Informing Great Lakes Open Water Bird Management

Workshop Summary

SUMMER 2016

A product of the Great Lakes Commission and the U.S. Fish & Wildlife Service based on the workshop held March 22-23, 2016, in Ann Arbor, Michigan.

Great Lakes Commission
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U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Informing Open Water Bird Management - Workshop Summary -

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Executive Summary

Organized by the Great Lakes Commission, the *Informing Great Lakes Open Water Bird Management Workshop* took place on March 22-23, 2016, in Ann Arbor, Michigan. Primary funding support for the workshop came from the U.S. Fish and Wildlife Service. Over thirty stakeholders, including avian researchers, federal and state resource managers and conservationists, met to achieve the following objectives:

1. Identify management needs for which data can inform decision-making.
2. Work with conservation managers and the regional project team to determine the best ways to apply the project's information to support their management activities.
3. Define user interface options for the analysis tools developed by the project that will be integrated into the Midwest Avian Data Center website.
4. Gauge the need for continued data collection, monitoring and review of impacts of management actions.

The main purpose of the workshop was to explore how the data collected from bird surveys that took place between September 2012 and June 2014 could be used to address conservation and management needs. This was done in part through breakout sessions that challenged small groups to consider how to apply the data to mock management scenarios. Case studies discussed were related to Long-tailed duck habitat restoration, offshore wind siting, and waterfowl monitoring.

Additionally, an update from the Monitoring and Mapping of Avian Resources over the Great Lakes project team was presented to workshop participants, with presentation from bird surveyors, data management team and the modeling team. Participants also had the opportunity to hear about other related research projects in the Great Lakes basin, including water bird and waterfowl monitoring on the Canadian Great Lakes, and the Great Lakes Migratory Bird Stopover Habitat Portal.

Introduction

Wildlife agencies often lack adequate knowledge of pelagic (open water) bird migration patterns and non-breeding habitat use in the Great Lakes and may thus be less equipped to recommend measures to avoid and minimize development impacts and habitat loss. The Monitoring and Mapping of Avian Resources over the Great Lakes project is the first step in answering the question: how do birds use near-shore and offshore areas of the Great Lakes during the non-breeding season, and how can this information be used to evaluate the potential impact of offshore wind energy projects and other resource management decisions?

The goal of this cooperative research project led by the Great Lakes Commission and the U.S. Fish and Wildlife Service is to begin creating a comprehensive regional picture of nearshore and offshore bird concentrations and to assist decision makers in conservation planning and identifying suitable areas for proposed offshore wind energy development.

For two annual cycles (2012-2014) the Great Lakes Commission (GLC) coordinated aerial pelagic bird surveys in selected offshore areas of the Great Lakes. The project is now in its third phase, in which a team of researchers will be exploring modeling methods that will help generate meaningful data and information for nearshore spatial planning, conservation activities, and wildlife management. The survey data will also be used to inform siting and planning decisions for offshore wind energy development.

Recognizing that there are other ongoing avian research efforts throughout the Great Lakes basin, the GLC held a workshop, *Informing Great Lakes Open Water Bird Management,* on March 22-23, 2016 in Ann Arbor, Michigan to bring together the researchers. The workshop was designed to explore the state of the science in avian research and support offshore wind impact assessments and conservation management initiatives.

This document summarizes the discussions from that workshop. Primary funding support for the workshop came from the U.S. Fish and Wildlife Service. Over thirty stakeholders, comprised of avian researchers, federal and state resource managers and conservationists met to achieve the following objectives:

1. Identify management needs for which data can inform decision-making.
2. Work with conservation managers and the regional project team to determine the best ways to apply the project's information to support their management activities.
3. Define user interface options for the analysis tools developed by the project that will be integrated into the Midwest Avian Data Center website.
4. Gauge the need for continued data collection, monitoring and review of impacts of management actions.

During the workshop experts reviewed and discussed risk of offshore wind energy development to avian resources and researchers presented the preliminary results of their on-going avian studies. The workshop also featured small group discussions where participants assessed avian research needs, cause and effect relationships between offshore wind energy development and its effects on avian life, the latest research methods and technology, and conservation management initiatives that could be informed by completed and ongoing pelagic water bird survey efforts. The workshop was fairly successful in meeting the stated objectives.

