was no way to safely transport nets). Fish sampling could not be conducted at Lower Napanee River 5 (5558) because we were unable to penetrate the rocky substrate with the net poles. Fish sampling could not be conducted at Long Point Bay Marsh 1 (5536) due to drier than usual conditions (which made accessing the site challenging) in combination with very deep unconsolidated sediment in the open water area of the marsh that was not suitable for setting nets.

Panel Survey Results

Sampling occurred August 5, 2025 to August 22, 2025. Data are currently being entered into the DMS.

<u>Reptiles:</u>

Painted Turtle (*Chrysemys picta*) was caught at sites 5088, 5251 (2 individuals), 5337, and 6048. Musk Turtle (*Sternotherus odoratus*) was caught at site 5257 (4) (Figure 40). Common Snapping Turtle (*Chelydra serpentina*) was caught at sites 5088, 5251, and 6048.

<u>Rare species:</u>

Tadpole Madtom (*Noturus gyrinus)* was caught at site 5257 (5 individuals) (Figure 41). This was only the second time that our crew has caught this species since the start of the program (last time was in 2014 at site 5573).

Figure 40. Musk turtle caught at East Lake Marsh (5257).

Non-native species:

Round Goby (*Neogobius melanostomus*) were caught at sites 5064 (13 individuals), 5088 (1), 5868 (1), and 6048 (3). Common Carp (*Cyprinus carpio*) were caught at site 5251 (7).

Extra Sites and Data

No benchmark sites were sampled.

Continued to collect data on short-term variation in dissolved oxygen and water levels for Dr. Jan Ciborowski (University of Windsor). These data are managed by Dr. Ciborowski's lab.

Figure 41. Tadpole madtom caught at East Lake Marsh 5 (5257).

Wetland Condition Observations and Results

Despite above average air temperatures and below average rainfall, water levels in August on Lake Ontario were consistent with seasonal averages.

Nothing else to add beyond what was mentioned in the Panel Survey Results above.

Data Processing

Entry of fish and field-collected water quality and invertebrate data is nearly complete. Records will be quality-assured by a team member with multiple years of experience working on the program, and with the data entry system. We are currently awaiting laboratory water quality results from the National Laboratory for Environmental Testing (NLET); we expect they will be ready by the end of October. Macroinvertebrate sample vials have been inventoried and will be sent to University of Windsor for identification this fall. Chlorophyll-a samples will be sent to University of Notre Dame this fall.

Mid-season QC Check Findings

No difficulties or anomalies were observed during mid-season checks.

Audit and QC Report and Findings

Data entry is currently ongoing. Records will be quality-assured by a team member with multiple years of experience working on the program, and with the data entry system. All QC issues identified between 2016 and 2022 in the Data Verification Interface have been addressed, as well as past point-matching issues.

Additional Funding and Projects

Since 2021, ECCC-CWS has worked with the International Joint Commission to update marsh bird ecological performance indicators used for adaptive management of outflow regulation on Lake Ontario. ECCC-CWS received support from the bird/anuran team in December 2021 to conduct an analysis using CWMP data, and ultimately identified six potential bird-based indicators for consideration by the IJC. This work was published in the Journal of Great Lakes Research in early 2023. Since then, CWS has worked with the Hydrodynamic and Ecohydraulic Section of the National Hydrological Service to utilize spatially-explicit, model-generated data pertaining to water depths, flooding patterns, and habitat extent and structure at wetland sites on Lake Ontario to develop predictive models of marsh bird abundance and richness. These predictive models are currently being used as ecological performance indicators for the ongoing expediated review of the current water-level regulation plan (Plan 2014). The associated manuscript is currently being prepared for submission to *Journal of Great Lakes Research*.

In 2024 and 2025, ECCC-CWS developed and tested a new plant-based Index of Biotic Condition (pIBC) for coastal wetlands of each of the five Laurentian Great Lakes. The pIBC shares conceptual similarities with Floristic Quality Assessment (FQA) metrics, but incorporates species-specific sensitivity and responsiveness to anthropogenic disturbance based on modeled probabilities of occurrence derived from field data. This distinguishes it from traditional FQA metrics, which rely on expert-assigned Coefficients of Conservatism and do not incorporate occurrence probability. We found that the lake-specific versions of the pIBC consistently outperformed seven other plant-based metrics, including multiple FQA variants, in predicting a composite index of water quality and land use disturbance in four of the five lakes (lakes Erie, Michigan, Ontario, and Superior), and was a close-second in the fifth (Lake Huron). The pIBC was also robust across wetlands of different hydrogeomorphic types and under different water-level conditions. The pIBC's strong performance suggests it is well suited for assessing coastal wetland condition across sites and within sites through time. Overall, this new index is a conceptually grounded and statistically robust tool for conservation practitioners that is easy to calculate and interpret. The associated manuscript is currently being prepared for submission to *Biological Conservation*.

Other Collaboration Activities

ECCC-CWS is collaborating on a project with Birds Canada to assess whether Mute Swans and Trumpeter Swans negatively influence species richness and abundance of marshbirds due to the aggressive and highly territorial behavior. Mute Swan, Trumpeter Swan, marshbird, and local habitat (< 100 m) data will be from the Great Lakes Marsh Monitoring Program and the Great Lakes Coastal Wetland Monitoring Program.

Other Data Requests

In November 2024, Credit Valley Conservation requested plant survey data (site-level species observations) for Canadian sites on Lake Ontario (2011-2023). Their group will use these data to help develop restoration success targets for a new conservation area just outside of Toronto, Ontario.

Related Student Research

In 2025, a junior ecologist on the ECCC-CWS team assessed the spatial distribution and abundance of *Nitellopsis obtusa* over time in Great Lakes coastal wetlands using CWMP data. Results indicate a dramatic increase in both presence and abundance of *Nitellopsis obtusa* across the region. From 2016 to 2020, it was only observed in Lake Ontario and Lake Erie, but since 2021 has been observed in at least one wetland in all five Great Lakes. Notable expansions occurred in Saginaw Bay and southern Georgian Bay, where *Nitellopsis obtusa* was previously undetected. These findings suggest rapid colonization and intensification of this invasive species. This study underscores the urgent need for coordinated management strategies, early detection, and more awareness of this species to safeguard the Great Lakes wetland ecosystems. The associated manuscript is currently being prepared for submission to *Wetlands Ecology and Management*.

CANADIAN EASTERN BASIN VEGETATION TEAM AT CANADIAN WILDLIFE SERVICE

Team Members

- Joe Fiorino, PI, wetland ecologist (since 2016)
- Ian Smith, crew leader, fish sampling, GIS tech (since 2014)
- Hayley Rogers, team leader, vegetation sampling (since 2017)
- Albert Garofalo, field crew member, vegetation sampling (intermittent since 2018)
- Kayla Alipanah, summer student field tech, WQ/invert/fish/vegetation sampling (2025)
- Breanna Pevec, summer student field tech, WQ/invert/fish/vegetation sampling (2025)

Training

Environment and Climate Change Canada – Canadian Wildlife Service (ECCC-CWS) field crew members were trained by Joe Fiorino, Ian Smith, and Hayley Rogers. The sampling protocol, technical equipment use, occupational health and safety, and field-based decision-making were covered in detail over multiple days; staff were assessed in the field for GPS use, measuring and spacing of transects, filling out datasheets properly, ensuring species coverages were recorded correctly and standardized, and collecting and taking notes for unknown plant specimens. A practice session at a nearby wetland and in our lab facility was conducted in July 2024 to provide hands-on training to new staff. An experienced staff member was paired with new personnel to reinforce project protocols and ensure high data quality. A mid-field-season check was conducted in mid-August. No problems were identified.

Challenges and Lessons Learned

None.

Site Visit List

As in previous years, the number of sites originally assigned to our group (21) exceeded the capacity of the ECCC-CWS field crew, so two sites were given to SUNY-Brockport (5005, 5196) and five sites were given to University of Windsor (5104, 5358, 5922, 6039, 6040).

Eleven sites were sampled. We were unable to secure permission to sample one site (5306) and two sites were “web rejects” (5090, 5857). Vegetation sampling was conducted at all 11 sites.

Panel Survey Results

Sampling occurred August 5, 2025 to August 22, 2025. Data are currently being entered into the DMS.

Rare species:

Swamp rose-mallow (*Hibiscus moscheutos*), a species of Special Concern under Schedule 1 of the Species at Risk Act in Canada, was observed while sampling Four Mile Creek Estuary (5312) (Figure 42).

Figure 42. Swamp rose-mallow observed while sampling Four Mile Creek Estuary (5312).

Non-native species:

Typha x glauca dominates most wetlands on Lake Ontario. Many invasive species are common (e.g., *Hydrocharis morsus-ranae, Myriophyllum spicatum, Lythrum salicaria, Nitellopsis obtusa, Phalaris arundinacea, Lycopus europaeus, Solanum dulcamara*). Less common invasive species that were observed multiple times in 2025 included *Glyceria maxima*, *Lysimachia nummularia, Cirsium arvense, Potamogeton crispus, Phragmites australis, Iris pseudacorus, Butomus umbellatus, and Najas minor.*

Extra Sites and Data

No benchmark sites were sampled and no extra data were collected.

Wetland Condition Observations and Results

Despite above average air temperatures and below average rainfall, water levels in August on Lake Ontario were consistent with seasonal averages.

Data Processing

Data entry is currently ongoing. Records will be quality-assured by an experienced member of the team with multiple years of experience working with the data entry system.

Mid-season QC Check Findings

No difficulties or anomalies were observed during mid-season checks.

Audit and QC Report and Findings

Data entry is currently ongoing. Records will be quality-assured by a team member with multiple years of experience working on the program, and with the data entry system. All QC issues identified between 2016 and 2022 in the Data Verification Interface have been addressed, as well as past point-matching issues.

Additional Funding and Projects

Since 2021, ECCC-CWS has worked with the International Joint Commission to update marsh bird ecological performance indicators used for adaptive management of outflow regulation on Lake Ontario. ECCC-CWS received support from the bird/anuran team in December 2021 to conduct an analysis using CWMP data, and ultimately identified six potential bird-based indicators for consideration by the IJC. This work was published in the Journal of Great Lakes Research in early 2023. Since then, CWS has worked with the Hydrodynamic and Ecohydraulic Section of the National Hydrological Service to utilize spatially-explicit, model-generated data pertaining to water depths, flooding patterns, and habitat extent and structure at wetland sites on Lake Ontario to develop predictive models of marsh bird abundance and richness. These predictive models are currently being used as ecological performance indicators for the ongoing expediated review of the current water-level regulation plan (Plan 2014). The associated manuscript is currently being prepared for submission to *Journal of Great Lakes Research*.

In 2024 and 2025, ECCC-CWS developed and tested a new plant-based Index of Biotic Condition (pIBC) for coastal wetlands of each of the five Laurentian Great Lakes. The pIBC shares conceptual similarities with Floristic Quality Assessment (FQA) metrics, but incorporates species-specific sensitivity and responsiveness to anthropogenic disturbance based on modeled probabilities of occurrence derived from field data. This distinguishes it from traditional FQA metrics, which rely on expert-assigned Coefficients of Conservatism and do not incorporate occurrence probability. We found that the lake-specific versions of the pIBC consistently outperformed seven other plant-based metrics, including multiple FQA variants, in predicting a composite index of water quality and land use disturbance in four of the five lakes (lakes Erie, Michigan, Ontario, and Superior), and was a close-second in the fifth (Lake Huron). The pIBC was also robust across wetlands of different hydrogeomorphic types and under different water-level conditions. The pIBC's strong performance suggests it is well suited for assessing coastal wetland condition across sites and within sites through time. Overall, this new index is a conceptually grounded and statistically robust tool for conservation practitioners that is easy to calculate and interpret. The associated manuscript is currently being prepared for submission to *Biological Conservation*.

Other Collaboration Activities

See fish, invertebrate, and water quality report.

Other Data Requests

In November 2024, Credit Valley Conservation requested plant survey data (site-level species observations) for Canadian sites on Lake Ontario (2011-2023). Their group will use these data to help develop restoration success targets for a new conservation area just outside of Toronto, Ontario.

Related Student Research

In 2025, a junior ecologist on the ECCC-CWS team assessed the spatial distribution and abundance of *Nitellopsis obtusa* over time in Great Lakes coastal wetlands using CWMP data. Results indicate a dramatic increase in both presence and abundance of *Nitellopsis obtusa* across the region. From 2016 to 2020, it was only observed in Lake Ontario and Lake Erie, but since 2021 has been observed in at least one wetland in all five Great Lakes. Notable expansions occurred in Saginaw Bay and southern Georgian Bay, where *Nitellopsis obtusa* was previously undetected. These findings suggest rapid colonization and intensification of this invasive species. This study underscores the urgent need for coordinated management strategies, early detection, and more awareness of this species to safeguard the Great Lakes wetland ecosystems. The associated manuscript is currently being prepared for submission to *Wetlands Ecology and Management*.

US EASTERN BASIN BIRD AND ANURAN TEAM AT SUNY BROCKPORT

Team Members

- Dr. Kathryn Amatangelo, Project PI, macroinvertebrates (since 2014)
- Matthew Silverhart, project manager, Fish PI, fish/invert/WQ crew lead (since 2020)
- Dr. Kristin Malone, Bird/Anuran PI (since 2023)

- Alexa Lashway, graduate research assistant, bird crew lead (new 2024)
- Addison Warriner, undergraduate technician, anuran crew leader (new)

Training

Both field technicians (Alexa Lashway and Addison Warriner) were trained by PI Dr. Kristen Malone and project manager Matthew Silverhart on proper field sampling techniques, data collection and recording, GPS use, and field safety. Both technicians were accompanied by project manager Matthew Silverhart for the first Bird and Anuran samplings of the season to ensure proper sampling techniques and train the technicians. Anuran training and observation took place 3 May 2025 at site 0029 – Long Pond. Bird training and observation took place 1 June 2025 at site 1840 – Presque Isle Wetland. Lastly, both field technicians were trained in data entry and QC checks in the database by project manager Matthew Silverhart. Both field technicians were successfully trained, passed the Bird (Alexa Lashway) and Anuran (Alexa Lashway and Addison Warrner) identification exams, and met pre-season training performance criteria described in the project QAPP.

Challenges and Lessons Learned

Several issues were encountered this season regarding field crew scheduling conflicts. Our new field technician, Addison Warriner, had health issues that resulted in their absence from the field for a full week twice during the season. The project manager, Matthew Silverhart, stepped in to complete the field work and Alexa Lashway had to adjust the schedule multiple times.

Site Visit List

Of the 24 assigned sites for the Bird/Anuran team of SUNY Brockport, 21 were sampled in full and 3 could not be accessed (either due to physical barriers or lack of ability to sample safely). 18 of the assigned sites were panel sites, 2 were resample sites from the previous year, 3 were presample sites for the following season, and 2 were benchmark sites (site 0051 was both a benchmark and a resample site). All benchmark sites were requested by SUNY Brockport PIs due to restoration projects either being planned, ongoing, or having previously occurred at the specified sites. This information can be used to better inform and shape restoration efforts.

Panel Survey Results

Sampling of panel sites for anurans began on 4 May 2025 at site 0070 – Port Bay Wetland and concluded on 7 July 2025 at site 1840 – Presque Isle Wetland. During the anuran sampling of panel sites, six species of anurans were detected. Those species were American Toad, Bullfrog, Chorus Frog, Gray Treefrog, Green Frog, Northern Leopard Frog, and Spring Peeper. The species detected most frequently were the Gray Treefrog, Green Frog, and Spring Peeper.

Sampling of panel sites for birds began on 1 June 2025 at site 1840 – Presque Isle Wetland and concluded on 8 July 2025 at site 1840 – Presque Isle Wetland. During the bird sampling of panel sites, 58 species of birds were detected and seven of those species were classified as unidentified. Two of the bird species at panel sites are listed as threatened, two species are listed as species of special concern, and one species is listed as a high priority species of greatest conservation needed by the New York Department of Environmental Conservation (NYDEC). The threatened species are Least Bittern and Pied-billed Grebe. The species of special concern are the Osprey and American Bittern, and the high priority species of greatest conservation needed is the Eastern Meadowlark. At most panel sites, more species of bird were detected in the AM sampling period than the PM sampling period. The most common species detected at panel sites were the Red-winged Blackbird, Yellow Warbler, American Robin, and Swamp Sparrow.

Extra Sites and Data

Sampling of benchmark sites for anurans began on 8 May 2024 at site 7052: Braddock Bay and concluded on 27 June 2024 at site 28: Salmon Creek. During the anuran sampling of benchmark sites, six species of anurans were detected. Those species were American Toad, Bullfrog, Gray Treefrog, Green Frog, Northern Leopard Frog, and Spring Peeper. The Northern Leopard Frog was only detected one time during our sampling at site 7052: Braddock Bay. The species detected most frequently were the Bullfrog, Gray Treefrog, and Green Frog.

Sampling of benchmark sites for birds began on 15 June 2025 at site 0029 – Long Pond Wetland and concluded on 3 July 2025 at site 0051 – Buck Pond. During the bird sampling of benchmark sites, 34 species of birds were detected and two of those species were classified as unidentified. None of the bird species at benchmark sites were listed as threatened, species of special concern, or high priority species of greatest conservation needed by the New York Department of Environmental Conservation (NYDEC). At most benchmark sites, more species of bird were detected in the AM sampling period than the PM sampling period.

Wetland Condition Observations and Results

With most sampling points being accessible from nearby parks and or roads, there were not major impacts from changing wetland conditions.

Data Processing

All data collected during 2025 GLCWMP Bird/Anuran sampling has been entered and checked. The habitat forms were collected during bird sampling and will be mailed to Doug Tozer in October of 2025. Digital copies have been created for backup.

Mid-season QC Check Findings

Mid-season QC check for the Bird/Anuran team occurred at site 1840 – Presque Isle Wetland on 1 June 2025 with project manager Matthew Silverhart administering the mid-season QC check. The crew members involved were Alexa Lashway and Addison Warriner. The crew performed all tasks to satisfaction and there were no issues noted that needed to be addressed.

Audit and QC Report and Findings

Other than minor data entry errors, there were no large-scale errors of note for the Bird/Anuran data entry and QC.

Additional Funding and Projects

No additional funding was used for any related projects or additional sampling.

Other Collaboration Activities

There were no additional collaboration activities during the 2025 sampling season for the Bird/Anuran sampling team.

Other Data Requests

There were no additional data requests during the 2025 sampling season for the Bird/Anuran sampling team.

Related Student Research

No student research coincided with Bird/Anuran sampling this season.

US EASTERN BASIN FISH, INVERTEBRATE, AND WATER QUALITY TEAM AT SUNY BROCKPORT

Team Members

- Dr. Kathryn Amatangelo, PI, Macroinvertebrate PI (since 2014)
- Matthew Silverhart, Project Manager, Fish PI, Fish/Invert/WQ crew lead (since 2020)
- Dr. Michael Chislock, Water Quality PI (since 2018)
- Dillon Vandemortel, graduate research assistant (since 2023)
- Grace Trebilcock, Graduate Research Assistant, Water Quality analysis (since 2024)
- Megan Gerber, Undergraduate Research Assistant, Fish/Invert/WQ crew member (new)
- Cameron Washburn, Undergraduate Research Assistant, Fish/Invert/WQ crew member (new)
- Victoria Kruppenbacher, Undergraduate Research Assistant, Fish/Invert/WQ crew member (new)

Training

All field technicians were trained by Project Manager Matthew Silverhart on proper field sampling techniques, lab data collection and recording, GPS use, boat use and safety, fish identification, fyke net operation, macroinvertebrate collection and storage, and date entry. PI Dr. Michael Chislock and Project Manager Matthew Silverhart trained field technicians on proper water quality sample storage, processing, and analysis. Training took place June 16-20, 2025, at the SUNY Brockport campus and site 0029 – Long Pond for field training. All field technicians were successfully trained and met pre-season and mid-season training performance criteria described in the project QAPP. These performance checks were administered by the associated PI and project manager.

Challenges and Lessons Learned

This season saw a crew of no returning technicians or graduate students on the team. The new dynamic of training individuals with no field experience to operate across two boats was a new challenge, but one that all participants were eager to tackle. This summer proved to be a learning experience for all involved. Some of the most important lessons learned by the crew was the importance of taking each site slowly and making sure all “boxes have been checked” as the GLCWMP SOP is comprised of many moving pieces and it can be easy to overlook certain equipment or tasks.

Site Visit List

Of the 15 assigned sites for the Fish/Invert/WQ team of SUNY Brockport, 11 were sampled in full, while 4 could not be accessed either due to physical barriers or lack of ability to sample safely. 9 of the assigned sites were panel sites, 2 were resample sites from the previous year, 3 were presample sites for the following season, and 2 were benchmark sites (site 0051 – Buck Pond was both a benchmark and a resample site). All benchmark sites were requested by SUNY Brockport PIs due to restoration projects either being planned, ongoing, or having previously occurred at the specified sites. This information can be used to better inform and shape restoration efforts.

Panel Survey Results

Macroinvertebrate ID is taking place over the winter by project manager Matthew Silverhart and updated data on their ID will be available in the Spring 2026 report. 45 species of fish (and turtles) were observed during the fyke net sampling of panel sites with seven of those species being listed as non-native by the New York Department of Environmental Conservation (NYDEC). The seven non-native species caught during panel sampling were Alewife, Chinook Salmon, Common Carp, Freshwater Tubenose Goby, Goldfish, Round Goby, and Rudd. Spotted Gar, which are listed as endangered by the NYDEC, were encountered while sampling site 5196, which is Collins Creek Wetland 2 in Canada. Panel sampling began on 24 June 2025 at site 7025 – Goose Pond and concluded on 31 July 2025 at site 5005 – Adolphustown Marsh 2.

Figure 43. Young-of-year Bowfin captured in a fyke net at site 0118 (Salmon River Marsh). Photo taken by Matthew Silverhart.

Extra Sites and Data

Macroinvertebrate ID is taking place over the winter by project manager Matthew Silverhart and updated data on their ID will be available in the Spring 2026 report. 18 species of fish (and turtles) were observed during the fyke net sampling of benchmark sites with two of those species being listed as non-native by the NYDEC. The two non-native species caught during benchmark sampling were Common Carp and Goldfish). Benchmark sampling began on 19 June 2025 at site 0029 – Long Pond and concluded on 20 June 2025 at site 0051 – Buck Pond. Each benchmark site was requested by PIs at SUNY Brockport to continue monitoring previous restoration efforts conducted at those sites.

Figure 44. (Left to right) Cameron Washburn, Victoria Kruppenbacher, and Megan Gerber deploying a fyke net at site 0118 (Salmon River Marsh). Photo taken by Matthew Silverhart.

Wetland Condition Observations and Results

Many of the barrier wetlands encountered have been separated from the open water of the Great Lakes basin by roads and culverts. While this is not a new occurrence, it makes it increasingly difficult to access barrier wetlands, which are still functioning, but their connectivity is continuously harder to evaluate. This, coupled with changing water levels around the Great Lakes basin, can have impacts on the seasonal passage for fish both to and from the barrier wetlands.

A vast majority of the wetlands sampled exhibited large mats of floating *Typha spp.* which were nearly impenetrable for sampling for Fish/Invert/WQ. While they are a monodominant vegetation zone, they do not allow for any of the Fish/Invert/WQ team to sample because there is no water on top of the mat and the water beneath them is inaccessible due to the thick root structures of the vegetation. Even if you can penetrate through the mat, there is only thick muck below.

Data Processing

At the time of this report's submission, all water quality analysis has been completed and is waiting to be entered and QC following the submission of these reports. All field water quality data have been entered and checked. Fyke data has been entered for all sites, and the QC process is completed. Macroinvertebrate ID is to be completed over the winter and entered/QC prior to the 2026 spring report. Main record and habitat data have been entered for all sites and has had QC completed.

Mid-season QC Check Findings

Mid-season QC check for the Fish/Invert/WQ team occurred at site 7023 on 22 July 2024 with Matthew Silverhart and Dr. Michael Chislock administering the mid-season QC check. The crew members involved were Dillon VanDemortel, Kai Schedel, and Grace Trebilcock. The crew performed all tasks to satisfaction and there were no issues noted that needed to be addressed.

Audit and QC Report and Findings

Mid-season QC check for the Fish/Invert/WQ team occurred at site 0161 – Muskalonge Bay Wetland on 21 July 2025 with Matthew Silverhart and Dr. Michael Chislock administering the mid-season QC check. The crew members involved were Megan Gerber, Cameron Washburn, and Victoria Kruppenbacher. The crew performed all tasks to satisfaction, and there were no issues noted that needed to be addressed.

Additional Funding and Projects

There were no additional funding and projects during the 2025 sampling season for the Fish/Invert/WQ sampling team.

Other Collaboration Activities

There were no additional collaboration activities during the 2025 sampling season for the Fish/Invert/WQ sampling team.

Other Data Requests

There were no additional data requests during the 2025 sampling season for the Fish/Invert/WQ sampling team.

Related Student Research

No student research coincided with Fish/Invert/WQ sampling this season.

US EASTERN BASIN VEGETATION TEAM AT SUNY BROCKPORT

Team Members

- Dr. Rachel Schultz, Vegetation PI (since 2019)
- Dr. Kathryn Amatangelo, PI, macroinvertebrate PI (since 2014)
- Matthew Silverhart, Project Manager, Fish PI, Fish/Invert/WQ crew lead (since 2020)
- Kendalyn Town, graduate research assistant, vegetation crew leader (since 2022)
- Sophia Maum, Undergraduate Technician (since 2024)

Training

Both field technicians (Kendalyn Town and Sophia Maum) were trained by PI Dr. Rachel Schultz and project manager Matthew Silverhart on proper field sampling techniques, data collection and recording, GPS use, and canoe use and safety. Both technicians were trained by PI Dr. Rachel Schultz in plant identification and sample preservation and storage. All training took place June 16-19, 2025 at the SUNY Brockport campus and site 0029 – Long Pond, for field training. Lastly, both field technicians were trained in data entry and QC checks in the database by project manager Matthew Silverhart. Both field technicians were successfully trained, passed the plant identification quiz, and met pre-season training performance criteria described in the project QAPP.

Challenges and Lessons Learned

This season saw the return of both crew members from the previous season. Having both crew members return allowed more focus to be put on professional development than simply the standard operating procedures. The focus of this field season was on preparing Sophia Maum for potentially leading the vegetation crew in the future. This meant training her on how to lead others and train them in the vegetation standard operating procedures.

Site Visit List

Of the 20 assigned sites for the Vegetation team of SUNY Brockport, 17 were sampled in full and 3 could not be accessed (either due to physical barriers or lack of ability to sample safely). Twelve of the assigned sites were panel sites, 4 were resample sites from the previous year, 2 were presample sites for the following season, and 3 were benchmark sites (site 28 was both a benchmark and a resample site). All benchmark sites were requested by SUNY Brockport PIs due to restoration projects either being planned, ongoing, or having previously occurred at the specified sites. This information can be used to better inform and shape restoration efforts.

Panel Survey Results

During the sampling of panel sites, 31 species of non-native plants were identified and 19 of those species were classified as invasive. *Lobelia cardinalis*, which is listed as an “exploitably vulnerable native plant” by the New York Department of Environmental Conservation, was encountered while sampling site 82: Blind Sodus Bay. Panel sampling began on 26 June 2024 at site 28 and concluded on 19 August 2024 at site 82.

Extra Sites and Data

At the benchmark sites, there were 16 non-native species identified and 14 of those species were listed as invasive species. Benchmark sampling began on 20 June 2024 at site 7052 and concluded on 27 June 2024 at site 51. Each benchmark site was requested by PIs at SUNY Brockport to continue monitoring of previously restoration efforts conducted at those sites.

One additional quadrat at the start point of each transect, along the wetland-upland edge (aside from any transects where the narrow sampling procedure was used in the uppermost vegetation zone) was collected for use in a thesis project by Kendalyn Town. In each quadrat, all plant species were identified, and their percent cover was estimated. This data will be used to answer questions about whether wetland vegetation species are using the wetland-upland edges as refugia.

Wetland Condition Observations and Results

Many of the barrier wetlands encountered have been separated from the open water of the Great Lakes basin by roads and culverts. A vast majority of the wetlands sampled exhibited large mats of floating *Typha spp.* which made it difficult for vegetation crews to access the meadow portion of the transects.

Data Processing

All data collected during 2025 GLCWMP vegetation sampling has been entered and checked.

Mid-season QC Check Findings

Mid-season QC check for the Vegetation team occurred at site 82 on 18 July 2024 with PI Dr. Rachel Schultz administering the mid-season QC check. The crew members involved were Kendalyn Town and Sophia Maum. The crew performed all tasks to satisfaction and there were no issues noted that needed to be addressed.

Figure 44. Sophia Maum (front) and Kendalyn Town (back) record visual observations of vegetation in a quadrat at site 82 (Blind Sodus Bay). Photo taken by Dr. Rachel Schultz.

Audit and QC Report and Findings

Other than minor data entry errors, there were no large-scale errors of note for the vegetation data entry and QC.

Additional Funding and Projects

Kendalyn Town had requested the additional quadrat data collection be conducted by the other crews that take part in the GLCWMP vegetation sampling. Other crews have been sending over their data to Kendalyn Town as part of this collaboration.

Other Data Requests

None.

Related Student Research

Please see the aforementioned Kendalyn Town thesis project description for this portion.

ASSESSMENT AND OVERSIGHT

The Quality Assurance Project Plan (QAPP) for this program was originally written, signed by all co-PIs, and approved by USEPA in the spring of 2011, prior to beginning any fieldwork. Throughout the first round of the project (2011-2015), five revisions were made to the QAPP. These revisions were necessary to improve methodology, better clarify protocols, and ensure the safety of all personnel. After each revision, all co-PIs and US EPA reviewed and signed the updated document prior to commencing fieldwork. The final QAPP revision for round 1 of the project was signed in March 2015. This 2015 revision (QAPP_r5) served as the basis for the second round of monitoring (2016-2020).

For the second 5-year sampling rotation, no substantial methodological or quality assurance/quality control changes were necessary. The QAPP_r5 document was reviewed by project PIs prior to our February 19, 2016 project meeting. The only changes that were required to QAPP_r5 related to the data management system. Project PIs signed the updated QAPP (QAPP_CWMII_v1) at the February 19, 2016 meeting. In thoroughly reviewing the QAPP and SOPs in early 2018, crews found inconsistencies between the QAPP and SOPs and another handful of minor corrections and clarifications. PIs signed off on these changes at the 2018 PI meeting in Michigan in February. These fixes were incorporated into the QAPP in 2018 and PIs again signed off on the QAPP at the March 1, 2019, meeting in Michigan. The updated QAPP (QAPP_CWMII_rev 1) and SOPs were submitted to EPA in April of 2019.

For the third 5-year sampling rotation, again no substantial methodological or QA/QC changes were necessary. The QAPP was updated to reflect turnover in program personnel, to continue to strive for clarity and understandability by others and to make the QAPP more of a stand-alone document without reference to proposals or reports, and to remove inconsistencies between the QAPP and SOPs. The only substantive change was to update the water chemistry section to better reflect the updated EPA guidance on calculating error and variability in various water chemistry measurements. This QAPP (QAPP_CWMPIII_2021) was signed by PIs in the spring of 2021. The QAPP was updated in spring of 2023 (signed by all PIs) to reflect the re-creation of the Site Management System by Limnotech to be housed at Central Michigan University. We are in the process of again updating the water quality SOP and that section of the QAPP to further clarify a few things and ensure that crews have the guidance they need to avoid confusion. These changes will be finalized and the QAPP signed by PIs in winter 2025-2026.

Major QA/QC elements that are on-going for this program:

- Training of all new laboratory staff responsible for macroinvertebrate sample processing: This training is conducted by experienced technicians at each regional lab and is overseen by the respective co-PI or resident macroinvertebrate expert. Those labs without such an expert sent their new staff to the closest collaborating lab for training. Macroinvertebrate IDers communicate with each other via their own email list and assist each other with difficult identifications and other questions that arise. Every few years, typically when a major identification guide is updated, IDers for all teams meet either in-person or virtually to discuss taxonomic issues and questions.

- Training of all fish, macroinvertebrate, vegetation, bird, anuran and water quality field crew members following the QAPP and SOPs. This included passing tests for procedural competence as well as identification tests for fish, vegetation, birds, and anurans. Training certification documents were archived with the lead PI and QA managers.

- GPS testing: Every GPS unit used during the field season was tested for accuracy and its ability to upload data to a computer. Field staff collected a series of points at locations that could be recognized on a Google Earth image (e.g., sidewalk intersections) then uploaded the points to Google Earth and viewed the points for accuracy. Precision was calculated by using the measurement tool in Google Earth. Results of these tests have been archived and referenced to each GPS receiver by serial number.

- Review of sites rejected after initial site visits: In cases where a site was rejected during a site visit, the reason for rejection was documented by the field crew in the site selection database. The project QA managers (Brady and Cooper) then reviewed these records to ensure consistency among crews. Occasionally, field crew leaders contacted Uzarski, Brady, or Cooper when deciding whether to reject a site. The frequency of these consultations increased in 2018 and 2019 as high water levels made sampling particularly challenging, but had returned to normal by 2020 as crews have become more accustomed to the high water levels and because water levels dropped quite a bit in 2021 and again in 2023 due to drought across the upper Great Lakes. Water levels for some of the Great Lakes were low again in 2025 for some lakes (particularly Michigan and Huron) but more average for the other Great Lakes.

- Collection of all training/certification documents and mid-season QA/QC forms from regional labs: These documents will be retained as a permanent record for the project.

- Maintenance, calibration, and documentation for all field meters: All field meters were calibrated and maintained according to manufacturer recommendations. Calibration/maintenance records are being archived at each institution.

- Collection of duplicate field samples: Precision and accuracy of many field-collected variables is being evaluated with duplicate samples. Duplicate water quality samples were collected in conjunction with approximately every 10th WQ sample collected.

- QC checks for all data entered into the data management system (DMS): Every data point that is entered into the DMS is being checked to verify consistency between the primary record (e.g., field data sheet) and the database. QC should be complete for all data by the spring semi-annual report submission each year.

- Linking of GPS points with field database: Inevitably, some errors occur when crew members type in GPS waypoint names and numbers. All non-linking points between these two databases were assessed and corrected in 2014, which took a hundred or more person-hours. We now have a more automated way to link GPS waypoints with data, crews are paying more attention to waypoint name/number accuracy, and the lat/longs for critical locations are being typed directly into the data management system. These three actions have greatly reduced number of GPS waypoints that cannot be linked to data in the DMS system.

- Mid-season QC checks: These were completed by PIs or head field crew leaders for each of the field crews to ensure that there were no sampling issues that developed after training and while crews were sampling on their own.
- Creation/maintenance of specimen reference collections: Reference collections for macroinvertebrates, fish, and plants have either been created or are being maintained and updated by each regional team. Macroinvertebrate reference collections, in particular, were developed or expanded as these samples were processed. Vegetation reference collections are often being kept in collaboration with local herbaria.
- Data Quality Objectives (DQO) for laboratory analyses: Participating water quality laboratories have generated estimates of precision, bias, accuracy, representativeness, completeness, comparability, and sensitivity for all water quality analyses.

DATA VERIFICATION

In 2022-2023 we, in collaboration with GDIT, implemented a data verification protocol that is being used to identify and resolve, or otherwise flag, issues related to data accuracy, consistency, and compliance with the Quality Assurance Project Plan (QAPP) and SOPs established for sampling the various taxa groups. The overall goal of this process is to establish the usability of each data record to ensure that the CWMP datasets are properly communicated to and applied by end data users. Initially, approximately 120 data verification criteria (rules) were developed by GDIT (USEPA's contractor) to conduct a suite of checks for specific components of the anuran, bird, vegetation, fish, macroinvertebrate, and water quality datasets. Examples of data verification checks include:

- Identifying bird surveys that took place outside the sampling seasonal frame (e.g., after breeding season).
- Identifying fish surveys for which nets did not fish correctly and yet the crew entered data from those nets.
- Identifying vegetation surveys for which some other number of transects than three was sampled.

The data verification checks have been automated by GDIT to run against the semi-annual CWMP database release (MS Access format) that is delivered to GLNPO in May and October of each year. Each record that fails to meet specific verification criteria (such as those listed above) is flagged with an appropriate data qualifier code (e.g., "LINTC" – lack of internal consistency, or "MRV" – missing required value). The results from the automated checks are written to a set of comma-separated variable (CSV) files (i.e., one file per check type), which are delivered by GDIT to LimnoTech for integration into the CWMP DMS. LimnoTech has incorporated additional tables ("data_rev_*") into the DMS and developed a utility application to ingest the CSV files into those dedicated tables. The enhanced DMS provides the capability to store and manage multiple sets of data verification results, including tracking of issue resolution and the assignment of data usability flags on a record-specific basis. Verification check results are stored in a set of dedicated tables, which are readily linked to any CWMP taxa data table that the results may be associated with. This approach supports linking the raw data to verification results/flags when needed, and it also avoids burdening the raw data tables with the detailed verification information.

Due to the large variety and number of verification checks and results, a dedicated "Data Verification Interface (DVI)" tool was implemented by LimnoTech on the CWMP main website to provide a platform for CWMP team members to efficient review and respond to individual verification results (Figure 46). The tool will allow any "Level 4" CWMP user to efficiently filter for verification results that are pertinent to their specific taxa team, to download the results to an Excel spreadsheet, and then to provide appropriate feedback for each individual result, including documenting the resolution of the issue (if any). Ultimately, each record will be assigned an appropriate data usability flag based on assessment by lead PIs.

This effort was initially focused on addressing a set of DV check results generated and provided by GDIT (EPA contractor) in fall 2022 for the 2016-2021 monitoring datasets. Subsequently, DV check results for 2022 and 2011-2015 provided by GDIT were also incorporated into the CWMP DMS and are being addressed by teams. In addition to achieving improved data quality, consistency and documentation, this effort has provided opportunities to "tune" the rules for some DV checks and to plan and implement improvements to QA/QC methods used during data entry and review of annual monitoring datasets prior to the semi-annual database releases to EPA. The DVI tool, introduced above, provides taxa teams with a streamlined approach for reviewing DV issues, applying corrections to data records (where applicable), documenting the check's resolution status, and assigning data usability status. To complement the information that taxa teams provide on DV issue cause, resolution, and data usability, the DVI has been enhanced to provide a "post-audit" analysis of the status of individual records. Post-auditing of records is achieved by running a batch of database queries designed to replicate the logic used in the original GDIT checks. This capability allows LimnoTech, individual taxa teams and the lead PIs to identify and address any outstanding data quality gaps following the initial review effort. In addition, the post-audit assessment is being used to help identify records that cannot be fully resolved (e.g., due to missing data elements) and should be assigned a “final qualifier” that will be attached to the data records when they are distributed to end users.

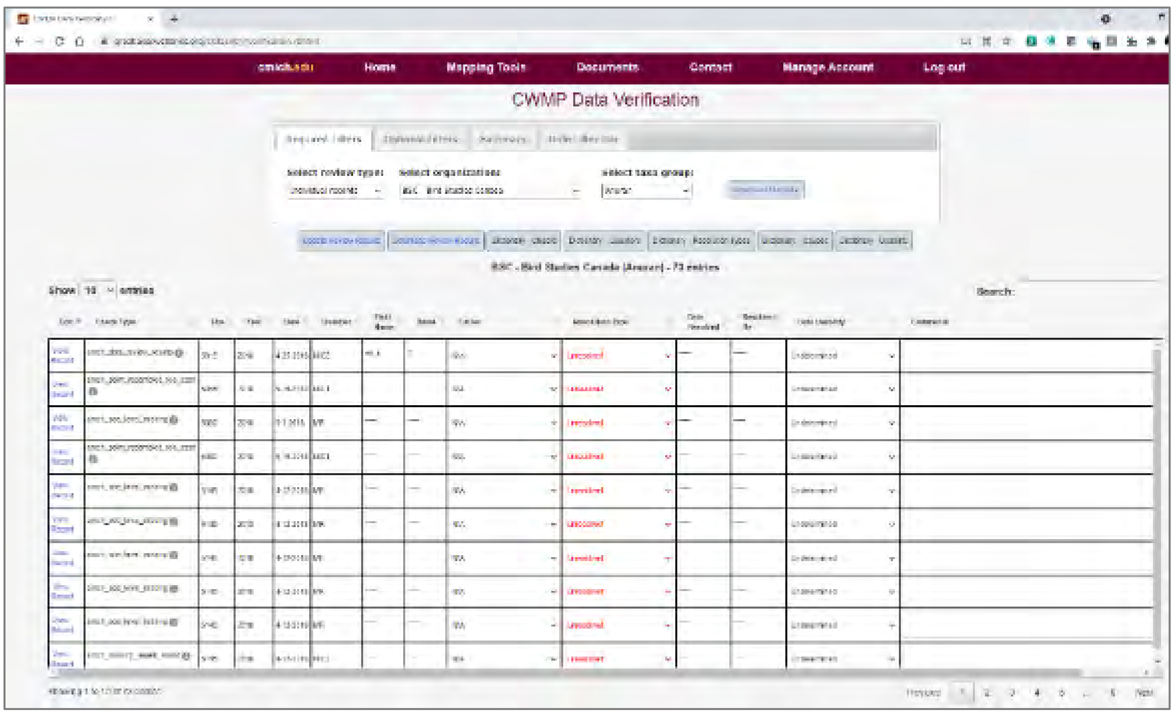


Figure 46. CWMP data verification user interface.

As of fall 2025, substantial progress had been made in addressing the 2016-2021 and 2022 DV check results. More than 14,500 issues were originally identified by the DV checks in the 2016-2021 dataset, and more than 99% of those issues have been reviewed and addressed in some fashion by the taxa teams. In addition, the taxa teams have reviewed and addressed greater than 99% of the 2022 DV check results provided by GDIT last fall. Roughly 90% of the initially flagged records have been resolved such that they now pass the DV checks, leaving approximately 1,500 outstanding records that require further assessment. LimnoTech and the lead PIs are actively conducting a check-specific analysis to determine which outstanding record issues will (and will not) necessitate applying a final qualifier to the raw data record. Significant progress has been made on this effort, and we anticipate finalizing the records for the entire 2016-2022 monitoring timeframe by the end of calendar year 2025. "Final" record status will be documented directly in the raw tables in the CWMP database via a newly added Boolean (true/false) field, and final qualifiers will be documented in a new set of tables that link to the raw data tables. It is anticipated that the DV check results for 2023 and 2024, which were recently delivered by GDIT, will be made available to the CWMP taxa teams for their review beginning in late 2025 or early 2026.