This workshop summary is organized into the following sections which reflect key topics discussed at the workshop:

1. Great Lakes open water bird survey results
2. Other avian research in the Great Lakes
3. Midwest Avian Data Center
4. Summary of the Phase 3 online data and information needs survey
5. Case study breakout outcomes
6. Models to inform management decision
7. Next steps

FEEDBACK REQUESTED!!! The Monitoring and Mapping of Avian Resources over the Great Lakes project team is seeking input from natural resources managers and others on how this data could be used to inform management decisions. The team would also like to know what are the data and modeling needs required for better decision-making. Please share your ideas by emailing Michele Leduc-Lapierre at michelel@glc.org. Contribution from all stakeholders will help improve the quality of the final product and help inform the next phase of the project.

Section 1: Initial Great Lakes Open Water Bird Survey Results

Overview of the 2012-2014 Great Lakes Open Water bird Surveys

The GLC and the USFWS coordinated aerial surveys of pelagic birds over selected areas of Lakes Michigan, Huron, and Erie during the fall 2012 and spring 2013 migration seasons (Phase 1) and the fall 2013 through the spring 2014 migration and overwintering seasons (Phase 2). A summary of these efforts was presented during the workshop. Please refer to Appendix A for detailed results from each group.

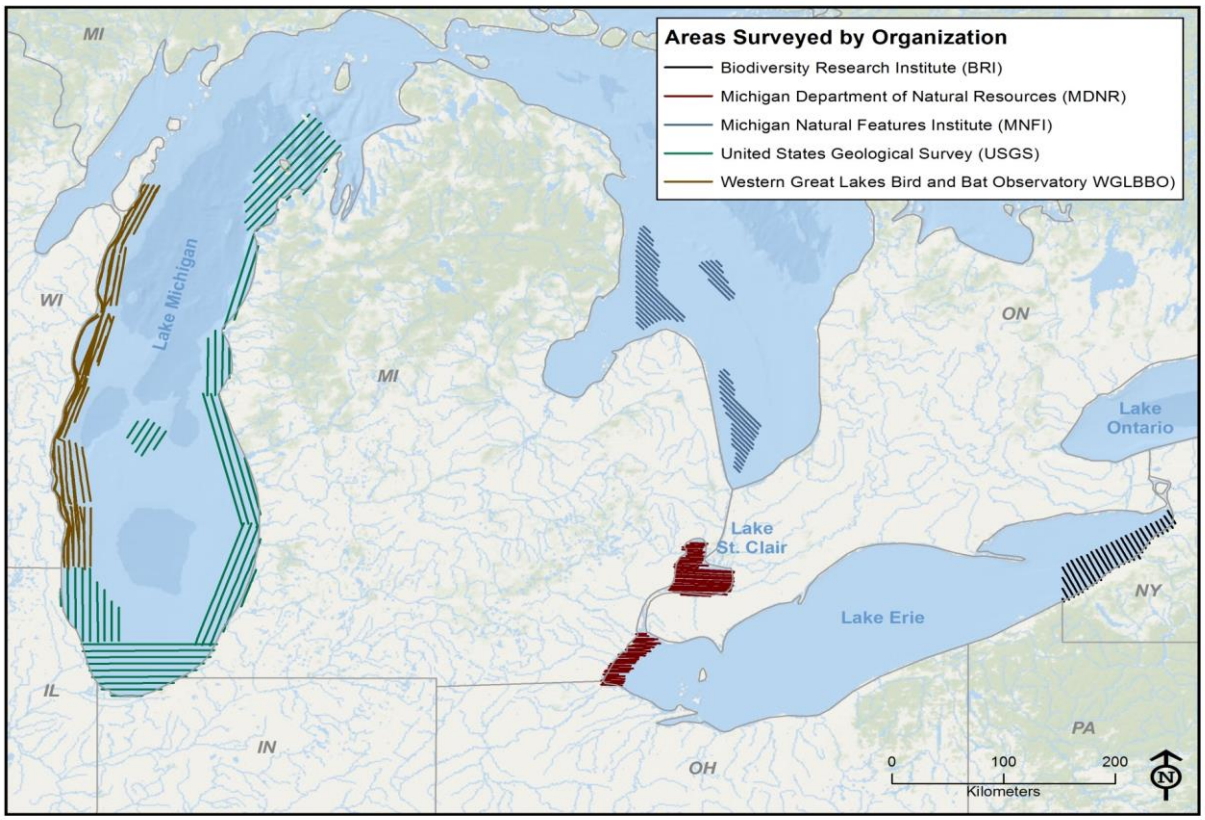


Figure 1. Map of the pelagic bird survey areas

Eastern and Southern Lake Michigan Surveys

Lead Surveyor: Kevin Kenow, U.S. Geological Survey Upper Midwest Environmental Science Center (USGS)