EXAMPLE WATER QUALITY QC INFORMATION

Laboratory Quality Assurances:

Water quality analyses from 2024 were previously completed by the NRRI Central Analytical Laboratory, Central Michigan University's Wetland Ecology Laboratory, Grand Valley State University's Annis Water Resources Institute, Brockport's water quality lab, and Environment Canada's national water quality lab. Laboratory results from 2024 have passed the criteria shown below (Table 24) or were excluded from the database.

Table 24. Data acceptance criteria for water quality analyses.

QA Component	Acceptance Criteria
External Standards (QCCS)	± 10%
Standard curve	$r^2 \geq 0.99$
Blanks	± 10%
Blank spikes	± 20%
Mid-point check standards	± 10%
Lab Duplicates	± 15% RPD* for samples above the LOQ**
Matrix spikes	± 20%

**Relative Percent Difference (RPD):* While our standard laboratory convention is to analyze 10% of the samples in duplicate and use %RSD (100 * CV) of the duplicates as a guide for accepting or rejecting the data, another measure of the variation of duplicates is RPD: RPD = ((|x1-x2|)/mean) *100.

** LOQ = *Limit of Quantification:* The LOQ is defined as the value for an analyte great enough to produce <15% RSD for its replication. LOQ = 10(S.D.) where 10(S.D.) is 10 times the standard deviation of the gross blank signal and the standard deviation is measured for a set of two replicates (in most cases).

Variability in Field Replicates (from 2024)

An analysis of field duplicate variability for samples collected in 2024 is shown in Table 25. It is important to note that for many constituents, the variability within sample sets is related to the mean concentration, and as concentrations approach the method detection limit (MDL), the variability increases dramatically. A calculation of field replicate variability with values at or near the level of detection will often result in high RPDs. For example, if the chlorophyll measurements on a set of field duplicates are 0.8 µg/L and 0.3 µg/L, mean = 0.6, resulting in a RPD of 91% (RPD = [abs (rep a-rep b)/ (rep a+ rep b)/2)]*100, but since the MDL is ± 0.5 µg/L, this can be misleading.

The same can occur with analyte lab duplicates, and in these instances the QA officer will determine whether data are acceptable. It is also important to note that RPD on field duplicates incorporates environmental (e.g., spatial) variability, since duplicate samples are collected from adjacent locations, as well as analytical variability (e.g., instrument drift). Therefore, RPD of field duplicates is generally higher than RPD of laboratory duplicates. Table 25 below lists average RPD values for 2024. Higher than expected average RPD values were associated with a preponderance of near detection limit values for ammonium, nitrate, and soluble reactive phosphorus (SRP), and high spatial variability for chlorophyll and turbidity. Other variables, such Total N, had values that were well above detection limits and low spatial variability; therefore, these values had much lower average RPD. Acceptance of data associated with higher-than-expected RPD was determined by the QA officers. The maximum expected RPD values are based on the MN Pollution Control Agency quality assurance project plan provided for the Event Based Sampling Program (http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/surface-water-financial-assistance/event-based-sampling-grants.html#for-grantees).

Table 25. Field duplicate sample variability for 2024 in relative percent difference for water quality parameters with the acceptance criteria. The maximum expected RPD values are based on the MN Pollution Control Agency quality monitoring requirements for integrated assessments (https://www.pca.state.mn.us/sites/default/files/wq-s1-15n.pdf). Average RPD (n) min-max RPD.

Analyte	**MDL**	**Maximum expected RPD**	**2024**
Chlorophyll-a ug/L	0.5 µg/l All Labs 0.01 µg/L Brockport	30	30 (18) 0-131
Total Phosphorus mg/L	0.0008 mg/L Brockport 0.006 mg/L CMU 0.0005 mg/L Env Can 0.006 mg/L GVSU 0.004 mg/L NRRI 0.0005 mg/L U Windsor	30	17 (18) 2-61

Table 25. Field duplicate sample variability for 2024 in relative percent difference for water quality parameters with the acceptance criteria. The maximum expected RPD values are based on the MN Pollution Control Agency quality monitoring requirements for integrated assessments (https://www.pca.state.mn.us/sites/default/files/wq-s1-15n.pdf). Average RPD (n) min-max RPD.

Analyte	MDL	Maximum expected RPD	2024
*Soluble Reactive Phosphorus mg/L	0.0003 mg/L Brockport 0.005 mg/L CMU 0.0002 mg/L Env Can 0.005 mg/L GVSU 0.003 mg/L NRRI 0.0002 mg/L U Windsor	10	38 (18) 0-181
Total Nitrogen mg/L	0.014 mg/L Brockport 0.027 mg/L CMU 0.015 mg/L Env Can 0.1 mg/L GVSU 0.02 mg/L NRRI 0.015 mg/L U Windsor	30	6 (18) 0.2-27
*NH4-N mg/L	0.002 mg/L Brockport 0.01 mg/L CMU 0.005 mg/L Env Can 0.01 mg/L GVSU 0.008 mg/L NRRI 0.005 mg/L U Windsor	10	28 (18) 0-142
*NO2/NO3-N mg/L	0.002 mg/L Brockport 0.008 mg/L CMU 0.005 mg/L Env Can 0.005 mg/L NRRI 0.005 mg/L U Windsor	10	12 (18) 0-44
True Color pt-co	1 CU Brockport 0.5 CU Env Can 2 CU NRRI 1 CU U Windsor	10	14 (13) 0-63
Chloride mg/L	0.1 mg/L CMU 0.01 mg/L Env Can 1.2 mg/L NRRI 0.01 mg/L U Windsor	20	19 (15) 0-159

Notes:
*The variability between soluble reactive phosphorus, ammonium-N and nitrate/nitrite-N field replicates often exceeded the criteria, however many values for each were < 10 X the MDL. Field duplicates are a second sample taken immediately after an initial sample in the exact same location to assess the site, sampling and possible temporal variability. Duplicate samples are collected in the exactly the same manner as the first sample, including the normal sampling equipment cleaning procedures. The relative percent difference (RPD) between the duplicate samples is calculated with the following equation:

RPD = (|Result 1 - Result 2|)/ ((Result 1 + Result 2)/2) x 100

COMMUNICATION AMONG PERSONNEL

Regional team leaders and co-PIs continue to maintain close communication as the program enters its thirteenth year (fourth year of round 3 sampling). Nearly all program members virtually attended an all-hands Zoom program organizational meeting in February of 2024. The 2025 PI meeting was cancelled due to circumstances beyond our control. Holding meetings virtually means that field and laboratory technicians and grad students can attend without worrying about having a travel budget. At these meetings PIs discuss issues pertaining to the upcoming field season, how we could keep diverse teams safe, data validation and correction, manuscripts, and report products. Individual taxonomic teams held their meetings virtually just before or after the overall program meeting.

Regional team leaders and co-PIs hold conference calls and e-mail discussions regarding fieldwork, taxonomic changes, data analysis, indicator refinement, data QC, and publications as needed. Typically, most PIs spend the first week of field season in the field with their crews to ensure that all protocols are being followed according to the standards set forth in the QAPP and SOPs and to certify or re-certify crew members. That changed because of Covid-19 (depending on the field crew and PI), but things returned to normal fieldwork by the 2023 field season. This year many crews had returning and experienced personal, and the PIs were in contact, provided training and gave advice in the manner that best suited their circumstances, at a minimum via phone calls and webinars. Under all circumstances, PIs keep in close contact with crews via cell phone, text, and email, and the leadership team is also always available via cell phone and text to answer crew questions.

OVERALL

The quality management system developed for this project has been fully implemented and PIs and their respective staff members continue to follow established protocols very closely, relying on the QAPP and SOPs as guiding documents. QA managers were also encouraged by each crew’s continued willingness to contact their supervisors or, in many cases, the project management team when questions arise.

Despite the somewhat dangerous nature of this work, injury rates continue to be very low. We are very proud of what our field crews accomplished safely despite a global pandemic. Crews sampled safely, accurately, and without spreading Covid-19. The entire CWM team is relieved that crews continue to maintain an exemplary safety record. This is due to the leadership and safety consciousness of PIs, field crew chiefs, and field team leaders. PIs are not complacent about the lack of injuries and are grateful for the willingness of their crews to work long hours day after day, to successfully sample under often adverse conditions (including a global pandemic), and to conduct that sampling in accordance with strict QA procedures.

LEVERAGED BENEFITS OF PROJECT (2010 – 2023)

This project has generated a number of spin-off projects and serves as a platform for many graduate and undergraduate thesis topics. In addition, project PIs are collaborating with many other groups to assist them in getting data for areas that are or will be restored or that are under consideration for protection. Finally, the project supports or partially supports many jobs (jobs created/retained). All of these are detailed below.

SPIN-OFF PROJECTS (CUMULATIVE SINCE 2010)

Investigating the Use of eDNA to Determine Fish Use of Otherwise Unsampleable Habitats: Some habitats cannot be sampled using fyke nets because of inappropriate water depth, unstable or unconsolidated bottom sediments or because that habitat is too fragile (e.g. wild rice). CoPI Valerie Brady with NRRI researcher Chan Lan Chun are investigating how well fyke net fish catches agree with fish eDNA collected from nearby benthic sediment to determine if eDNA could be used as a surrogate in situations where fish cannot be physically collected to determine habitat use.

Macroinvertebrate Monitoring for Delisting the Degradation of Benthos Beneficial Use Impairment in the Muskegon Lake Area of Concern: The West Michigan Shoreline Regional Development Commission, with support from the Michigan Department of Environment, Great Lakes, and Energy funded a project to conduct macroinvertebrate sampling at 2 coastal wetlands in the Muskegon Lake Area of Concern in an effort to evaluate "Degradation of Benthos" BUI in the AOC. Samples were collected in 2021 and 2023 and data from several Lake Michigan reference wetlands were used to compare the AOC restoration sites. Dr. Matt Cooper led this project with students from Muskegon Community College.

Compiling and Assessing IBI and Environmental Stress Data to Assess Habitat Condition in the Detroit River Area of Concern (AOC): The Detroit River Canadian Clean-up (convened by Environment and Climate Change Canada and the Province of Ontario) is evaluating the weight of evidence with regard to delisting several Beneficial Use Impairments in the Detroit River AOC (Degradation of Fish and Wildlife, Degradation of Benthos, and Loss of Fish and Wildlife Habitat. However, years of monitoring and assessment have failed to demonstrate clear time trends in the condition of biota (aquatic vegetation, aquatic macroinvertebrates, fishes, birds) of the

Detroit River's aquatic and riparian habitats. Attempts to evaluate indices of biotic integrity (IBIs) using the Reference Condition Approach (RCA) have been limited by an inability to achieve consensus on appropriate reference conditions. CoPIs Jan Ciborowski, Greg Grabas and Doug Tozer compiled land-based stressor data at the scale of second-order watersheds for the Detroit River AOC to let us assess how the IBI scores for sites in the Detroit River and adjacent areas (Lake Erie, Lake St. Clair, St. Clair River) vary as a function of environmental stress. We compiled all available biological monitoring datasets relating to aquatic vegetation, macroinvertebrates, fishes and birds within the study region and calculated composite measures of condition (IBIs) for each of the groups of biota and plotted the resulting scores against the stressor measures. We found provisional evidence of environmental stress thresholds for at least one IBI of each of the taxa investigated. Mapping the distribution of nondegraded vs. degraded watersheds for each of the biological groups will help the DRCC identify whether and where further remediation is necessary to allow delisting of the BUIs.

Minnesota Land Trust Natural Areas Project and Grassy Point Restoration: In 2018, the Minnesota Land Trust contracted a project with the Natural Resources Research Institute in Duluth, MN to conduct bird surveys along the St. Louis River Estuary (SLRE), within nine project areas that were nominated for inclusion in the Duluth Natural Areas Program (DNAP). This program was created in 2002 to manage Duluth's environmentally significant areas to ensure the preservation of services and values such as habitat diversity and water quality. In addition to data collected for this project, we also included breeding bird data collected by the CWMP at benchmark sites located within the SLRE that aligned spatially with the nine DNAP project areas. Collectively these data were used to determine if the proposed land parcels included in the nomination met the criteria of qualifying as an Important Bird Congregation Area (criteria included numeric thresholds for different guilds of species). Use of these data qualified all nine parcels as meeting the Important Bird Congregation Area criteria.

These data were then used in a spin-off project with Minnesota Land Trust, where bird communities were associated with spatially-explicit environmental and habitat variables to help guide conservation and management effort in the SLRE. In this project we were also able to identify habitat availability at the landscape-level to identify specific features that are under-represented in the SLRE but likely important to avian species (specifically wetland-dependent species). These analyses have been used to guide restoration plans at specific locations within the SLRE, including Grassy Point (a wetland located in a heavily industrialized area of the SLRE). Efforts to restore this wetland site are being developed by using the habitat requirements of wetland-dependent marsh bird species as a guide and restoration goal. The plans for Grassy

Point are complete and on-the-ground restoration is scheduled to begin in the spring of 2020. NRRI CWMP teams will be involved in post-restoration monitoring of this site as well.

Deriving and Calibrating Environmental and Biological data for Lake Erie in Support of the Great Lakes Water Quality Agreement's Nearshore Framework: As part of the Annex 2 and Annex 7 plans of the revised GLWQA, Environment and Climate Change Canada (ECCC) and GLNPO began work to jointly develop an Integrated Nearshore Framework for the Great Lakes. The goal was to assemble scientific and technical recommendations for nearshore assessment. The assessment was expected to be used to set priorities and design an approach to identify areas of high quality for protection and areas under stress requiring restoration. ECCC and GLNPO convened several workshops beginning in 2014. In 2016, ECCC initiated a pilot project on the Canadian side of Lake Erie to come up with a workable methodology and approach to combining assessments of different condition measures. CWM coPIs Jan Ciborowski and Greg Grabas took part in a series of workshops and contributed information collected in part from CWM wetland surveys on Lake Erie. The first overall assessment of the nearshore in Lake Erie was reported in 2018. The weight of evidence indicated that there is a strong east to west gradient in nearshore condition with the highest quality habitat and biota observed in the eastern basin, and low quality in the western basin, influenced largely by seasonal occurrences of cyanobacteria. The nearshore of the Detroit River and Lake St. Clair was classified as being of moderate quality. Insufficient data were available to assess the St. Clair River. Assessments of the condition of coastal wetland across the study area were limited by variation in the types of data collected by different programs. A future goal will be to determine how best to align data collected from other programs with information collected using the CWM protocols.

Real-Time Logging of Water Level, DO, Light, and Wind to Assess Hydrological Conditions in Great Lakes Coastal Wetlands: The University of Windsor is coordinating a project to test the hypothesis that the numbers and species of fishes caught in wetland fyke nets are related to temporal variation in dissolved-oxygen (DO), and that such DO variation is partly driven by seiche activity causing temporary movement of cool, well-oxygenated lakewater into and out of wetlands. This variation in DO may be especially important in the densely vegetated, shoreline-associated wetland zones (usually wet meadow, under high-water conditions). An SOP document was developed in spring 2019 and circulated to all field crews.

Each field team has been encouraged to deploy water level and DO loggers at their fyke net sites over the course of the summer. In addition to providing important basic hydrological information about the condition of coastal wetlands, the resulting Great Lakes-wide dataset will be used to help account for variation in fish catches and ultimately improve the precision of fish

IBI estimates. Preliminary data collected over the field season and suggestions for improvement will be discussed at the winter field meeting.

Bathymetry and mapping of wetlands in Point Pelee National Park during a period of hydrologic change: In 2018 Point Pelee National Park (PPNP) received approval through the Parks Canada Conservation and Restoration Project to begin a 4-year marsh restoration project. The project was focused 1) on increasing open water habitat and interspersion within the marsh and 2) reducing invasive vegetation. Members of the Ciborowski CWM team were asked if they would be able to conduct a preliminary survey of PPNP wetlands to determine the bottom profile and distribution of submerged aquatic vegetation. There was especial interest in the bathymetry of Lake Pond, whose eastern shoreline had been breached by wave action from Lake Erie during the summer as a consequence of the historically high water levels. In fall 2018 and during the 2019 field season, we conducted a benchmark survey of vegetation, aquatic invertebrates and water chemistry. We also assessed water depth, macrophyte distribution and cover and sediment characteristics throughout the wetland using the remotely-operated ROVER, which was developed for shallow-water data collection in remote locations. Water level and dissolved oxygen loggers set in place in the spring provided a full-season record of the frequency of seiches and associated changes in water quality. CWM researchers are anticipated to be involved as collaborators throughout the restoration project.

Inventory and distribution of zooplankton in coastal wetlands: As part of ongoing interest in assessing the condition of CWM wetlands we began assessing the community composition of zooplankton in the wetlands visited as part of the annual program. Pilot samples were first collectedin 2017. In 2018, zooplankton samples were collected at 16 Great Lakes coastal wetlands, situated off Manitoulin Island, northern Lake Huron, the western basin of Lake Erie, the Bruce Peninsula and Georgian Bay. In each wetland, samples were collected at 3 shallow-water points along a dissolved oxygen gradient. Records of water depth, substrate characteristics and vegetation density and composition were also tabulated. The sampling methods were based on techniques proposed by Lougheed and Chow-Fraser (2002) in developing their Zooplankton Quality Index. Seven Lake Huron wetlands were sampled in 2019.

Evaluating Fish and Invertebrate Distribution in Great Lakes Coastal Wetlands - an Occupancy Modeling Approach: Led by University of Windsor postdoctoral fellow student Martin Jeanmougin, this project involves fish PIs Joseph Gathman, Carl Ruetz, Dennis Higgs and Jan Ciborowski. Occupancy modelling is a statistical approach that allows one to estimate the probability that a taxon is present in an area and the probability that it can be detected by sampling. Applying this approach to the invertebrate and fish CWM data could help us to identify important environmental factors influencing the likelihood that selected taxa occur in particular habitats and to more accurately estimate their distribution across the Great Lakes. Also, an analysis of the detection patterns can provide important information on potential biases in the protocols we use to sample the biota. The previous work done by K. Dykstra of Grand Valley State University (Carl Ruetz's lab) for the thesis on Yellow Perch distribution will be a good starting point for this project.

Genetic Barcodes for Wetland Macroinvertebrates: Surveillance of aquatic macroinvertebrates in the Great Lakes is of utmost importance. However, many organisms, particularly aquatic macroinvertebrates, lack information that can assist in their identification, whether through molecular barcodes or morphological characteristics. We are using previously collected aquatic macroinvertebrate samples from throughout the Great Lakes basins to generate genetic barcodes that will assist in identification of species (MOTUs) and expand the currently available molecular genetic databases. Our work is targeting specific groups to improve morphological identification to lowest taxonomic levels. Finally, we will be able to use these data to test the usefulness of metabarcoding for Great Lakes surveillance to provide managers with valuable monitoring information.

Assessing Climate Vulnerability in Apostle Islands Coastal Wetlands: Funded by the National Park Service and GLRI, a team from Northland College sampled fish, macroinvertebrates, vegetation, and hydrologic variables in lagoon wetlands throughout the Apostle Islands National Lakeshore to identify species and communities that may be particularly vulnerable to climate change. This work represents an intensification of sampling effort within a sensitive and relatively pristine area of the Great Lakes. Data from this project were analyzed in relation to CWMP data to put Apostle Islands wetlands into a broader Great Lakes context.

Functional Indicators of Coastal Wetland Condition: Funded by the USGS through a Cooperative Ecosystem Studies Unit (CESU), this pilot project ran from fall 2016 through fall of 2019 to better determine functional indicators of Great Lakes coastal wetland usage by Great Lakes fish species. Sampling was done during the spring and fall at about 15 US wetlands already being assessed for CWM indicators during the summer. Data collected focus on fish usage of wetlands and the forage base for those fish, evaluated using macroinvertebrate sampling and examination of fish gut contents. Special emphasis was placed on determining usage of wetlands by young or spawning fish.

Conservation Assessment for Amphibians and Birds of the Great Lakes: Several members of the CWM project team have initiated an effort to examine the role that Great Lakes wetlands play in the conservation of amphibians and birds in North America. The Great Lakes have many

large, intact freshwater wetlands in the interior portion of the North American continent. Their unique character, size, and plant composition supports populations of many species of amphibians and birds, many of which have been identified as endangered, threatened, or of special concern in North America. CWM PIs will use the extensive data that have been gathered by USEPA, such as the Great Lakes Environmental Indicators project and the Great Lakes Wetlands Consortium, as well as Bird Studies Canada, as critical input to this assessment.
The initial stages in the development of the conservation assessment will be to analyze habitat and landscape characteristics associated with Great Lakes coastal wetlands that are important to wetland-obligate bird species occupying these habitats. By combining breeding bird data from the sources above and incorporating landscape variables, classification trees can be developed to predict presence and relative abundance of these species across the Great Lakes Basin. These methods, outlined in Hannah Panci's thesis; 'Habitat and landscape characteristics that influence Sedge Wren (*Cisthorus platensis*) and Marsh Wren (*C. palustris*) distribution and abundance in Great Lakes Coastal Wetlands'(University of Minnesota Duluth). She compiled data for over 800 wetlands in her analysis, which will provide a basis for analyzing additional wetland-obligate species.

Bird and Anuran Metrics and Indicator Calculations: Avian and anuran responses to landscape stressors can be used to inform land managers about the health of coastal wetlands and the landscape stressors that affect these systems (Howe et. al. 2007). Data that has been entered into the data management system and QC'd are being used to calculate some of the metrics and indicators for these wetlands.

Influence of broadcast timing and survey duration on marsh breeding bird point count results: Several members of the project team, with D. Tozer as lead, examined the importance of survey duration and timing of broadcast playbacks on occurrence and counts of wetland breeding birds. The results of this analysis suggest that 10-min point counts are superior to 15-min counts which have important implications for future monitoring and cost-effectiveness. These findings have been published in the journal of Avian Conservation and Ecology (Tozer et al. 2017).

North Maumee Bay Survey of Diked Wetland vs. Un-Diked Wetland: Erie Marsh Preserve is being studied as a benchmark site for the CWM project. As a benchmark site, Erie Marsh Preserve will serve as a comparison against randomly-selected project sites, and will be surveyed each year of the CWM project. Benchmark sampling began prior to Phase 1 of a planned restoration by The Nature Conservancy, allowing for pre- and post-restoration comparisons. In addition, biota and habitat within the diked wetlands area will be compared to conditions outside of the dike, but still within the preserve. These data will also be used for post-construction comparisons to determine what biotic and abiotic changes will occur once restoration efforts have reconnected the dike to the shallow waters of Lake Erie.

Cattails-to-Methane Biofuels Research: CWM crews collected samples of invasive plants (hybrid cattail) which were analyzed by Kettering University and their Swedish Biogas partner to determine the amount of methane that can be generated from this invasive. These samples was compared to their data set of agricultural crops, sewage sludge, and livestock waste that are currently used to commercially generate methane. Results demonstrated that hybrid cattail and reed canary grass both generated adequate levels of methane for use as feedstocks for biodigestion. The result of this and other CWM data collection are summarized in the Carson *et al.* 2018 journal article. The cattails-to-methane biofuels project is also funded (separately) by GLRI.

Plant IBI Evaluation: A presentation at the 2014 Joint Aquatic Science meeting in Portland, Oregon evaluated Floristic Quality Index and Mean Conservatism score changes over time utilized data collected during the first three years of the GLRI study. Mean C scores showed little change between years from 2011 through 2013 due to stable water levels.

Correlation between Wetland Macrophytes and Wetland Soil Nutrients: CWM vegetation crews collected wetland soil samples and provided corresponding macrophyte data to substantially increase the number of sites and samples available to the USEPA Mid-Continent Ecology Division. USEPA MED researchers studied wetland macrophyte and wetland soil nutrient correlations. The MED laboratory ran the sediment nutrient analyses and shared the data with CWM PIs.

Comparative study of bulrush growth between Great Lakes coastal wetlands and Pacific Northwest estuaries. This study includes investigation of water level effects on bulrush growth rates in Great Lakes coastal wetlands. With leveraged funding from NSF for the primary project on bulrush ability to withstand wave energy.

Braddock Bay, Lake Ontario, Sedge Meadow and Barrier Beach Restoration: Braddock Bay is being studied as a benchmark site in conjunction with the US Army Corps of Engineers to assess the current extent of, and potential restoration of, sedge meadow and the potential of restoring the eroded barrier beach to reduce wetland loss. CWM crews collected pre-restoration data to help plan and implement restoration activities and will collect post-restoration data to help plan and implement restoration activities and assess results. The results will help build a model for future sedge meadow restoration in Lake Ontario to mitigate the harmful impacts of invasive cattails and provide habitat for fish and wildlife species. Additionally, this project will be expanded, in conjunction with Ducks Unlimited, to four nearby wetlands, pending funding from NOAA.

Thunder Bay AOC, Lake Superior, Wetland Restoration: Nine wetlands around Thunder Bay were sampled for macroinvertebrates, water quality, and aquatic vegetation by CWM crews in 2013 using methods closely related to CWM methods. These data will provide pre-restoration baseline data as part of the AOC delisting process. Wetlands sampled included both wetlands in need of restoration and wetlands being used as a regional reference. All of this sampling was in addition to normal CWM sampling, and was done with funding from Environment Canada.

Common Tern Geolocator Project: In early June 2013, the NRRI CWM bird team volunteered to assist the Wisconsin DNR in deploying geolocator units on Common Terns nesting on Interstate Island. In 2013, 15 birds between the ages of 4-9 yrs old were outfitted with geolocators. Body measurements and blood samples were also taken to determine the sex of each individual. In June of 2014, geolocators were removed from seven birds that returned to nest on the island. Of the seven retrieved geolocators, four were from female birds and three from males. The data collected during the year will be used to better understand the migratory routes of Common Terns nesting on Interstate Island. This is the first time that geolocators have been placed on Common Terns nesting in the Midwest, which is important because this species is listed as threatened in Minnesota and endangered in Wisconsin. Tracking Common Terns throughout their annual cycle will help identify locations that are important during the non-breeding portion of their life cycle. Data are currently being analyzed by researchers at the Natural Resources Research Institute in Duluth MN.

Using Monitoring Results to Improve Management of Michigan's State-Owned Costal Wetlands: One year project, 2016-2017, awarded to Central Michigan University by the Michigan Department of Environmental Quality. The project will focus on the prioritization of high-quality and important state-owned coastal wetlands that have been monitored as part of the Great Lakes CWM program, and development of site-specific management plans for these wetlands which address diverse management goals and objectives with a broad focus including biodiversity, ecological services, habitat for fish and wildlife, climate change adaptation, and rare species.

Developing a Decision Support System for Prioritizing Protection and Restoration of Great Lakes Coastal Wetlands: While a number of large coastal wetland restoration projects have been initiated in the Great Lakes, there remains little regional or basin-scale prioritization of restoration efforts. Until recently we lacked the data necessary for making systematic prioritization decisions for wetland protection and restoration. However, now that basin-wide coastal wetland monitoring data is available, development of a robust prioritization tool is possible and we propose to develop a new Decision Support System (DSS) to prioritize protection and restoration investments. This project, funded by the Upper Midwest and Great Lakes Landscape Conservation Cooperative, the Michigan Office of the Great Lakes, and the US Army Corp. of Engineers, has developed a DSS for wetlands along the US shoreline of the Great Lakes.

Quantifying Coastal Wetland – Nearshore Linkages in Lake Michigan for Sustaining Sport Fishes: With support from Sea Grant (Illinois-Indiana and Wisconsin programs), personnel from UND and CWM are comparing food webs from coastal wetlands and nearshore areas of Lake Michigan to determine the importance of coastal wetlands in sustaining the Lake Michigan food web. The project emphasis is on identifying sport fish-mediated linkages between wetland and nearshore habitats. Specifically, we are (1) constructing cross-habitat food webs using stable C and N isotope mixing models, (2) estimating coastal wetland habitat use by sport fishes using otolith microchemistry, and (3) building predictive models of both linkage types that account for the major drivers of fish-mediated linkages in multiple Lake Michigan wetland types, including some wetlands sampled by the coastal wetland monitoring project. Collaborators are the University of Wisconsin – Green Bay and Loyola University Chicago.

Clough Island (Duluth/Superior) Preservation and Restoration: The Wisconsin Department of Natural Resources requested (and funded) a special report on sites sampled using CWM protocols around Clough Island within the St. Louis River Area of Concern (AOC). Their interests were to see if CWM data indicated any differences in habitat or species composition/abundances among Clough Island and other St. Louis River sites, and also how Clough Island compared to other nearby Lake Superior coastal wetlands. The 46 page report was submitted to Cherie Hagan of the WDNR in May of 2014. Clough Island was recently acquired by the Nature Conservancy and they are using the data in the report for their development of conservation plans for the area.

Floodwood Pond and Buck Pond South, Lake Ontario, Wetland Pothole Restoration: Open water potholes were established in these two wetlands by The Nature Conservancy to replace openings that had filled with cattail following lake-level regulation. CWM crews collected pre- and post-restoration data as benchmark sites in both wetlands to allow TNC to assess changes.

Buck Pond West and Buttonwood Creek, Lake Ontario, Sedge Meadow Restoration: These two wetlands in the Rochester Embayment AOC are actively being restored by a consortium involving Ducks Unlimited, The College at Brockport, NYS Department of Environmental Conservation, and the Town of Greece. CWM crews collected pre-restoration data as a benchmark site to help plan and implement restoration activities. Post-restoration data collection is underway under CWM to help assess results and help build a model for future sedge meadow restoration in Lake Ontario to mitigate the harmful impacts of invasive cattails and provide habitat for fish and wildlife species.

Salmon/West Creek, Long Pond, and Buck Pond East, Lake Ontario, Emergent Marsh Restoration: These three wetlands in the Rochester Embayment AOC are being studied as benchmark sites by CWM crews to provide the U.S. Fish and Wildlife Service with pre-restoration data for projects currently in the design phase. Future CWM data collection has been requested to assist in post-restoration assessment.

Lower Green Bay and Fox River AOC: Results from the Coastal Wetland Monitoring (CWM) Project and the Great Lakes Environmental Indicators (GLEI) Project are playing a central role in a $471,000 effort to establish fish and wildlife beneficial use impairment (BUI) removal targets for the Lower Green Bay and Fox River AOC (2015-2017) 1) Protocols for intensive sampling of bird, anurans, and emergent wetland plants in the project area have followed the exact methods used in the CWM project so that results will be directly comparable with sites elsewhere in the Great Lakes. 2) Data from GLEI on diatoms, plants, invertebrates, fish, birds, and anurans and from CWM on birds and anurans have been used to identify sensitive species that are known to occur in the AOC and have shown to be sensitive to environmental stressors elsewhere in the Great Lakes. These species have been compiled into a database of priority conservation targets. 3) Methods of quantifying environmental condition developed and refined in the GLEI and CWM projects are being used to assess current condition of the AOC (as well as specific sites within the AOC) and to set specific targets for the removal of two important BUIs (fish and wildlife populations and fish and wildlife habitats). 4. Application of the Index of Ecological Condition method (e.g., Howe et al. 2007) for measuring the condition of birds, anurans, and other fish and wildlife groups. Follow-up work was funded for 2018-2020 at $87,000 to continue refining field monitoring methods and metrics of 40 fish and wildlife habitats and populations.

SOGL/SOLEC Indicators: CWM project PIs have developed a set of indicator metrics for the State of the Great Lakes/State of the Lakes Ecosystem Conference (SOLEC). These metrics fill a much-needed gap in quantifying responses of biotic communities to environmental stress throughout the Great Lakes. Sites for all coastal wetlands sampled by the GLEI, CWM, and Marsh Monitoring Program projects have been scored according to several complementary indices that provide information about local and regional condition of existing wetlands.

Roxana Marsh Restoration (Lake Michigan): The University of Notre Dame (UND) team, led by graduate student Katherine O'Reilly and undergraduate Amelia McReynolds under the direction of project co-PI Gary Lamberti, leveraged the GLCWM monitoring project to do an assessment of recently-restored Roxana Marsh along the south shore of Lake Michigan. Roxana Marsh is a 10-ha coastal wetland located along the Grand Calumet River in northwestern Indiana. An EPA-led cleanup of the west branch of the Grand Calumet River AOC including the marsh was completed in 2012 and involved removing approximately 235,000 cubic yards of contaminated sediment and the reestablishment of native plants. Ms. McReynolds obtained a summer 2015 fellowship from the College of Science at UND to study the biological recovery of Roxana Marsh, during which several protocols from the GLCWM project were employed. During summer 2015 sampling of Roxana Marsh, an unexpected inhabitant of the Roxana Marsh was discovered -- the invasive oriental weatherfish (*Misgurnus anguillicaudatus*). Oriental weatherfish are native to southeast Asia and believed to have been introduced to the U.S. via the aquarium trade. Although there have been previous observations of *M. anguillicaudatus* in the river dating back to 2002, it had not been previously recorded in Roxana Marsh, and little information is available on its biological impacts there or elsewhere. We are currently using stable carbon and nitrogen isotopes, along with diet analysis, to determine the role of *M. anguillicaudatus* in the wetland food web and its potential for competition with native fauna for food or habitat resources. This discovery received media attention from the Illinois-Indiana Sea Grant College Program.

Chlorophyll-*a* Modeling: The UND team, in collaboration with Northland College, CMU, and others, is investigating the drivers that influence water column chlorophyll-*a* in coastal wetlands. Our hypothesis is that chlorophyll-*a* will be related to nutrient status of wetlands and degree of development of adjoining land. Along with CWM water data, we are utilizing GIS land use and connectivity data. Specifically, we seek to answer the following questions: (1) What variables best predict chlorophyll-*a* in coastal wetlands across the entire Great Lakes basin? (2) How do these variables change across each basin (i.e., Lake Michigan, Lake Erie, Lake Ontario, Lake Superior, Lake Huron)? (3) Are there differences in predictor variables across sub-basins (e.g., Lake Erie North vs. Lake Erie South)? (4) Does wetland type (lacustrine, riverine, or barrier) change chlorophyll-*a* predictors? (5) How do other potential variables, such as vegetation zone type or year, change chlorophyll-*a* predictors?

Invasion Vulnerability Index: The UND team, in collaboration with other CWM teams, aims to create a usable tool that predicts which aquatic invasive species from a list of 10 Great Lakes Aquatic Nuisance Species Information System (GLANSIS) watchlist species are of highest concern for prevention and early detection. We will combine Habitat Suitability Indexes (HSIs) made using wetland site-specific physio-chemical measurements and potential pathway data (distance to potential introduction pathways and distance to known established populations). Ultimately, we will produce an interactive, exploratory tool where a wetland can be selected, and a table will appear that shows the breakdown of invasion risk by species as invasion likelihood scores. If more information is desired about how the invasion likelihood score was calculated, an attribute table will display the numerical values for each criterion in the model. One of the main concerns with invasive species is how climate change will alter habitat suitability. To accommodate this concern, we will also include versions with future climate change scenarios using published IPCC environmental conditions. This information will be packaged together in an IVI for Great Lakes wetlands usable by scientists, managers, and the general public.

Green Bay Area Wetlands: Data from the benchmark site Suamico River Area Wetland was requested by and shared with personnel from the Wisconsin Department of Natural Resources and The Nature Conservancy, who are involved in the restoration activities to re-connect a diked area with Green Bay. In 2011 NRRI sampled outside the diked area following CWM methods, and in 2013 we sampled within the diked area as a special request. The data were summarized for fish, invertebrates, water quality, birds, and vegetation and shared with David Halfmann (WDNR) and Nicole Van Helden (TNC).

Hybridizing fish: In 2013 the NRRI field crew encountered gar around the Green Bay area of Lake Michigan which exhibited mixed morphological traits of shortnose and longnose species. At that time, John Lyons at the Wisconsin Department of Natural Resources was working on a project to confirm hybrid individuals in the Fox River watershed (which drains into Green Bay, WI). Josh Dumke at NRRI contributed photos of gar captured in Green Bay during Coastal

Wetland Monitoring fish surveys to John Lyons, and those contributions were acknowledged in a recently-published article: (Lyons, J., and J.T. Sipiorski. 2020. Possible large-scale hybridization and introgression between Longnose Gar (Lepisosteous osseus) and Shortnose Gar (Lepisosteous platostomus) in the Fox River drainage, Wisconsin. *American Midland Naturalist*, 183:105-115). In 2014 and 2015 Coastal Wetland Monitoring fish teams collected gar fin clips across the entire Great Lakes basin for a much more comprehensive look at species distributions and hybridization, but sample processing and analysis of those stored samples is dependent upon securing additional funds.

Management alternatives for hybrid cattail (*Typha x glauca*) 2011- 2014: Differing harvest regimes for hybrid cattail were evaluated at Cheboygan, Cedarville, and Munuscong Bay in northern Michigan with USEPA GLRI funding. At all of these sites plant data was collected by CWM and used as baseline data that was compared to control sites. Analyses demonstrated that during low-water conditions, native plant diversity was increased by harvest of hybrid cattail.

Impacts of hybrid cattail management on European frogbit (*Hydrocharis morsus-ranae*); This study, funded by MI DNR in 2016-2017 for research by Loyola Chicago and Oregon State University studied the response of European frogbit to cattail management, using CWM plant data collected in Munuscong Bay as baseline data. CWM data collected from 2011 to 2015 provided documentation of the expanding range of frogbit into the western Great Lakes. The study found that open, flooded stands of hybrid cattail provided important habitat for European frogbit, but that management to remove cattail was not effective for frogbit control.

Nutrient limitation in Great Lakes coastal wetlands: GLCWMP water quality data indicate that reactive nitrogen concentration is often much lower in wetland habitats than the adjacent Great Lake nearshore. With funding from Illinois-Indiana Sea Grant and the Wisconsin DNR we have evaluated the role of nitrogen limitation on benthic algal growth in wetlands throughout Lakes Michigan, Huron, and Superior.

SUPPORT FOR UN-AFFILIATED PROJECTS

CWM PIs and data managers continue to provide data and support to other research projects around the Great Lakes even though CWM PIs are not collaborators on these projects. Dr. Laura Bourgeau-Chavez at Michigan Tech University mapped the spatial extent of Great Lakes coastal wetlands using GIS and satellite information to help in tracking wetland gains and losses over time (Implementation of the Great Lakes Coastal Wetlands Consortium Mapping Protocol, funded by GLRI). We provided her with vegetation data and sampling locations each year to assist with this effort. Dr. Bourgeau-Chavez was also given funding to assess herbicide effectiveness against *Phragmites* in Green Bay and Saginaw Bay. CWM data are being used to find the best locations, provide baseline data, and provide pointers on site access (from field crew notes) in support of this project.

Reports on new locations of non-native and invasive species: Vegetation sampling crews and PIs have been pro-active over the years in reporting new locations of invasive vegetation. Fish and macroinvertebrate PIs and crews have also realized that they may be discovering new locations of invasive species, particularly invasive macroinvertebrates. To ensure that all new sightings get recorded, we are pulling all records of non-native fish and macroinvertebrates out of the database once per year and sending these records to the Nonindigenous Aquatic Species tracking website maintained by USGS (http://nas2.er.usgs.gov/). Wetland vegetation PIs contributed new SOLEC indicator guidelines and reports and continue to participate in the indicator review process.

Wetland Floristic Quality in the St. Louis River Estuary: With support from WI Sea Grant 2014-2017, vegetation PI N. Danz has integrated vegetation surveys from the CWM project with data from 14 other recent projects in the estuary. A new relational database was created that is being used to assess spatial and temporal patterns in floristic quality and to develop materials to inform and monitor wetland restorations in this AOC.

Coordination and Partnership with National Audubon: Per the agreement to share CWMP bird data with the National Audubon Society, we have provided data and guidance on appropriate use of these data for their project “Prioritizing coastal wetlands for marsh bird conservation in the U.S. Great Lakes”. The resulting manuscript from this project is currently in review with the journal ‘*Biological Conservation*’ and per the agreement all CWMP bird and anuran co-investigators have had the opportunity to contribute to the manuscript and be included as co-authors. We expect to maintain communications regarding any potential future use of the CWMP data by National Audubon and will continue to provide guidance on appropriate uses in future projects and analyses.

Targeting Invasive Plant Species in Wisconsin Coastal Wetlands: In collaboration with WI Department of Natural Resources and Lake Superior Research Institute, vegetation PIs have summarized patterns of invasive plant occurrence in Wisconsin coastal wetlands. These summaries are being used to develop a more comprehensive invasive plant monitoring strategy throughout the Wisconsin basin.

REQUESTS FOR ASSISTANCE COLLECTING MONITORING DATA

Project PIs provided monitoring data and interpretation of data for many wetlands where restoration activities were being proposed by applicants for “Sustain Our Great Lakes” funding. This program is administered by the National Fish and Wildlife Foundation (NFWF) and includes GLRI funding. Proposal writers made data/information requests via NFWF, who communicated the requests to us. Lead PI Don Uzarski, with assistance from co-PIs, then pulled relevant project data and provided interpretations of IBI scores and water quality data. This information was then communicated to NFWF, who communicated with the applicants. This information sharing reflects the value of having coastal wetland monitoring data to inform restoration and protection decisions. We anticipate similar information sharing in the coming years as additional restoration and protection opportunities arise.

In addition to the NFWF program, CWM PIs have received many requests to sample particular wetlands of interest to various agencies and groups. In some instances the wetlands are scheduled for restoration and it is hoped that our project can provide pre-restoration data, and perhaps also provide post-restoration data to show the beginnings of site condition improvement, depending on the timing. Such requests have come from the St. Louis River (Lake Superior), Maumee Bay (Lake Erie), and Rochester (Lake Ontario) Area of Concern delisting groups, the Great Lakes National Park Service, the Nature Conservancy (sites across lakes Michigan and Huron for both groups), as well as state natural resource departments. Several requests involve restorations specifically targeted to create habitat for biota that are being sampled by CWM. Examples include: a NOAA-led restoration of wetlands bordering the Little Rapids of the St. Marys River to restore critical spawning habitat for many native freshwater fishes and provide important nursery and rearing habitat in backwater areas; TNC-led restoration of pike spawning habitats on Lake Ontario and in Green Bay; a US Army Corps of Engineers project in Green Bay to create protective barrier islands and restore many acres of aquatic and wetland vegetation; a USACE project to improve wetland fish and vegetation habitat in Braddock Bay, Lake Ontario; a New York state project to increase nesting habitat for state-endangered black tern; and projects in Wisconsin to restore degraded coastal wetlands on the Lake Superior shore. Many of these restoration activities are being funded through GLRI, so through collaboration we increase efficiency and effectiveness of restoration efforts across the Great Lakes basin.