The survey area was broke down in eight survey areas and an area was added in the mid-lake plateau because of its potential for wind energy siting. The Manistee Bay area was added during Phase II. Because the surveys were weather dependant, there is a variation in the number of surveys for each area. Water bird distribution patterns were consistent for a number of species, including Long-tailed ducks, scoters, common loons and red-throated loons. These consistent patterns should be seen in the modeling efforts. Weather conditions have an impact on the distribution of birds as there was a shift in bird distribution relative to ice distribution. This factor will have to be considered in the modeling.

Central Lake Huron Wind Resource Areas Surveys

Lead Surveyor: Michael Monfils, Michigan Natural Features Inventory (MNFI)

Surveys were made according to the locations identified as wind resources areas by the Michigan Great Lake Wind Council. The sampling effort in Phase I was a little greater than Phase II. This is partly explained by the fact that there was a lot of ice in spring of 2014, which had an impact on the conditions. Results show that there are not a lot of birds in the middle of Lake Huron. In general, birds were detected in small flocks of birds widely distributed on the survey area.

Lake St. Clair, Detroit River and Western Lake Erie Surveys

Lead Surveyor: David Luukkonen, Michigan Department of Natural Resources (MDNR)

Transects covered the totality of the water bodies for Lake St. Clair and Western Lake Erie. The Detroit River was flown over and observations were recorded, but no transects were done. Results show that diving ducks is the largest species group in the area and indicate that this is a significant area for duck migration. As it the case in all surveys efforts, there were some limitations in raw observations because of wind speed that create waves and glare. Surveyors also pointed out that night observations should be made to have a better idea of the situation, because we don't have data from poor weather periods or at night, so developing a way to survey at night would allow us to develop a more complete picture of water bird distributions and habitat use. Bird distribution is likely influenced by water depth, plant species richness and boating activity.

Eastern Lake Erie Surveys

Lead Surveyor: Kate Williams, Biodiversity Research Institute (BRI)

BRI joined the survey efforts during Phase II of the project, so there is a more limited water bird dataset available for New York waters of Lake Erie than for other areas surveyed in Phases 1-2. The most common species groups across all surveys in 2013-2014 were mergansers, scaup, and gulls, which are somewhat different than the most common species reported by surveyors in some other areas of the Great Lakes. Large aggregations of water birds were consistently observed near the mouth of the Buffalo River. In general, more birds were observed in nearshore areas, although some groups, such as loons (which were observed during migration), were primarily observed farther offshore. Distribution patterns clearly varied with taxa, season, and other environmental variables such as ice coverage.

Western Lake Michigan Surveys

Lead Surveyor: William Mueller, Western Great Lakes Bird and Bat Observatory (WGLBBO)

This group flew survey transects parallel to the long axis of the lake, from one to ten miles offshore, and examined the potential correlation of avian numbers with bathymetry. They conducted a shoreline count from the Ozaukee County lakeshore as well. Variations were observed between each phase and each season, and migratory movements varied according to each species' timing of migration, and were influenced by changing weather conditions. Usually, birds observed during surveys were seen resting on the water, or in flight only a few meters above the water's surface, with some noteworthy exceptions (Tundra Swans and many individual gulls). Long-tailed ducks were often found far offshore in deeper water. The group reported that locations of concentrations of birds changed constantly, and that winter is challenging for finding and mapping waterfowl during times and in areas that have extensive ice coverage.

Discussion

Several surveyors suggested that pelagic water bird distributions in winter seemed to be influenced by ice coverage, and it was suggested that a similar avoidance could occur around wind farms. In Australia, some studies show that there can be changes in migration patterns to avoid wind farms, but it is species and location specific. These are the types of questions the work of the group could try to answer in the future. But before starting to use the data-based models to make important decisions, however, we need to develop these models further and understand the degree of uncertainty in model and predictions.