At some sites, restoration is still in the planning stages and restoration committees are interested in the data CWM can provide to help them create a restoration plan. This is happening in the St. Louis River AOC, in Sodus Bay, Lake Ontario, for the Rochester NY AOC, wetlands along Wisconsin's Lake Superior shoreline, and for the St. Marys River restoration in 2015 by tribal biologists at Sault Ste Marie.

Other groups have requested help sampling sites that are believed to be in very good condition (at least for their geographic location), or are among the last examples of their kind, and are on lists to be protected. These requests have come from The Nature Conservancy for Green Bay sites (they are developing a regional conservation strategy and attempting to protect the best remaining sites); the St. Louis River AOC delisting committee to provide target data for restoration work (i.e., what should a restored site "look" like); and the Wisconsin DNR Natural Heritage Inventory has requested assistance in looking for rare, endangered, and threatened species and habitats in all of the coastal wetlands along Wisconsin's Lake Superior coastline. Southern Lake Michigan wetlands have mostly been lost, and only three remain that are truly coastal wetlands. CWM PIs are working with Illinois agencies and conservation groups to collaboratively and thoroughly sample one of these sites, and the results will be used to help manage all 3 sites.

Other managers have also requested data to help them better manage wetland areas. For example, the Michigan Clean Water Corps requested CWM data to better understand and manage Stony Lake, Michigan. Staff of a coal-fired power plant abutting a CWM site requested our fish data to help them better understand and manage the effects of their outfalls on the resident fish community. The Michigan Natural Features Inventory is requesting our data as part of a GLRI-funded invasive species mapping project. The US Fish and Wildlife Service requested all data possible from wetlands located within the Rochester, NY, Area of Concern as they assess trends in the wetlands and compare data to designated delisting criteria. The NERR on Lake Erie (Old Woman Creek) has requested our monitoring data to add to their own. The University of Wisconsin Green Bay will use our data to monitor control of *Phragmites* in one of their wetlands, and hope to show habitat restoration. Thunder Bay National Marine Sanctuary (Lake Huron) has requested our data to facilitate protection and management of coastal resources within the Sanctuary. The Wisconsin DNR has requested data for the Fish Creak Wetland as part of an Environmental Impact Assessment related to a proposed Confined Animal Feeding Operation upstream of the wetland.

We have received a request from the USFWS for data to support development of a black tern distribution/habitat model for the Great Lakes region. The initial effort will focus on Lakes Huron, Erie and their connecting channels. Various FWS programs (e.g., Migratory Bird, Joint Venture, and Landscape Conservation Cooperatives) are interested in this model as an input to conservation planning for Great Lakes wetlands.

The College at Brockport has been notifying an invasive species rapid-response team led by The Nature Conservancy after each new sighting of water chestnut. Coupling the monitoring efforts of this project with a rapid-response team helped to eradicate small infestations of this new invasive before it became a more established infestation.

We are also now receiving requests to do methods comparison studies. For example, USGS and Five Fathom National Marine Park have both requested data and sampling to compare with their own sampling data.

Overall, CWM PIs have had many requests to sample specific wetlands. It has been challenging to accommodate all requests within our statistical sampling design and our sampling capacities.

STUDENT RESEARCH SUPPORT

Graduate Research with Leveraged Funding:

- Using advanced morphometrics to improve identification of Sphaeriidae (fingernail clams) of the Great lakes as informed by DNA analyses (University of Minnesota Duluth; other field crews providing specimens).
- Importance of coastal wetlands to offshore fishes of the Great Lakes: Dietary support and habitat utilization (Central Michigan University; with additional funding from several small University grants and the US Fish and Wildlife Service).
- Spatial variation in macroinvertebrate communities within two emergent plant zones in Great Lakes coastal wetlands (Central Michigan University; with additional funding from CMU).
- Invertebrate co-occurrence patterns in coastal wetlands of the Great Lakes: Community assembly rules (Central Michigan University; additional funding from CMU)
- Functional indicators of Great Lakes coastal wetland health (University of Notre Dame; additional funding by Illinois-Indiana Sea Grant).
- Evaluating environmental DNA detection alongside standard fish sampling in Great Lakes coastal wetland monitoring (University of Notre Dame; additional funding by Illinois-Indiana Sea Grant).
- Nutrient-limitation in Great Lakes coastal wetlands (University of Notre Dame; additional funding by the UND College of Science).
- A summary of snapping turtle (*Chelydra serpentina*) by-catch records in Lake Ontario coastal wetlands (with additional funding by University of Toronto).
- Evaluating a zoobenthic indicator of Great Lakes wetland condition (with additional funding from University of Windsor).
- Testing and comparing the diagnostic value of three fish community indicators of Great Lakes wetland condition (with additional funding from GLRI GLIC: GLEI II and University of Windsor).
- Quantifying Aquatic Invasion Patterns Through Space and Time: A Relational Analysis of the Laurentian Great Lakes (University of Minnesota Duluth; with additional funding and data from USEPA)
- Novel Diagnostics for Biotransport of Aquatic Environmental Contaminants (University of Notre Dame, with additional funding from Advanced Diagnostics & Therapeutics program)

- Conservation of Common Terns in the Great Lakes Region (University of Minnesota; with additional funding from USFWS, MNDNR, and multiple smaller internal and external grants).
- Distribution of yellow perch in Great Lakes coastal wetlands (Grand Valley State University; with additional funding from GVSU).
- Variation in aquatic invertebrate assemblages in coastal wetland wet meadow zones of Lake Huron, of the Laurentian Great Lakes (University of Windsor; with additional funding from the University of Windsor).
- Influence of water level fluctuations and diel variation in dissolved oxygen concentrations on fish habitat use in Great Lakes coastal wetlands (University of Windsor; with additional funding from the University of Windsor).
- Bird community response to changes in wetland extent and lake level in Great Lakes coastal wetlands (University of Wisconsin-Green Bay with additional funding from Bird Studies Canada)
- Inferential measures for a quantitative ecological indicator of ecosystem health (University of Wisconsin-Green Bay)
- Per- and polyfluorinated alkyl substances (PFAS) in Great Lakes food webs and sportfish (University of Notre Dame)

Undergraduate Research with Leveraged Funding:

- Production of a short documentary film on Great Lakes coastal wetlands (University of Notre Dame; additional funding by the UND College of Arts and Letters).
- Heavy metal loads in freshwater turtle species inhabiting coastal wetlands of Lake Michigan (University of Notre Dame; additional funding by the UND College of Science, and ECI – Environmental Change Institute). Online coverage, TV and radio.
- Nitrogen-limitation in Lake Superior coastal wetlands (Northland College; additional funding from the Wisconsin DNR and Northland College).
- Patterns in chlorophyll-*a* concentrations in Great Lakes coastal wetlands (Northland College; additional funding provided by the college).
- *Phragmites australis* effects on coastal wetland nearshore fish communities of the Great Lakes basin (University of Windsor; with additional funding from GLRI GLIC: GLEI II).
- Sonar-derived estimates of macrophyte density and biomass in Great Lakes coastal wetlands (University of Windsor; with additional funding from GLRI GLIC: GLEI II presented at the International Association for Great Lakes Research annual meeting).
- Effects of disturbance frequency on the structure of coastal wetland macroinvertebrate communities (Lake Superior State University; with additional funding from LSSU's

Undergraduate Research Committee; awarded Best Student Poster award at LSSU Research Symposium; presented at MI American Fisheries Society annual meeting).

- Resistance and resilience of macroinvertebrate communities in disturbed and undisturbed coastal wetlands (Lake Superior State University; with additional funding from LSSU's Undergraduate Research Committee, (presented at MI American Fisheries Society annual meeting and Midwest Fish and Wildlife Conference).
- Structure and function of restored Roxana Marsh in southern Lake Michigan (University of Notre Dame, with additional funding from the UND College of Science)
- Nutrient limitation in Great Lakes coastal wetlands (Central Michigan University, CMU Biological Station on Beaver Island)
- Effects of wetland size and adjacent land use on taxonomic richness (University of Minnesota Duluth, with additional funding from UMD's UROP program)
- Water depth optima and tolerances for St. Louis River estuary wetland plants (University of Wisconsin-Superior, with additional funding from WI Sea Grant)
- Mapping Wetland Areal Change in the St. Louis River Estuary Using GIS (University of Wisconsin-Superior, with additional funding from WI Sea Grant)
- An analysis of Microcystin concentrations in Great Lakes coastal wetlands (Central Michigan University; additional funding by CMU College of Science and Engineering).
- Bathymetry and water levels in lagoonal wetlands of the Apostle Islands National Lakeshore (Northland College; additional funding from the National Park Service). Several presentations at regional meetings and IAGLR.
- Non-native fish use of Great Lakes coastal wetlands (Northland College funding). Poster presentations by Northland College students at Wisconsin Wetland Science Meeting and IAGLR.

<u>Graduate Research without Leveraged Funding:</u>

- Impacts of drainage outlets on Great Lakes coastal wetlands (Central Michigan University).
- Effects of anthropogenic disturbance affecting coastal wetland vegetation (Central Michigan University).
- Great Lakes coastal wetland seed banks: what drives compositional change? (Central Michigan University).
- Spatial scale variation in patterns and mechanisms driving fish diversity in Great Lakes coastal wetlands (Central Michigan University).
- Building a model of macroinvertebrate functional feeding group community through zone succession: Does the River Continuum Concept apply to Great Lakes coastal wetlands? (Central Michigan University).

- Chemical and physical habitat variation within Great Lakes coastal wetlands; the importance of hydrology and dominant plant zonation (Central Michigan University)
- Macroinvertebrate-based Index of Biotic Integrity for Great Lakes coastal wetlands (Central Michigan University)
- Habitat conditions and invertebrate communities of Great Lakes coastal habitats dominated by Wet Meadow, and *Phragmites australis*: implications of macrophyte structure changes (Central Michigan University)
- The establishment of *Bithynia tentaculata* in coastal wetlands of the Great Lakes (Central Michigan University)
- Environmental covariates as predictors of anuran distribution in Great Lakes coastal wetlands (Central Michigan University)
- Impacts of muskrat herbivory in Great Lakes coastal wetlands (Central Michigan University).
- Mute swan interactions with native waterfowl in Great Lakes coastal wetlands (Central Michigan University).
- Effects of turbidity regimes on fish and macroinvertebrate community structure in coastal wetlands (Lake Superior State University and Oakland University).
- Scale dependence of dispersal limitation and environmental species sorting in Great Lakes wetland invertebrate meta-communities (University of Notre Dame).
- Spatial and temporal trends in invertebrate communities of Great Lakes coastal wetlands, with emphasis on Saginaw Bay of Lake Huron (University of Notre Dame).
- Model building and a comparison of the factors influencing sedge and marsh wren populations in Great Lakes coastal wetlands (University of Minnesota Duluth).
- The effect of urbanization on the stopover ecology of Neotropical migrant songbirds on the western shore of Lake Michigan (University of Minnesota Duluth).
- Assessing the role of nutrients and watershed features in cattail invasion (*Typha angustifolia* and *Typha* x *glauca*) in Lake Ontario wetlands (The College at Brockport).
- Developing captive breeding methods for bowfin (*Amia calva*) (The College at Brockport).
- Water chestnut (*Trap natans*) growth and management in Lake Ontario coastal wetlands (The College at Brockport).
- Functional diversity and temporal variation of migratory land bird assemblages in lower Green Bay (University of Wisconsin-Green Bay).
- Effects of invasive *Phragmites* on stopover habitat for migratory shorebirds in lower Green Bay, Lake Michigan (University of Wisconsin-Green Bay).
- Plant species associations and assemblages for the whole Great Lakes, developed through unconstrained ordination analyses (Oregon State University).
- Genetic barcoding to identify black and brown bullheads (Grand Valley State University).

- Coastal wetland – nearshore linkages in Lake Michigan for sustaining sport fishes (University of Notre Dame)
- Anthropogenic disturbance effects on bird and anuran communities in Lake Ontario coastal wetlands (The College at Brockport)
- A fish-based index of biotic integrity for Lake Ontario coastal wetlands (The College at Brockport)
- Modeling potential nutria habitat in Great Lakes coastal wetlands (Central Michigan University)
- Modeling of Eurasian ruffe (*Gymnocephalus cernua*) habitat preferences to predict future invasions (University of Minnesota Duluth in collaboration with USEPA MED)
- Modeling species-specific habitat associations of Great Lakes coastal wetland birds (University of Minnesota)
- The effect of urbanization on the stopover ecology of Neotropical migrant songbirds on the western shore of Lake Michigan (University of Minnesota Duluth).
- Nutrient limitation in Great Lakes coastal wetlands: gradients and their influence (Central Michigan University; with additional funding from the CMU College of Science and Engineering)
- Invasive *Phragmites australis* management (Central Michigan University; with additional funding from the CMU College of Science and Technology)
- The relationship between vegetation and ice formation in Great Lakes coastal wetlands (Central Michigan University; with additional funding from CMU College of Science and Engineering)
- PFAS accumulation by Dressenidae *spp* in Great Lakes Coastal Wetlands (Central Michigan University)
- Development of a vegetation based IBI for Great Lakes Coastal Wetlands (Central Michigan University)
- Development of a model for Great-Lakes wide invasive plant harvest for bioenergy production and nutrient recycling (Loyola Chicago and Oregon State University)
- Updating the Macroinvertebrate-based Index of Biotic Integrity for Great Lakes coastal wetlands (Central Michigan University)
- Great Lakes coastal wetland bird and anuran habitat associations (UW-Green Bay)

Undergraduate Research without Leveraged Funding:

- Sensitivity of fish community metrics to net set locations: a comparison between Coastal Wetland Monitoring and GLEI methods (University of Minnesota Duluth).

- Larval fish usage and assemblage composition between different wetland types (Central Michigan University).
- Determining wetland health for selected Great Lakes Coastal Wetlands and incorporating management recommendations (Central Michigan University).
- Invertebrate co-occurrence trends in the wetlands of the Upper Peninsula and Western Michigan and the role of habitat disturbance levels (Central Michigan University).
- Is macroinvertebrate richness and community composition determined by habitat complexity or variation in complexity? (University of Windsor, complete; Published in *Ecosphere*).
- Modeling American coot habitat relative to faucet snail invasion potential (Central Michigan University).
- Nutrient uptake by *Phragmites australis* and native wetland plants (Central Michigan University).
- Comparison of the diagnostic accuracy two aquatic invertebrate field collection and laboratory sorting methods (University of Windsor, complete).
- Validation of a zoobenthic assemblage condition index for Great Lakes coastal wetlands (University of Windsor, complete).
- Water depth-related variation in net ecosystem production in a Great Lakes coastal wet meadow (University of Windsor, complete).
- Anuran habitat use in the Lower Green Bay and Fox River Area of Concern (University of Wisconsin-Green Bay with support from GLRI/AOC funding).
- Impacts of European frog-bit invasion on wetland macroinvertebrate communities (Lake Superior State University; presented at Midwest Fish and Wildlife Conference).
- Effects of European frog-bit on water quality and fish assemblages in St. Marys River coastal wetlands (Lake Superior State University; presented at Midwest Fish and Wildlife Conference).
- Functional diversity of macroinvertebrates in coastal wetlands along the St. Marys River (Lake Superior State University; awarded Best Student Poster award at LSSU Research Symposium; presented at Midwest Fish and Wildlife Conference).
- A comparison of macroinvertebrate assemblages in coastal wetlands exposed to varying wave disturbance (Lake Superior State University; presented at MI American Fisheries Society annual meeting).
- Coastal wetlands as nursery habitat for young-of-year fishes in the St. Marys River (Lake Superior State University; presented at MI American Fisheries Society annual meeting)

- Relationship between water level and fish assemblage structure in St. Marys River coastal wetlands (Lake Superior State University; presented at MI American Fisheries Society annual meeting)
- Dominance patterns in macroinvertebrate communities in Great Lakes coastal wetlands: does environmental stress lead to uneven community structure? Northland College.
- Understanding drivers of chlorophyll-a in Great Lakes coastal wetlands. University of Notre Dame
- Evaluating fish assemblage changes throughout the summer in St. Marys River coastal wetlands (Lake Superior State University)
- Quantifying litter decomposition in wetlands of varying condition (Lake Superior State University)

JOBS CREATED/RETAINED (2020)

- Principal Investigators (partial support): 22
- Post-doctoral researchers (partial support): 4
- Total graduate students supported on project (part-time): 19
- Unpaid undergraduate internship (summer): Not possible in 2020 due to Covid-19
- Undergraduate students (paid; summer and/or part-time): 21
- Technicians, jr. scientists (summer and/or partial support): 39
- Volunteers: Could not have volunteers in 2020 or 2021 due to Covid-19

Total jobs at least partially supported in 2020: 105.
Students and post-doctoral researchers trained in 2020: 44.

JOBS CREATED/RETAINED (CUMULATIVE SINCE 2011, LAST UPDATED 2020)

- Principal Investigators (partial support): 20 (average per year)
- Post-doctoral researchers (partial support; cumulative): 7
- Total graduate students supported on project (part-time; cumulative): 113
- Unpaid undergraduate internship (summer, cumulative): 35
- Undergraduate students (paid; summer and/or part-time; cumulative): 194
- Technicians, jr. scientists (summer and/or partial support; cumulative): 135
- Volunteers (cumulative): 47

Total jobs at least partially supported: 469.

Students and post-doctoral researchers trained: 349.

At our annual meetings in 2021 and 2023, we conducted a formal discussion session on Diversity, Equity, and Inclusion (DEI). In 2021, we split into 10 breakout groups to discuss three questions related to best practices for enhancing DEI in the CWMP workforce. In brief, the three questions concerned 1) current practices used to enhance DEI, 2) perceived barriers to enhancing DEI, and 3) potential mechanisms for enhancing DEI in the future. These discussion notes were compiled and organized, and then redistributed to all CWMP participants. In 2023 we focused our discussion on how to increase crew safety as field crews diversify, acknowledging that people from differing backgrounds, ethnicities, and identities may be treated differently and feel less safe. Our goal, as always, is for all field crew members to both feel and be safe. CWMP leadership will continue to monitor and encourage DEI goals for the program.

PRESENTATIONS ABOUT THE COASTAL WETLAND MONITORING PROJECT

(INCEPTION THROUGH 2023)

Albert, Dennis. 2013. Use of Great Lakes Coastal Wetland Monitoring data in restoration projects in the Great Lakes region. 5th Annual Conference on Ecosystem Restoration, Schaumburg, IL. July 30, 2013. 20 attendees, mostly managers and agency personnel.

Albert, Dennis. 2013. Data collection and use of Great Lakes Coastal Wetland Monitoring data by Great Lakes restorationists. Midwestern State Wetland Managers Meeting, Kellogg Biological Station, Gull Lake, MI, October 31, 2013. 40 attendees; Great Lakes state wetland managers.

Albert, Dennis, N. Danz, D. Wilcox, and J. Gathman. 2014. Evaluating Temporal Variability of Floristic Quality Indices in Laurentian Great Lakes Coastal Wetlands. Society of Wetland Scientists, Portland, OR. June.

Albert, Dennis, et al. 2015. Restoration of wetlands through the harvest of invasive plants, including hybrid cattail and *Phragmites australis*. Presented to Midwestern and Canadian biologists. June.

Albert, Dennis, et al. 2015. Great-Lakes wide distribution of bulrushes and invasive species. Coastal and Estuarine Research Federation Conference in Portland, Oregon. November.

Amatangelo, K., D. Wilcox, R. Schultz, M. Altenritter, M. Chislock, and G. Lawrence. 2021. Application of the Great Lakes Coastal Wetlands Monitoring Program to Restoration

Projects in Lake Ontario Wetlands. State of Lake Ontario Conference. March 9-11, 2021, online.

Baldwin, R., B. Currell, and A. Moerke. 2014. Effects of disturbance history on resistance and resilience of coastal wetlands. Midwest Fish and Wildlife Conference, January, Kansas City, MO.

Baldwin, R., B. Currell, and A. Moerke. 2014. Effects of disturbance history on resistance and resilience of coastal wetlands. MI American Fisheries Society annual meeting, February, Holland, MI.

Bergen, E., E. Shively, M.J. Cooper. Non-native fish species richness and distributions in Great Lakes coastal wetlands. International Association for Great Lakes Research Annual Conference, June 10-14, 2019, Brockport, NY. (poster)

Bergen, E., E. Shively, M.J. Cooper. Drivers of non-native fish species richness and distribution in the Laurentian Great Lakes. February 19-21, 2019. Madison, WI. (poster)

Bozimowski, S. and D.G. Uzarski**.** 2016. The Great Lakes coastal wetland monitoring program. 2016 Wetlands Science Summit, Richfield, OH. September, Oral Presentation.

Bozimowski, A.A., B.A. Murry, and D.G. Uzarski. 2012 Invertebrate co-occurrence patterns in the wetlands of northern and eastern Lake Michigan: the interaction of the harsh-benign hypothesis and community assembly rules. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Bozimowski, A. A., B. A. Murry, P. S. Kourtev, and D. G. Uzarski. 2014. Aquatic macroinvertebrate co-occurrence patterns in the coastal wetlands of the Great Lakes: the interaction of the harsh-benign hypothesis and community assembly rules. Great Lakes Science in Action Symposium, Central Michigan University, Mt. Pleasant, MI. April.

Bozimowski, A.A., B.A. Murry, P.S. Kourtev, and D.G. Uzarski. 2015. Aquatic macroinvertebrate co-occurrence patterns in the coastal wetlands of the Great Lakes. 58th International Conference on Great Lakes Research, Burlington, VT.

Bozimowski, A.A. and D.G. Uzarski. 2017. Monitoring a changing ecosystem: Great Lakes coastal wetlands. Saginaw Bay Watershed Initiative Network's State of the Bay Conference.

Bracey, A. M., R. W. Howe, N.G. Walton, E. E. G. Giese, and G. J. Niemi. Avian responses to landscape stressors in Great Lakes coastal wetlands. 5th International Partners in Flight Conference and Conservation Workshop. Snowbird, UT, August 25-28, 2013.

Brady, V., D. Uzarski, and M. Cooper. 2013. Great Lakes Coastal Wetland Monitoring: Assessment of High-variability Ecosystems. USEPA Mid-Continent Ecology Division Seminar Series, May 2013. 50 attendees, mostly scientists (INVITED).

Brady, V., G. Host, T. Brown, L. Johnson, G. Niemi. 2013. Ecological Restoration Efforts in the St. Louis River Estuary: Application of Great Lakes Monitoring Data. 5th Annual Conference on Ecosystem Restoration, Schaumburg, IL. July 30, 2013. 20 attendees, mostly managers and agency personnel.

Brady, V. and D. Uzarski. 2013. Great Lakes Coastal Wetland Fish and Invertebrate Condition. Midwestern State Wetland Managers Meeting, Kellogg Biological Station, Gull Lake, MI, October 31, 2013. 40 attendees; Great Lakes state wetland managers.

Brady, V., D. Uzarski, T. Brown, G. Niemi, M. Cooper, R. Howe, N. Danz, D. Wilcox, D. Albert, D. Tozer, G. Grabas, C. Ruetz, L. Johnson, J. Ciborowski, J. Haynes, G. Neuderfer, T. Gehring, J. Gathman, A. Moerke, G. Lamberti, C. Normant. 2013. A Biotic Monitoring Program for Great Lakes Coastal Wetlands. Society of Wetland Scientists annual meeting, Duluth, MN, June 2013. 25 attendees, mostly scientists, some agency personnel.

Brady, V., D. Uzarski, T. Brown, G. Niemi, M. Cooper, R. Howe, N. Danz, D. Wilcox, D. Albert, D. Tozer, G. Grabas, C. Ruetz, L. Johnson, J. Ciborowski, J. Haynes, G. Neuderfer, T. Gehring, J. Gathman, A. Moerke, G. Lamberti, C. Normant. 2013. Habitat Values Provided by Great Lakes Coastal Wetlands: based on the Great Lakes Coastal Wetland Monitoring Project. Society of Wetland Scientists annual meeting, Duluth, MN, June 2013. 20 attendees, mostly scientists.

Brady, V.J., D.G. Uzarski, M.J. Cooper, D.A. Albert, N. Danz, J. Domke, T. Gehring, E. Giese, A. Grinde, R. Howe, A.H. Moerke, G. Niemi, H. Wellard-Kelly. 2018. How are Lake Superior's wetlands? Eight years, 100 wetlands sampled. State Of Lake Superior Conference. Houghton, MI. Oral Presentation.

Brady, V., G. Niemi, J. Dumke, H. Wellard Kelly, M. Cooper, N. Danz, R. Howe. 2019. The role of monitoring data in coastal wetland restoration: Case studies from Duluth and Green Bay. International Association of Great Lakes Research Annual Meeting, Brockport, NY, June 2019. Invited oral presentation.

Buckley, J.D., and J.J.H. Ciborowski. 2013. A comparison of fish indices of biological condition at Great Lakes coastal margins. 66th Canadian Conference for Freshwater Fisheries Research, Windsor, ON, January 3-5 2013. Poster Presentation.

Chorak, G.M., C.R. Ruetz III, R.A. Thum, J. Wesolek, and J. Dumke. 2015. Identification of brown and black bullheads: evaluating DNA barcoding. Poster presentation at the Annual

Meeting of the Michigan Chapter of the American Fisheries Society, Bay City, Michigan. January 20-21.

Cooper, M.J. Great Lakes coastal wetland monitoring: chemical and physical parameters as co-variates and indicators of wetland health. Biennial State of the Lakes Ecosystem Conference, Erie, PA, October 26-27, 2011. Oral presentation.

Cooper, M.J. Coastal wetland monitoring: methodology and quality control. Great Lakes Coastal Wetland Monitoring Workshop, Traverse City, MI, August 30, 2011. Oral presentation.

Cooper, M.J., D.G. Uzarski, and G.L. Lamberti. GLRI: coastal wetland monitoring. Michigan Wetlands Association Annual Conference, Traverse City, MI, August 30-September 2, 2011. Oral presentation.

Cooper, M.J. Monitoring the status and trends of Great Lakes coastal wetland health: a basin-wide effort. Annual Great Lakes Conference, Institute of Water Research, Michigan State University, East Lansing, MI, March 8, 2011. Oral presentation.

Cooper, M.J., G.A. Lamberti, and D.G. Uzarski. Monitoring ecosystem health in Great Lakes coastal wetlands: a basin-wide effort at the intersection of ecology and management. Entomological Society of America, Reno, NV, November 13-16, 2011. Oral presentation

Cooper, M.J., and G.A. Lamberti. Taking the pulse of Great Lakes coastal wetlands: scientists tackle an epic monitoring challenge. Poster session at the annual meeting of the National Science Foundation Integrative Graduate Education and Research Traineeship Program, Washington, D.C., May 2012. Poster presentation.

Cooper, M.J., J.M. Kosiara, D.G. Uzarski, and G.A. Lamberti. Nitrogen and phosphorus conditions and nutrient limitation in coastal wetlands of Lakes Michigan and Huron. Annual meeting of the International Association for Great Lakes Research. Cornwall, Ontario. May 2012. Oral presentation.

Cooper, M.J., G.A. Lamberti, and D.G. Uzarski. Abiotic drivers and temporal variability of Saginaw Bay wetland invertebrate communities. International Association for Great Lakes Research, 56th annual meeting, West Lafayette, IN. June 2013. Oral presentation.

Cooper, M.J., D.G. Uzarski, J. Sherman, and D.A. Wilcox. Great Lakes coastal wetland monitoring program: support of restoration activities across the basin. National Conference on Ecosystem Restoration, Chicago, IL. July 2013. Oral presentation.

Cooper, M.J. and J. Kosiara. Great Lakes coastal wetland monitoring: Chemical and physical parameters as co-variates and indicators of wetland health. US EPA Region 5 Annual

Wetlands Program Coordinating Meeting and Michigan Wetlands Association Annual Meeting. Kellogg Biological Station, Hickory Corners, MI. October 2013. Oral presentation.

Cooper, M.J. Implementing coastal wetland monitoring. Inter-agency Task Force on Data Quality for GLRI-Funded Habitat Projects. CSC Inc., Las Vegas, NV. November 2013. Web presentation, approximately 40 participants.

Cooper, M.J. Community structure and ecological significance of invertebrates in Great Lakes coastal wetlands. SUNY-Brockport, Brockport, NY. December 2013. Invited seminar.

Cooper, M.J. Great Lakes coastal wetlands: ecological monitoring and nutrient-limitation. Limno-Tech Inc., Ann Arbor, MI. December 2013. Invited seminar.

Cooper, M.J., D.G. Uzarski, and V.J. Brady. A basin-wide Great Lakes coastal wetland monitoring program: Measures of ecosystem health for conservation and management. Great Lakes Wetlands Day, Toronto, Ont. Canada, February 4, 2014. Oral presentation.

Cooper, M.J., G.A. Lamberti, and D.G. Uzarski. Supporting Great Lakes coastal wetland restoration with basin-wide monitoring. Great Lakes Science in Action Symposium. Central Michigan University. April 4, 2014.

Cooper, M.J. Expanding fish-based monitoring in Great Lakes coastal wetlands. Michigan Wetlands Association Annual Meeting. Grand Rapids, MI. August 27-29, 2014.

Cooper, M.J. Structure and function of Great Lakes coastal wetlands. Public seminar of Ph.D. dissertation research. University of Notre Dame. August 6, 2014.

Cooper, M.J., D.G. Uzarski, and T.N. Brown. Developing a decision support system for protection and restoration of Great Lakes coastal wetlands. Biodiversity without Borders Conference, NatureServe. Traverse City, MI. April 27, 2015.

Cooper, M.J. and D.G. Uzarski. Great Lakes coastal wetland monitoring for protection and restoration. Lake Superior Monitoring Symposium. Michigan Technological University. March 19, 2015.

Cooper, M.J. Where worlds collide: ecosystem structure and function at the land-water interface of the Laurentian Great Lakes. Central Michigan University Department of Biology. Public Seminar. February 5, 2015.

Cooper, M.J. Where worlds collide: ecosystem structure and function at the land-water interface of the Laurentian Great Lakes. Sigurd Olson Environmental Institute, Northland College. Public Seminar. May 4, 2015.

Cooper, M.J., and D.G. Uzarski. Great Lakes coastal wetland monitoring for protection and restoration. Lake Huron Restoration Meeting. Alpena, MI. May 14, 2015.

Cooper, M.J., D.G. Uzarski, and V.J. Brady. Developing a decision support system for restoration and protection of Great Lakes coastal wetlands. Wisconsin Wetlands Association Annual Meeting. February 24-25, 2016. Green Bay, WI.

Cooper, M.J., Stirratt, H., B. Krumwiede, and K. Kowalski. Great Lakes Resilient Lands and Waters Initiative, Deep Dive. Remote presentation to the White House Council on Environmental Quality and partner agencies, January 28, 2016.

Cooper, M., Redder, T., Brady, V. and D. Uzarski. 2016. Developing a decision support tool to guide restoration and protection of Great Lakes coastal wetlands. Annual Meeting of the Wisconsin Wetlands Association, Stevens Point, WI. February. Presentation.

Cooper, M.J.. Nutrient limitation in wetland ecosystems. Wisconsin Department of Natural Resources, February 12, 2016, Rhinelander, WI.

Cooper, M.J., D.G. Uzarski and V.J. Brady. 2016. Developing a decision support system for restoration and protection of Great Lakes coastal wetlands. Wisconsin Wetlands Association Annual Meeting, Green Bay, WI. February 24-25. Oral Presentation.

Cooper, M.J.. Monitoring biotic and abiotic conditions in Great Lakes coastal wetlands. Wisconsin DNR Annual Surface Water Quality Conference. May 2016, Tomahawk, WI.

Cooper, M.J. The Depth of Wisconsin's Water Resources. Panel Discussion, Wisconsin History Tour, Northern Great Lakes Visitors Center, June 15, 2016, Ashland, WI.

Cooper, M.J.. Great Lakes Coastal Wetlands. The White House Resilient Lands and Waters Initiative Roundtable. Washington, DC, November 17, 2016.

Cooper, M.J. Translating Science Into Action in the Great Lakes. Marvin Pertzik Lecture Series. Northland College, May 2016.

Cooper, M.C., C. Hippensteel, D.G. Uzarski, and T.M. Redder. Developing a decision support tool for Great Lakes coastal wetlands. LCC Coastal Conservation Working Group Annual Meeting, Great Lakes Environmental Research Laboratory, Ann Arbor, MI, Oct. 6, 2016.

Cooper, M.J., T.M. Redder, C. Hippensteel, V.J. Brady, D.G. Uzarski. Developing a decision support tool to guide restoration and protection of Great Lakes coastal wetlands. Midwest Fish and Wildlife Conference, Feb. 5-8, 2017, Lincoln, NE.

Cooper, M.J., T.M. Redder, V.J. Brady, D.G. Uzarski. Developing a decision support tool to guide restoration and protection of Great Lakes coastal wetlands. Wisconsin Wetlands Association Annual Conference, February 28-March 2, 2017, Steven's Point, WI.

Cooper, M.J. Coastal Wetlands as Metabolic Gates, Sediment Filters, Swiss Army Knife Habitats, and Biogeochemical Hotspots. Science on Tap, Ashland, WI, March 21, 2017.

Cooper, M.J., Brady, V.J., Uzarski, D.G., Lamberti, G.A., Moerke, A.H., Ruetz, C.R., Wilcox, D.A., Ciborowski, J.J.H., Gathman, J.P., Grabas, G.P., and Johnson, L.B. An Expanded Fish-Based Index of Biotic Integrity for Great Lakes Coastal Wetlands. International Association for Great Lakes Research 60th Annual Meeting, Detroit, MI, May 15-19, 2017.

Cooper, M.J., D.G. Uzarski, and A. Garwood. Great Lakes Coastal Wetland Monitoring." Webinar hosted by Michigan Department of Environmental Quality, April 14, 2017. 78 attendees.

Cooper, M.J., A. Hefko, M. Wheeler. Nitrogen limitation of Lake Superior coastal wetlands. Society for Freshwater Science Annual Conference, May 20-24, 2018, Detroit, MI.

Cooper, M.J. The Role of Wetlands in Maintaining Water Quality. Briefing to the International Joint Commission, Ashland, WI, September 26, 2019.

Cooper, M.J., V.J. Brady, and D.G. Uzarski. Great Lakes Coastal Wetland Monitoring. Plenary Presentation, Great Lakes Coastal Wetland Symposium, Oregon, OH, September 19, 2019.

Cooper, M.J. and S. Johnson. Life on the Soggy Edges. Madeline Island Wilderness Preserve Lecture Series, Madeline Island Museum, La Pointe, WI, June 19, 2019.

Cooper, M.J., T.M. Redder, V.J. Brady, D.G. Uzarski. A data visualization tool to support protection and restoration of Great Lakes coastal wetlands. International Association for Great Lakes Research Annual Conference, June 10-14, 2019, Brockport, NY

Cooper, M.J., V.J. Brady, and D.G. Uzarski. 2022. Detecting Human Disturbance in Coastal Wetlands Across Temporal and Spatial Scales Using Biotic Indicators. Great Lakes Coastal Symposium. Sept. 19-21, 2022. Sault Ste. Marie, MI

Cooper, M.J., V.J. Brady, and D.G. Uzarski. 2023. Monitoring Great Lakes Coastal Wetlands. Michigan Wetlands Association Annual Meeting. Sept. 12-14, 2023. Kalamazoo, MI

Curell, Brian. 2014. Effects of disturbance frequency on macroinvertebrate communities in coastal wetlands. MI American Fisheries Society annual meeting, February, Holland, MI.

Dahlberg, N., N.P. Danz, and S. Schooler. 2015. Integrating prior vegetation surveys from the St. Louis River estuary. Poster presentation at the 2015 Annual St. Louis River Summit, Superior, WI.

Dahlberg, N., N.P. Danz, and S. Schooler. 2017. 2012 Flood Impacts on St. Louis River Plant Communities. Poster presentation at St. Louis River Summit, Superior, WI.

Danz, N.P. 2014. Floristic quality of Wisconsin coastal wetlands. Oral presentation at the Wisconsin Wetlands Association 19th Annual Wetlands Conference, LaCrosse, WI. Audience mostly scientists.

Danz, N.P. Floristic Quality of Coastal and Inland Wetlands of the Great Lakes Region. Invited presentation at the University of Minnesota Duluth, Duluth, MN.

Danz, N.P., S. Schooler, and N. Dahlberg. 2015. Floristic quality of St. Louis River estuary wetlands. Oral presentation at the 2015 Annual St. Louis River Summit, Superior, WI.

Danz, N.P. 2016. Floristic quality of St. Louis River estuary wetlands. Invited presentation at the Center for Water and the Environment, Natural Resources Research Institute, Duluth, MN.

Danz, N.P. 2017. Connections Between Human Stress, Wetland Setting, and Vegetation in the St. Louis River Estuary. Oral presentation at the Wetland Science Conference, Stevens Point, WI.

Danz, N.P. 2017. 10 Things We Learned from Your Vegetation Data. Oral presentation at the St. Louis River Summit, Superior, WI.

Daly, D., T. Dunn, and A. Moerke. 2016. Effects of European frog-bit on water quality and fish assemblages in St. Marys River wetlands. Midwest Fish and Wildlife Conference, Grand Rapids, MI. January 24-27.

Des Jardin, K. and D.A. Wilcox. 2014. Water chestnut: germination, competition, seed viability, and competition in Lake Ontario. New York State Wetlands Forum, Rochester, NY.

Dumke, J.D., V.J. Brady, J. Ciborowski, J. Gathman, J. Buckley, D. Uzarski, A. Moerke, C. Ruetz III. 2013. Fish communities of the upper Great Lakes: Lake Huron's Georgian Bay is an outlier. Society for Wetland Scientists, Duluth, Minnesota. 30 attendees, scientists and managers.

Dumke, J.D., V.J. Brady, R. Hell, A. Moerke, C. Ruetz III, D. Uzarski, J. Gathman, J. Ciborowski. 2013. A comparison of St. Louis River estuary and the upper Great Lakes fish communities (poster). Minnesota American Fisheries Society, St. Cloud, Minnesota. Attendees scientists, managers, and agency personnel.

Dumke, J.D., V.J. Brady, R. Hell, A. Moerke, C. Ruetz III, D. Uzarski, J. Gathman, J. Ciborowski. 2013. A comparison of wetland fish communities in the St. Louis River estuary and the upper Great Lakes. St. Louis River Estuary Summit, Superior, Wisconsin. 150 attendees, including scientists, managers, agency personnel, and others.

Dumke, J.D., V.J. Brady, J. Erickson, A. Bracey, N. Danz. 2014. Using non-degraded areas in the St. Louis River estuary to set biotic delisting/restoration targets. St. Louis River Estuary Summit, Superior, Wisconsin. 150 attendees, including scientists, managers, agency personnel, and others.

Dumke, J., C.R. Ruetz III, G.M. Chorak, R.A. Thum, and J. Wesolek. 2015. New information regarding identification of young brown and black bullheads. Oral presentation at the Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, Eau Claire, Wisconsin. February 24-26. 150 attendees, including scientists, managers, agency personnel, and others.

Dunn, T., D. Daly, and A. Moerke. 2016. Impacts of European frog-bit invasion on Great Lakes wetlands macroinvertebrate communities. Midwest Fish and Wildlife Conference, Grand Rapids, MI. January 24-27.

Dykstra, K.M., C.R. Ruetz III, M.J. Cooper, and D.G. Uzarski. 2018. Occupancy and detection of yellow perch in Great Lakes coastal wetlands. Poster presentation at the Annual Meeting of the Society for Freshwater Science, Detroit, Michigan. May 20-24.

Dykstra (Emelander), K.M., C.R. Ruetz III, M.J. Cooper, and D.G. Uzarski. 2018. Occupancy and detection of yellow perch in Great Lakes coastal wetlands: preliminary results. Poster presentation at the annual meeting of the Michigan Chapter of the American Fisheries Society, Port Huron, Michigan. February 13-14.

Elliot, L.H., A.M. Bracey, G.J. Niemi, D.H. Johnson, T.M. Gehring, E.E. Gnass Giese, G.P. Grabas, R.W. Howe, C.J. Norment, and D.C. Tozer. Habitat Associations of Coastal Wetland Birds in the Great Lakes Basin. American Ornithological Society Meeting, East Lansing, Michigan. Poster Presentation. 31 July-5 August 2017.

Elliott, L.H., A. Bracey, G. Niemi, D.H. Johnson, T. Gehring, E. Giese, G. Grabas, R. Howe, C. Norment, and D.C. Tozer. 2018. Hierarchical modeling to identify habitat associations of secretive marsh birds in the Great Lakes. IAGLR Conference, Toronto, Canada. Oral Presentation. 18-22 June 2018.

Fraley, E.F. and D.G. Uzarski 2017. The relationship between vegetation and ice formation in Great Lakes coastal wetlands. 60th Annual Meeting of the International Association of Great Lakes Research. Detroit, MI. Poster.

Fraley, E.F. and D.G. Uzarski. 2016. The Impacts of Ice on Plant Communities in Great Lakes Coastal Wetlands. 7th Annual Meeting of the Michigan Consortium of Botanists, Grand Rapids, MI. October. Poster.

Gathman, J.P. 2013. How healthy are Great Lakes wetlands? Using plant and animal indicators of ecological condition across the Great Lakes basin. Presentation to Minnesota Native Plant Society. November 7, 2013.

Gathman, J.P., J.J.J. Ciborowski, G. Grabas, V. Brady, and K.E. Kovalenko. 2013. Great Lakes Coastal Wetland Monitoring project: progress report for Canada. 66th Canadian Conference for Freshwater Fisheries Research, Windsor, ON, January 3-5, 2013. Poster Presentation.

Gilbert, J.M., N. Vidler, P. Cloud Sr., D. Jacobs, E. Slavik, F. Letourneau, K. Alexander. 2014. *Phragmites australis* at the crossroads: Why we cannot afford to ignore this invasion. Great Lakes Wetlands Day Conference, Toronto, ON, February 4, 2014.

Gilbert, J.M. 2013. Phragmites Management in Ontario. Can we manage without herbicide? Webinar, Great Lakes *Phragmites* Collaborative, April 5, 2013.

Gilbert, J.M. 2012. *Phragmites australis*: a significant threat to Laurentian Great Lakes Wetlands, Oral Presentation, International Association of Great Lakes Wetlands, Cornwall, ON, May 2012

Gilbert, J.M. 2012. *Phragmites australis:* a significant threat to Laurentian Great Lakes Wetlands, Oral Presentation to Waterfowl and Wetlands Research, Management and Conservation in the Lower Great Lakes. Partners' Forum, St. Williams, ON, May 2012.

Gil de LaMadrid, D., and N.P. Danz. 2015. Water depth optima and tolerances for St. Louis River estuary wetland plants. Poster presentation at the 2015 Annual St. Louis River Summit, Superior, WI.

Gnass Giese, E.E. 2015. Great Lakes Wetland Frog Monitoring. Annual Lower Fox River Watershed Monitoring Program Symposium at the University of Wisconsin-Green Bay, Green Bay, Wisconsin. April 14, 2015. Oral Presentation.

Gnass Giese, E.E. 2015. Wetland Birds and Amphibians: Great Lakes Monitoring. Northeastern Wisconsin Audubon Society meeting at the Bay Beach Wildlife Sanctuary, Green Bay, Wisconsin. February 19, 2015. Oral Presentation.

Gnass Giese, E.E., R.W. Howe, N.G. Walton, G.J. Niemi, D.C. Tozer, W.B. Gaul, A. Bracey, J. Shrovnal, C.J. Norment, and T.M. Gehring. 2016. Assessing wetland health using breeding birds as indicators. Wisconsin Wetlands Association Conference, Radisson Hotel & Convention Center, Green Bay, Wisconsin. February 24, 2016. Poster Presentation.

Gnass Giese, E., R. Howe, A. Wolf, and G. Niemi. 2017. Breeding Birds and Anurans of Dynamic Green Bay Coastal Wetlands. State of Lake Michigan Conference, Green Bay, Wisconsin. Oral Presentation. 8 November 2017.Gnass Giese, E.E., R.W. Howe, A.T. Wolf, N.A. Miller, and N.G. Walton. An ecological index of forest health based on breeding birds. 2013. Webpage: http://www.uwgb.edu/biodiversity/forest-index/

Gnass Giese, E.E., R.W. Howe, A.T. Wolf, N.A. Miller, and N.G. Walton. 2014. Using Bird Data to Assess Condition of Western Great Lakes Forests. Midwest Bird Conservation and Monitoring Workshop, Port Washington, Wisconsin. Poster Presentation. 4-8 August 2014.Gnass Giese, E.E. 2013. Monitoring forest condition using breeding birds in the western Great Lakes region, USA. Editors: N. Miller, R. Howe, C. Hall, and D. Ewert. Internal Report. Madison, WI and Lansing, MI: The Nature Conservancy. 44 pp.

Gunsch, D., J.P. Gathman, and J.J.H. Ciborowski . 2018. Variation in dissolved-oxygen profiles along a depth gradient in Lake Huron coastal wet meadows relative to vegetation density and agricultural stress over 24 hours. IAGLR Conference, Toronto, Canada. Poster Presentation. 18-22 June 2018.

Gurholt, C.G. and D.G. Uzarski. 2013. Into the future: Great Lakes coastal wetland seed banks. IGLR Graduate Symposium, Central Michigan University, Mt. Pleasant, MI. March.

Gurholt, C.G. and D.G. Uzarski. 2013. Seed Bank Purgatory: What Drives Compositional Change of Great Lakes Coastal Wetlands. 56th International Association for Great Lakes Research Conference, Purdue University, West Lafayette, IN. June.

Harrison, A.M., M.J. Cooper, and D.G. Uzarski. 2019. Spatial and temporal (2011-2018) variation of water quality in Great Lakes coastal wetlands. International Association for Great Lakes Research. Brockport, NY. Presentation.

Hefko, A.G., M. Wheeler, M.J. Cooper. Nitrogen limitation of algal biofilms in Lake Superior coastal wetlands. International Association for Great Lakes Research Annual Conference, June 10-14, 2019, Brockport, NY. (poster)

Hein, M.C. and Cooper, M.J. Untangling drivers of chlorophyll a in Great Lakes coastal wetlands. International Association for Great Lakes Research 60th Annual Meeting, Detroit, MI, May 15-19, 2017.

Hirsch, B. E.E. Gnass Giese, and R. Howe. 2021. Anuran Occurrences in High and Low Water within the Lower Green Bay & Fox River AOC. Wisconsin Wetlands Association Conference, Virtual. Poster Presentation. February 2021.

Hohman, T., B. Howe, E. Giese, A. Wolf, and D. Tozer. 2019. Bird Community Response to Changes in Wetland Extent and Interspersion in Great Lakes Coastal Wetlands. Heckrodt Birding Club Meeting, Menasha, Wisconsin. Oral Presentation. 6 August 2019.

Hohman, T.R., R.W. Howe, A.T. Wolf, E.E.Gnass Giese, D.C. Tozer, T.M. Gehring, G.P. Grabas, G.J. Niemi, and C.J. Norment. 2019. Bird Community Response to Changes in Wetland Extent and Interspersion in Great Lakes Coastal Wetlands. Presented at the 62nd Annual Meeting of the International Association of Great Lakes Research (IAGLR), 12 June 2019, Brockport, NY.

Houghton, C.J., C.C. Moratz, P.S. Forsythe, G.A. Lamberti, D.G. Uzarski, and M.B. Berg. 2016. Relative use of wetland and nearshore habitats by sportfishes of Green Bay. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Howe, R.W., R.P. Axler, V.J. Brady, T.N. Brown, J.J.H. Ciborowski, N.P. Danz, J.P. Gathman, G.E. Host, L.B. Johnson, K.E. Kovalenko, G.J. Niemi, and E.D. Reavie. 2012. Multi-species indicators of ecological condition in the coastal zone of the Laurentian Great Lakes. 97th Annual Meeting of the Ecological Society of America. Portland, OR.

Howe, B., E. Giese, A. Wolf, and B. Kupsky. 2019. Restoration Targets for Great Lakes Coastal Wetlands in the Lower Green Bay & Fox River AOC. International Association for Great Lakes Research, Brockport, New York. Oral Presentation. 12 June 2019.

Howe, R.W., G.J. Niemi, N.G. Walton, E.E.G. Giese, A.M. Bracey, V.J. Brady, T.N. Brown, J.J.H. Ciborowski, N.P. Danz, J.P. Gathman, G.E. Host, L.B. Johnson, K.E. Kovalenko, and E.D. Reavie. 2014. Measurable Responses of Great Lakes Coastal Wetland Biota to Environmental Stressors. International Association for Great Lakes Research Annual Conference, Hamilton, Ontario (Canada). May 26-30, 2014. Oral Presentation.

Howe, B., A. Wolf, E. Giese, V. Pappas, B. Kupsky, M. Grimm, and N. Van Helden. 2018. Lower Green Bay & Fox River Area of Concern Wildlife and Habitat Assessment Tools. AOC RAP Meeting, Green Bay, Wisconsin. Oral Presentation. 25 April 2018.

Howe, B., A. Wolf, E. Giese, V. Pappas, B. Kupsky, M. Grimm, and N. Van Helden. 2018. Assessing the Fish and Wildlife Habitat BUI for the Lower Green Bay and Fox River Area of Concern. Annual Great Lakes Areas of Concern Conference, Sheboygan, Wisconsin. Oral Presentation. 16 May 2018.

Howe, R.W., A.T. Wolf, and E.E. Gnass Giese. 2016. What's so special about Green Bay wetlands? Wisconsin Wetlands Association Conference, Radisson Hotel & Convention Center, Green Bay, Wisconsin. February 23-25, 2016. Oral Presentation.

Howe, R.W., N.G. Walton, E.G. Giese, G.J. Niemi, and A.M. Bracey. 2013. Avian responses to landscape stressors in Great Lakes coastal wetlands. Society of Wetland Scientists, Duluth, Minnesota. June 2-6, 2013. Poster Presentation.

Howe, R.W., N.G. Walton, E.E.G. Giese, G.J. Niemi, N.P. Danz, V.J. Brady, T.N. Brown, J.J.H. Ciborowski, J.P. Gathman, G.E. Host, L.B. Johnson, E.D. Reavie. 2013. How do different taxa respond to landscape stressors in Great Lakes coastal wetlands? Ecological Society of America, Minneapolis, Minnesota. August 4-9, 2013. Poster Presentation.

Howe, R.W., A.T. Wolf, J. Noordyk, and J. Stoll. 2017. Benefits and outcomes of Green Bay restoration: ecosystem and economic perspectives. Presented at the Summit on the Ecological and Socio-Economic Tradeoffs of Restoration in the Green Bay, Lake Michigan, Ecosystem (July 18-20, 2017).

Howe, R.W., A.T. Wolf, and E.E. Giese. 2016. Proposed AOC de-listing process. Presentation to Lower Green Bay and Fox River AOC stakeholders. 16 December 2016.

Howe, R.W., A.T. Wolf, and E.E. Giese. 2017. Lower Green Bay & Fox River Area of Concern: A Plan for Delisting Fish and Wildlife Habitat & Populations Beneficial Use Impairments. A paper presented to AOC Technical Advisory Group. 3 August 2017.

Johnson, L., M. Cai, D. Allan, N. Danz, D. Uzarski. 2015. Use and interpretation of human disturbance gradients for condition assessment in Great Lakes coastal ecosystems. International Association for Great Lakes Research Conference, Burlington, VT.

Johnson, Z., M. Markel, and A. Moerke. 2019. Functional diversity of macroinvertebrates in coastal wetlands along the St. Marys River. Midwest Fish and Wildlife Conference, Cleveland, OH.

Kneisel, A.N., M.J. Cooper, and D.G. Uzarski. 2016. The impact of Phragmites australis invasion on macroinvertebrate communities in the coastal wetlands of Thunder Bay, MI. Institute for Great Lakes Research, 4th Annual Student Research Symposium, Central Michigan University, Mt. Pleasant, MI. February. Oral Presentation.

Kneisel, A.N., M.J. Cooper, and D.G. Uzarski. 2016. Impact of *Phragmites* invasion on macroinvertebrate communities in wetlands of Thunder Bay, MI. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Kosiara, J.M., M.J. Cooper, D.G. Uzarski, and G.A. Lamberti. 2013. Relationships between community metabolism and fish production in Great Lakes coastal wetlands. International Association for Great Lakes Research, 56th annual meeting. June 2-6, 2013. West Lafayette, IN. Poster presentation.

Kneisel, A.N., M.J. Cooper, and D.G. Uzarski. 2017. The impact of Phragmites australis invasion on Great Lakes coastal wetlands. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

Kneisel, A.K., M.J. Cooper, D.G. Uzarski. 2018. Coastal wetland monitoring data as a resource for invasive species management. ELLS-IAGLR Big Lakes Small World Conference. Évian, France. September. Poster.Kosiara, J.K., J.J. Student, and D.G. Uzarski. 2017. Exploring coastal habitat-use patterns of Great Lakes yellow perch with otolith microchemistry. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

Kosiara, J.M., J. Student and D.G. Uzarski. 2016. Assessment of yellow perch movement between coastal wetland and nearshore waters of the Great Lakes. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Kowalke, C.J. and D.G. Uzarski. 2019. Assessing the competitive impacts of invasive round goby on lake whitefish in northern Lake Michigan. International Association for Great Lakes Research. Brockport, NY. Poster.

Lamberti, G.A., D.G. Uzarski, V.J. Brady, M.J. Cooper, T.N. Brown, L.B. Johnson, J.J. Ciborowski, G.P. Grabas, D.A. Wilcox, R.W. Howe, and D. C. Tozer. An integrated monitoring program for Great Lakes coastal wetlands. Society for Freshwater Science Annual Meeting. Jacksonville, FL. May 2013. Poster presentation.

Lamberti, G.A. Pacific Salmon in Natal Alaska and Introduced Great Lakes Ecosystems: The Good, the Bad, and the Ugly. Department of Biology, Brigham Young University. Dec 5, 2013. Invited seminar.

Lamberti, G. A. The Global Freshwater Crisis. The Richard Stockton College of New Jersey and South Jersey Notre Dame Club. November 18, 2014.

Lamberti, G. A. The Global Freshwater Crisis. Smithsonian Journey Group and several University Alumni Groups. March 1, 2015.

Lamberti, G.A. The Global Freshwater Crisis. Newman University and Notre Dame Alumni Club of Wichita. September 28, 2016.

Lamberti, G.A. The Global Freshwater Crisis. Air and Wastewater Management Association and Notre Dame Alumni Club of Northeastern New York. December 2, 2016.

Lamberti, G.A. The Global Freshwater Crisis: Lessons for the Amazon. Association of University Alumni Clubs. Iquitos, Peru. September 9, 2019.

Lamberti, G. A. Pacific Salmon in Natal Alaska and Introduced Great Lakes Ecosystems: The Good, the Bad, and the Ugly. Annis Water Resources Institute, Grand Valley State University. December 12, 2014.

Lamberti, G.A., M.A. Brueseke, W.M. Conard, K.E. O'Reilly, D.G. Uzarski, V.J. Brady, M.J. Cooper, T.M. Redder, L.B. Johnson, J.H. Ciborowski, G.P. Grabas, D.A. Wilcox, R.W. Howe, D.C. Tozer, and T.K. O'Donnell. Great Lakes Coastal Wetland Monitoring Program: Vital resources for scientists, agencies and the public. Society for Freshwater Science Annual Metting. Raleigh, NC. June4-9, 2017. Poster.

Langer, T.A., K. Pangle, B.A. Murray, and D.G. Uzarski. 2014. Beta Diversity of Great Lakes Coastal Wetland Communities: Spatiotemporal Structuring of Fish and Macroinvertebrate Assemblages. American Fisheries Society, Holland, MI. February.

Langer, T., K. Pangle, B. Murray, D. Uzarski. 2013. Spatiotemporal influences, diversity patterns and mechanisms structuring Great Lakes coastal wetland fish assemblages. Poster. Institute for Great Lakes Research 1st Symposium, MI. March.

Lemein, T.J., D.A. Albert, D.A. Wilcox, B.M. Mudrzynski, J. Gathman, N.P. Danz, D. Rokitnicki-Wojcik, and G.P. Grabas. 2014. Correlation of physical factors to coastal wetland vegetation community distribution in the Laurentian Great Lakes. Society of Wetland Scientists/Joint Aquatic Sciences Meeting, Portland, OR.

MacDonald, J.L., L.S. Schoen, J.J. Student, and D.G. Uzarski. 2016. Variation in yellow perch (*Perca flavescens*) growth rate in the Great Lakes. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Makish, C.S., K.E. Kovalenko, J.P. Gathman, and J.J.H. Ciborowski. 2013. invasive phragmites effects on coastal wetland fish communities of the Great Lakes basin. 66th Canadian Conference for Freshwater Fisheries Research, Windsor, ON, January 3-5, 2013. Poster Presentation.

Markel, M., Z. Johnson, and A. Moerke. 2019. A comparison of macroinvertebrate assemblages in coastal wetlands exposed to varying wave disturbance. March 13-15, Gaylord, MI.

McReynolds, A.T., K.E. O'Reilly, and G.A. Lamberti. 2016. Food web structure of a recently restored Indiana wetland. University of Notre Dame College of Science Joint Annual Meeting, Notre Dame, IN.

Miranda, D.A., Zachritz, A.M., Whitehead, H.D., Peaslee, G.F., Cressman, S. R., Lamberti, G.A. PFAS Permeates Native and Introduced Salmonids from Lake Michigan, USA. Joint Aquatic Sciences Meeting, Grand Rapids, MI. May 2022.

Miranda, D.A., Zachritz, A.M., Whitehead, H.D., Peaslee, G.F., Cressman, S. R., Lamberti, G.A., A Survey of Sportfish for Per-and Polyfluoroalkyl Substances (PFAS): An Emerging Contaminant in the Great Lakes. Portage, IN, October 2022

Miranda, D.A., Zachritz, A.M., Whitehead, H.D., Peaslee, G.F., Cressman, S. R., Lamberti, G.A. "PFAS in Prey and Predator Fish from Lake Michigan", USA. SETAC North America 43 rd. Annual Meeting. November 2022.

Miranda, D.A., Zachritz, A.M., Whitehead, H.D., Cressman, S., Klepinger, S., Peaslee, G.F. Lamberti, G.A. "Biomagnification of PFAS in Lake Michigan food web". Colleges of Science and Engineering Joint Annual Meeting, Notre Dame IN. December 9, 2022.

Miranda, D.A., PFAS in Lake Michigan Fish, Annual Great Lakes Conference, Institute of Water Research– Michigan State University MI. March 7, 2023.

Moerke, A. 2015. Coastal wetland monitoring in the Great Lakes. Sault Naturalist meeting, Sault Sainte Marie, MI; approximately 40 community members present.

Monks, A., S. Lishawa, D. Albert, B. Mudrzynski, D.A. Wilcox, and K. Wellons. 2019. Innovative management of European frogbit and invasive cattail. International Association for Great Lakes Research. Brockport, NY

Moore, L.M., M.J. Cooper, and D.G. Uzarski. 2017. Nutrient limitation in Great Lakes coastal wetlands: gradients and their influence. 60th International Conference on Great Lakes Research, Detroit, MI. May 17. Presentation.

Mudrzynski, B.M., N.P. Danz, D.A. Wilcox, D.A. Albert, D. Rokitnicki-Wojcik, and J. Gathman. 2016. Great Lakes wetland plant Index of Biotic Integrity (IBI) development: balancing broad applicability and accuracy. Society of Wetland Scientists, Corpus Christi, TX.

Mudrzynski, B.M., D.A. Wilcox, and A. Heminway. 2012. Habitats invaded by European frogbit (Hydrocharis morsus-ranae) in Lake Ontario coastal wetlands. INTECOL/Society of Wetland Scientists, Orlando, FL.

Mudrzynski, B.M., D.A. Wilcox, and A.W. Heminway. 2013. European frogbit (Hydrocharis morsus-ranae): current distribution and predicted expansion in the Great Lakes using niche-modeling. Society of Wetland Scientists, Duluth, MN.

Mudrzynski, B.M. and D.A. Wilcox. 2014. Effect of coefficient of conservatism list choice and hydrogeographic type on floristic quality assessment of Lake Ontario wetlands. Society of Wetland Scientists/Joint Aquatic Sciences Meeting, Portland, OR.

Mudrzynski, B.M., K. Des Jardin, and D.A. Wilcox. 2015. Predicting seed bank emergence within flooded zones of Lake Ontario wetlands under novel hydrologic conditions. Society of Wetlands Scientists. Providence, RI.

Newman, W.L., L.P. Moore, M.J. Cooper, D.G. Uzarski, and S.N. Francoeur. 2019. Nitrogen-Fixing Diatoms as Indicators of Historical Nitrogen Limitation in Laurentian Great Lakes Coastal Wetlands. Society for Freshwater Science. Salt Lake City, UT. Presentation.

O'Donnell, T.K., Winter, C., Uzarski, D.G., Brady, V.J., and Cooper, M.J. 2017. Great Lakes coastal wetland monitoring: moving from assessment to action. Ecological Society of America Annual Conference. Portland, OR. August 6-11. Presentation.

O'Donnell, T.K., D.G. Uzarski, V.J. Brady, and M.J. Cooper. 2016. Great Lakes Coastal Wetland Monitoring: Moving from Assessment to Action. 10th National Monitoring Conference; Working Together for Clean Water, Tampa, Florida. May. Oral Presentation.

O'Reilly, K.E., A. McReynolds, and G.A. Lamberti. Quantifying Lake Michigan coastal wetland-nearshore linkages for sustaining sport fishes using stable isotope mixing models. Annual Meeting of the Ecological Society of America. Baltimore, MD. August 9-14, 2015.

O'Reilly, K.E., A. McReynolds, C. Stricker, and G.A. Lamberti. Quantifying Lake Michigan coastal wetland-nearshore linkages for sustaining sport fishes. State of Lake Michigan Conference. Traverse City, MI. October 28-30, 2015.

O'Reilly, K.E., A. McReynolds, C. Stricker, and G.A. Lamberti. 2016. Quantifying Lake Michigan coastal wetland-nearshore linkages for sustaining sport fishes. Society for Freshwater Science, Sacramento, CA.

O'Reilly, K.E., A. McReynolds, C. Stricker, and G.A. Lamberti. 2016. Quantifying Lake Michigan coastal wetland-nearshore linkages for sustaining sport fishes. International Association for Great Lakes Research, Guelph, ON.

O'Reilly, K.E., J.J. Student, B.S. Gerig, and G.A. Lamberti. 2019. Metalheads: What can sport fish otoliths reveal about heavy metal exposure over time? Annual Meeting of the Society for Freshwater Science, Salt Lake City, UT.

Otto, M., J. Marty, E.G. Gnass Giese, R. Howe, and A. Wolf. Anuran habitat use in the Lower Green Bay and Fox River Area of Concern (Wisconsin). University of Wisconsin-Green Bay Academic Excellence Symposium, Green Bay, Wisconsin. April 6, 2017. Poster Presentation.

Otto, M., J. Marty, E.G. Gnass Giese, R. Howe, and A. Wolf. Anuran habitat use in the Lower Green Bay and Fox River Area of Concern (Wisconsin). Green Bay Conservation Partners Spring Roundtable Meeting, Green Bay, Wisconsin. April 25, 2017. Poster Presentation.

Redder, T.M., D.G. Uzarski, V.J. Brady, M.J. Cooper, and T.K. O'Donnell. 2018. Application of data management and decision support tools to support coastal wetland management in the Laurentian Great Lakes. National Conference on Ecosystem Restoration. New Orleans, LA. August 26-30, 2018. Oral Presentation.

Reisinger, L. S., Pangle, K. L., Cooper, M. J., Learman, D. R., Uzarski, D. G., Woolnough, D. A., Bugaj, M. R., Burck, E. K., Dollard, R. E., Goetz, A., Goss, M., Gu, S., Karl, K., Rose, V. A., Scheunemann, A. E., Webster, R., Weldon, C. R., and J., Yan. 2017. The influence of water currents on community and ecosystem dynamics in coastal Lake Michigan. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

Reisinger, A. J., and D. G., Uzarski. 2017. Natural and anthropogenic disturbances affect water quality of Great Lakes coastal wetlands. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

St.Pierre, J.I., K.E. Kovalenko, A.K. Pollock, and J.J.H. Ciborowski.2013. Is macroinvertebrate richness and community composition determined by habitat complexity or variation in complexity? 66th Canadian Conference for Freshwater Fisheries Research, Windsor, ON, January 3-5, 2013. Poster Presentation.

Schmidt, N. C., Schock, N., and D. G. Uzarski. 2013. Modeling macroinvertebrate functional feeding group assemblages in vegetation zones of Great Lakes coastal wetlands. International Association for Great Lakes Research Conference, West Lafayette, IN. June.

Schmidt, N.C., N.T. Schock, and D.G. Uzarski. 2014. Influences of metabolism on macroinvertebrate community structure across Great Lakes coastal wetland vegetation zones. Great Lakes Science in Action Symposium, Central Michigan University, Mt. Pleasant, MI. April.

Schock, N.T. and D.G. Uzarski. Stream/Drainage Ditch Impacts on Great Lakes Coastal Wetland Macroinvertebrate Community Composition. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Schock N.T., Uzarski D.G., 2013. Habitat conditions and macroinvertebrate communities of Great Lakes coastal habitats dominated by wet meadow, Typha spp. and Phragmites australis: implications of macrophyte structure changes. International Association for Great Lakes Research Conference, West Lafayette, IN. June.

Schock, N.T., B.A. Murry, D.G. Uzarski 2014. Impacts of agricultural drainage outlets on Great Lakes coastal wetlands. Great Lakes Science in Action Symposium, Central Michigan University, Mt. Pleasant, MI. April.

Schock, N.T., Schuberg, D.H., and Uzarski, D.G. 2015. Chemical and physical habitat gradients within Great Lakes coastal wetlands. 58th International Association for Great Lakes Research Conference, Burlington, VT. May.

Schoen, L.S., J.J. Student, and D.G. Uzarski. 2014. Reconstruction of fish movements between Great Lakes coastal wetlands. American Fisheries Society, Holland, MI. February.

Sherman, J.S., T.A. Clement, N.T. Schock, and D.G. Uzarski. 2012. A comparison of abiotic and biotic parameters of diked and adjacent open wetland complexes of the Erie Marsh Preserve. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Sherman, J.J., and D.G. Uzarski. 2013. A Comparison of Abiotic and Biotic Parameters of Diked and Adjacent Open Wetland Complexes of the Erie Marsh Preserve. 56th International Conference on Great Lakes Research, West Lafayette, IN. June.

Sierszen, M., Schoen, L., Hoffman, J., Kosiara, J., and D. Uzarski. 2017. Support of coastal fishes by nearshore and coastal wetland habitats. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

Sierzen, M., L. Schoen, J. Hoffman, J. Kosiara and D. Uzarski. 2018. Tracing multi-habitat support of coastal fishes. Association for the Sciences of Limnology and Oceanography-Ocean Sciences Meeting. Portland, OR. February 2018. Oral Presentation.

Smith, D.L., M.J. Cooper, J.M. Kosiara, and G.A. Lamberti. 2013. Heavy metal contamination in Lake Michigan wetland turtles. International Association for Great Lakes Research, 56th annual meeting. June 2-6, 2013. West Lafayette, IN. Poster presentation.

Stirratt, H., M.J. Cooper. Landscape Conservation Design for the Great Lakes. International Union for the Conservation of Nature World Conservation Congress, September 6-10, 2016, Honolulu, Hawai'i.

Thoennes, J., and N.P. Danz. 2017. Mapping Wetland Areal Change in the St. Louis River Estuary Using GIS. Poster presentation at the St. Louis River Summit, Superior, WI.

Tozer, D.C., and S.A. Mackenzie. Control of invasive *Phragmites* increases breeding marsh birds but not frogs. Long Point World Biosphere Research and Conservation Conference, Simcoe, Ontario, Canada. Oral Presentation. 8 November 2019.

Tozer, D.C., M. Falconer, A. Bracey, E. Giese, T. Gehring, G. Grabas, R. Howe, G. Niemi, and C. Norment. 2018. Detecting and monitoring elusive marsh breeding birds in the Great Lakes. IAGLR Conference, Toronto, Canada. Oral Presentation. 18-22 June 2018. (INVITED).

Trebitz, A., J. Hoffman, G. Peterson, G. Shepard, A. Frankiewicz, B. Gilbertson, V. Brady, R. Hell, H. Wellard Kelly, and K. Schmude. 2015. The faucet snail (*Bithynia tentaculata*) invades the St. Louis River Estuary. St. Louis River Estuary Summit, Superior, Wisconsin. Mar. 30 – Apr. 1.

Tuttle, E., T.N. Brown, D.A. Albert, and *T.J. Lemein. 2013. Comparison of two plant indices: Floristic Quality Index (FQI) and an index based on non-native and invasive species. Annual Society of Wetland Scientists Conference, Duluth, MN. June 4, 2013.

Unitis, M.J., B.A. Murry and D.G. Uzarski. 2012. Use of coastal wetland types by juvenile fishes. Ecology and Evolutionary Ecology of Fishes, Windsor, Ontario. June 17-21.

Uzarski, D.G. 2011. Great Lakes Coastal Wetland Monitoring for Restoration and Protection: A Basin-Wide Effort. State Of the Lakes Ecosystem Conference (SOLEC). Erie, Pennsylvania. October 26.

Uzarski, D.G. 2011. Coastal Wetland Monitoring: Background and Design. Great Lakes Coastal Wetland Monitoring Meeting. MDEQ; ASWM. Acme, Michigan. August 29.

Uzarski, D.G., N.T. Schock, T.A. Clement, J.J. Sherman, M.J. Cooper, and B.A. Murry. 2012. Changes in Lake Huron Coastal Wetland Health Measured Over a Ten Year Period During Exotic Species Invasion. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Uzarski, D.G., M.J. Cooper, V.J. Brady, J. Sherman, and D.A. Wilcox. 2013. Use of a basin-wide Great Lakes coastal wetland monitoring program to inform and evaluate protection and restoration efforts. International Association for Great Lakes Research, West Lafayette, IN. (INVITED)

Uzarski, D.G. 2013. A Basin Wide Great Lakes Coastal Wetland Monitoring Plan. Region 5 State and Tribal Wetlands Meeting: Focusing on Wetland Monitoring and Assessment around the Great Lakes. October 31. Kellogg Biological Station, Hickory Corners, MI.

Uzarski, D.G. 2013. Great Lakes Coastal Wetland Assessments. Lake Superior Cooperative Science and Monitoring Workshop. September 24-25. EPA Mid-Continent Ecology Division Lab, Duluth, MN.

Uzarski, D.G. 2013. A Basin-Wide Great Lakes Coastal Wetland Monitoring Program. 5th National Conference on Ecosystem Restoration. July 29-August 2. Schaumburg, IL.

Uzarski, D.G., Cooper, M.J., Brady, V., Sherman, J.J., and D.A. Wilcox. 2013. Use of a Basin Wide Great Lakes Coastal Wetland Monitoring Program to inform and Evaluate Protection and Restoration Efforts. 56th International Conference on Great Lakes Research, West Lafayette, IN.

Uzarski, D., M. Cooper and V. Brady. 2014. Implementing a Basin-wide Great Lakes Coastal Wetland Monitoring Program. Webinar for Sustain Our Great Lakes, Jan. 29, 2014. On-line webinar for Great Lakes researchers, managers, agency personnel, and environmental groups. Attendance approximately 400.

Uzarski, D.G., Schock, N.T., Schuberg, D.H., Clement, T.A., and Cooper, M.J. 2015. Interpreting multiple organism-based IBIs and disturbance gradients: Basin wide monitoring. 58th International Conference on Great Lakes Research, Burlington, VT. May.

Uzarski, D.G., N. Schock, T.M. Gehring, and B.A. Wheelock. 2016. Faucet snail (*Bithynia tentaculata*) occurrence across the Great lakes basin in coastal wetlands. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Uzarski, D.G., V.J. Brady, M.J. Cooper, D.A. Wilcox, A.A. Bozimowski. 2017. Leveraging landscape level monitoring and assessment program for developing resilient shorelines throughout the Laurentian Great Lakes. Society of Wetland Scientists Annual Meeting. San Juan, Puerto Rico. June. Presentation.

Uzarski, D.G., V.J. Brady, and M.J. Cooper. 2017. The Great Lakes Coastal Wetland Monitoring Program: Seven Years of Implementation. 60th International Conference on Great Lakes Research, Detroit, MI. May. Presentation.

Uzarski, D.G. 2017. Emerging Issues in Wetland Science. Michigan Wetland Association Conference. Gaylord, Michigan. Plenary Presentation.

Uzarski, D.G. 2018. Monitoring multiple biological attributes in Great Lakes coastal wetlands: database access for invasive species management. Association of State Wetlands Managers. Webinar Presentation.

Uzarski, D.G. Global Significance & Major Threats to the Great Lakes. 2018. Frey Foundation Strategic Learning Session. The Great Lakes: Global Significance, Major Threats & Innovative Solutions. Petoskey, MI.

Uzarski, D.G., V.J. Brady, M.J. Cooper, et al. 2018. The Laurentian Great Lakes Coastal Wetland Monitoring Program: Landscape level assessment of ecosystem health. ELLS-IAGLR Big Lakes Small World Conference. Évian, France. September. Poster

Uzarski, D.G. and M.J. Cooper. 2019. Using a decision tree approach to inform protection and restoration of Great Lakes coastal wetlands. International Association for Great Lakes Research. Brockport, NY.

Walton, N.G., E.E.G. Giese, R.W. Howe, G.J. Niemi, N.P. Danz, V.J. Brady, T.N. Brown, J.H. Ciborowski, J.P. Gathman, G.E. Host, L.B. Johnson, E.D. Reavie, and K.E. Kovalenko. 2013. How do different taxa respond to landscape stressors in Great Lakes coastal wetlands? 98th Annual Meeting of the Ecological Society of America. Minneapolis, MN, August 4-9.

Webster, W.C. and D.G. Uzarski. 2012. Impacts of Low Water level Induced Disturbance on Coastal Wetland Vegetation. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Wheeler, R. and D.G. Uzarski. 2012. Spatial Variation of Macroinvertebrate Communities within Two Emergent Plant Zones of Great Lakes Coastal Wetlands. 55th International Conference on Great Lakes Research, Cornwall, Ontario.

Wheeler, R.L. and D.G. Uzarski. 2013. Effects of Vegetation Zone Size on a Macroinvertebrate-based Index of Biotic Integrity for Great Lakes Coastal Wetlands. 56th International Conference on Great Lakes Research, West Lafayette, IN. June.

Wheelock, B.A., T.M. Gehring, D.G. Uzarski, G.J. Niemi, D.C. Tozer, R.W. Howe, and C.J. Norment. 2016. Factors affecting current distribution of Anurans in Great Lakes coastal wetlands. 59th International Conference on Great Lakes Research, Guelph, Ontario Canada. May. Oral Presentation.

Wilcox, D.A. 2018. Application of the Great Lakes Coastal Wetland Monitoring Program to restoration projects in Lake Ontario wetlands. Society of Wetland Scientists, Denver, CO.

Wilcox, D.A. 2018. Wetland restorations in the Braddock Bay Fish and Wildlife Management Area of Lake Ontario. Great Lakes Coastal Wetland Monitoring Program. Midland, MI. (INVITED)

Wilcox, D.A. and B.M. Mudrzynski. 2011. Wetland vegetation sampling protocols under the Great Lakes Coastal Wetland Monitoring program: experience in Lake Ontario. State of the Lakes Ecosystem Conference, Erie, PA. (INVITED)

Wilcox, D.A. and B.M. Mudrzynski. 2012. Implementing Great Lakes coastal wetlands monitoring: southern Lake Ontario. SUNY Great Lakes Research Consortium Conference, Oswego, NY. (INVITED)

Wilcox, D.A., B.M. Mudrzynski, D.G. Uzarski, V.J. Brady, M.J. Cooper, and T.N. Brown.

2016. Great Lakes coastal wetland monitoring program assesses wetland condition across the basin. Society of Wetland Scientists, Corpus Christi, TX.

Wilcox, D.A., B.M. Mudrzynski, D.G. Uzarski, V.J. Brady, and M.J. Cooper. 2017. A second phase of the Great Lakes Coastal Wetland Monitoring Program to assess wetland health across the basin. Society of Wetland Scientists, San Juan, PR.

Wilcox, D.A. 2012. Wetland restoration options under the Great Lakes Restoration Initiative. SUNY Great Lakes Research Consortium Conference, Oswego, NY. (INVITED)

Wilcox, D.A., D.G. Uzarski, V.J. Brady, M.J. Cooper, and T.N. Brown. 2013. Great Lakes coastal wetland monitoring program assists restoration efforts. Fifth World Conference on Ecological Restoration, Madison, WI.

Wilcox, D.A., D.G. Uzarski, V.J. Brady, M.J. Cooper, and T.N. Brown. 2014. Wetland restoration enhanced by Great Lakes coastal wetland monitoring program. Society of Wetland Scientists, Portland, OR.

Wilcox, D.A., D.G. Uzarski, V.J. Brady, and M.J. Cooper. 2019. Student training in wetland science through the Great Lakes Coastal Wetland Monitoring Program. Society of Wetland Scientists, Baltimore, MD.

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APPENDIX

News articles about faucet snail detection in Great Lakes coastal wetlands.

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2. http://www.wwmt.com/news/features/top-stories/stories/Snail-harmful-to-ducks-spreading-in-Great-Lakes-63666.shtml
3. http://fox17online.com/2014/12/16/gvsu-researchers-find-more-of-invasive-snail-species-in-lake-michigan/
4. http://www.ourmidland.com/news/cmu-scientists-identify-spread-of-invasive-species/article_e9dc5876-00f4-59ff-8bcd-412007e079e8.html
5. http://www.therepublic.com/view/story/4cde108b10b84af7b9d0cfcba603cf7a/MI--Invasive-Snails
6. http://media.cmich.edu/news/cmu-institute-for-great-lakes-research-scientists-identify-spread-of-invasive-species
7. http://www.veooz.com/news/qHv4acl.html
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14. http://usnew.net/invasive-snail-in-the-great-lakes-region.html
15. http://www.cadillacnews.com/ap_story/?story_id=298696&issue=20141216&ap_cat=2
16. http://theoryoflife.com/connect/researchers-track-invasive-9251724/
17. http://snewsi.com/id/1449258811
18. http://www.newswalk.info/muskegon-mich-new-scientists-say-742887.html
19. http://www.petoskeynews.com/sports/outdoors/snail-harmful-to-ducks-spreading-in-great-lakes/article_b94f1110-9572-5d18-a5c7-66e9394a9b24.html
20. http://www.chron.com/news/science/article/Snail-harmful-to-ducks-spreading-in-Great-Lakes-5959538.php
21. http://usa24.mobi/news/snail-harmful-to-ducks-spreading-in-great-lakes
22. http://www.wopular.com/snail-harmful-ducks-spreading-great-lakes
23. http://www.news.nom.co/snail-harmful-to-ducks-spreading-in-14203127-news/
24. http://www.mlive.com/news/muskegon/index.ssf/2014/12/hard_to_kill_invasive_faucet_s.html
25. http://wkar.org/post/researchers-eye-spread-invasive-faucet-snails

26. http://www.greenfieldreporter.com/view/story/4cde108b10b84af7b9d0cfcba603cf7a/MI--Invasive-Snails
27. http://www.natureworldnews.com/articles/11259/20141217/invasive-snails-killing-great-lake-birds.htm
28. http://www.wsbt.com/news/local/snail-harmful-to-ducks-spreading-in-great-lakes/30251286
29. http://www.wtkg.com/articles/wood-news-125494/invasive-and-deadly-snail-found-in-13073963
30. http://www.techtimes.com/articles/22378/20141218/invasive-snail-problem-in-great-lakes-difficult-to-deal-with-says-experts.htm
31. http://perfscience.com/content/214858-invasive-snails-kill-birds-great-lakes
32. http://www.hollandsentinel.com/article/20141216/NEWS/141219279
33. http://www.woodradio.com/articles/wood-news-125494/invasive-and-deadly-snail-found-in-13073963
34. http://www.full-timewhistle.com/science-27/great-lake-invasive-snails-kill-birds-265.html
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36. http://americanlivewire.com/2014-12-17-invasive-snail-species-attack-birds-great-lakes/
37. http://www.seattlepi.com/news/science/article/Snail-harmful-to-ducks-spreading-in-Great-Lakes-5959538.php
38. http://www.pendletontimespost.com/view/story/4cde108b10b84af7b9d0cfcba603cf7a/MI--Invasive-Snails/
39. http://www.wilx.com/home/headlines/Invasive-Snail-Spreading-in-Great-Lakes-285933261.html
40. http://www.watertowndailytimes.com/article/20150119/NEWS03/150118434
41. http://howardmeyerson.com/2015/01/15/scientists-invasive-snail-more-prevalent-than-thought-poses-grave-danger-to-waterfowl/

Mock-up of press release produced by collaborating universities.

FOR IMMEDIATE RELEASE: December 9, 2014

CONTACT: June Kallestad, NRRI Public Relations Manager, 218-720-4300

USEPA-sponsored project greatly expands known locations of invasive snail

DULUTH, Minn. – Several federal agencies carefully track the spread of non-native species. This week scientists funded by the Great Lakes Restoration Initiative in partnership with USEPA's Great Lakes National Program Office greatly added to the list of known locations of faucet snails (*Bithynia tentaculata*) in the Great Lakes. The new locations show that the snails have invaded many more areas along the Great Lakes coastline than anyone realized.

The spread of these small European snails is bad news for water fowl: They are known to carry intestinal flukes that kill ducks and coots.

"We've been noting the presence of faucet snails since 2011 but didn't realize that they hadn't been officially reported from our study sites," explained Valerie Brady, NRRI aquatic ecologist who is collaborating with a team of researchers in collecting plant and animal data from Great Lakes coastal wetlands.

Research teams from 10 universities and Environment Canada have been sampling coastal wetlands all along the Great Lakes coast since 2011 and have found snails at up to a dozen sites per year [See map 1]. This compares to the current known locations shown on the USGS website [see map 2].

"Our project design will, over 5 years, take us to every major coastal wetland in the Great Lakes. These locations are shallow, mucky and full of plants, so we're slogging around, getting dirty, in places other people don't go. That could be why we found the snails in so many new locations," explained Bob Hell, NRRI's lead macroinvertebrate taxonomist. "Luckily, they're not hard to identify."

The small snail, 12 – 15 mm in height at full size, is brown to black in color with a distinctive whorl of concentric circles on the shell opening cover that looks like tree rings. The tiny size of young snails means they are easily transported and spread, and they are difficult to kill.

According to the Minnesota Department of Natural Resources, the faucet snail carries three intestinal trematodes that cause mortality in ducks and coots. When waterfowl consume the infected snails, the adult trematodes attack the internal organs, causing lesions and hemorrhage. Infected birds appear lethargic and have difficulty diving and flying before eventually dying.

Although the primary purpose of the project is to assess how Great Lakes coastal wetlands are faring, detecting invasives and their spread is one of the secondary benefits. The scientific team expects to report soon on the spread of non-native fish, and has helped to locate and combat invasive aquatic plants.

“Humans are a global species that moves plants and animals around, even when we don’t mean to. We’re basically homogenizing the world, to the detriment of native species,” Brady added, underscoring the importance of knowing how to keep from spreading invasive species. Hell noted, “We have to make sure we all clean everything thoroughly before we move to another location.”

For more information on how to clean gear and boats to prevent invasive species spread, go to www.protectyourwaters.net.