One of the objectives of Phase 3 of the project is to evaluate survey efforts, identify what additional data collection efforts may be needed, and determine how to gather the necessary data. It's always challenging to find long-term funding for monitoring, and support for future surveys will be dependent upon how well survey data can be used to address a range of management decisions. We need to address questions about methodology and approaches, take a step back, evaluate what has been done to date, and try to make recommendations to the different regions regarding what additional survey work may be needed and how limited funding could best be used to address data needs for resource management. Another consideration is the existence of new technologies, like drones, that can help reduce the cost of monitoring. Citizen science is another way we can help reduce the cost of gathering data and ensure long-term monitoring.

Originally, survey efforts were focused on wind development, but with climate change, bird patterns may also change. Moving forward, the work should not only focus on potential wind farms, but also on identifying impacts of climate change on various species.

Another question we should consider is what species of birds to focus on. The Migratory Bird Treaty Act and the Endangered Species Act help define species of focus due to the legal protections afforded by these laws. However, other species may be worth further examination to more fully inform management decisions related to conservation of the open waters of the Great Lakes. Great Lakes indicators may also help to focus this work.

Section 2: Other Great Lakes Research Highlights

Water bird and Waterfowl Monitoring on the Canadian Great Lakes

Presenter: David Moore, Canadian Wildlife Service, Environment Canada

The Binational Decadal Great Lakes Colonial Water bird Survey is a long-term population monitoring program for water birds in the Great Lakes that was initiated in 1976, with the most recent surveys in 2009. Results have allowed researchers to identify potential drivers of population change: changes in distribution and abundance of prey fish, effects of hyper-abundant species like cormorants and ring-billed gulls on other water bird populations, development and other anthropogenic activities, predation, and stressors outside of the Great Lakes region.

A second long-term monitoring program, the Migratory Waterfowl Surveys project, monitors abundance, distribution, and species composition of migrant waterfowl in the Ontario portion of the lower Great Lakes. This project also allowed for the evaluation of trends in abundance for areas of high historic use, and an examination of the degree to which species composition in these priority areas has changed over time (between 1968 and 2011). The results show that this area is important to waterfowl for staging and wintering. Spring and fall distribution are generally correlated, and the use is higher in the fall. Across time, the pattern in species composition is generally consistent. There is variation in abundance, but this does not seem to be a long-term trend.

Great Lakes Migratory Bird Stopover Habitat Portal

Presenter: August Froelich, The Nature Conservancy

The Great Lakes Migratory Bird Stopover Habitat Portal[1] is a website that can be used to learn about stopover sites in the Great Lakes region. It's also a tool that can be used to study stopover sites, apply models and download data. To predict migratory bird hotspots, attributes of stopover sites were identified and scored. Potential stopover habitats were mapped across the region (based on literature and available GIS layers), and rated by relative importance. It was very difficult to compare and rank habitats. Ranks were developed by combining land cover (habitat) values by species with geographic values (neighborhood values). Several different types of maps are available to users, and results can be downloaded in a choice of format. This was made possible by comparing information found in the literature with GIS analyses, and using case studies. In the future, they will improve the portal by updating models and adding case studies. It could also be interesting to find a way to incorporate this work with other projects such as the Midwest Data Center.

[1] Available at: http://glmigratorybirds.org/

Section 3: Midwest Avian Data Center – Developing a Data Management System for Great Lakes Researchers

The Midwest Avian Data Center – Bird Conservation through Data, Science, and Partnerships

Presenter: Katie Koch, U.S. Fish and Wildlife Service

The Midwest Avian Data Center[2] (MWADC) is a node – an interconnection of points – of the Avian Knowledge Network (AKN). The AKN is a partnership of people, institutions and government agencies supporting the conservation of birds and their habitats based on data, adaptive management and the best available science. Some of its functions are to serve as a tool to manage scientific data, foster meaningful data visualizations and coordinate partnerships around conservation questions. Through different levels of data availability, users of the MWADC can navigate through the database and visualize the information through different outputs. Data comes from different sources and there might duplication; eliminating these is something that is being worked on.

The Data Life Cycle in the Midwest Avian Data Center

Presenter: Leo Salas, Point Blue Conservation Science

There are seven steps to managing a project's data in MWADC. The first one is to register and create a project. Then, the user has to describe data collection protocols, researchers and their roles, and sampling location. Once these steps are complete, the user enters and edits data, and can finally visualize it. Several tools are available for visualization. The MWADC is partnering with GLC in the project to integrate data from phases 1 and 2 and allow visualization of the results.

[2] Available at: http://data.pointblue.org/partners/mwadc/index.php?page=home

Section 4: Summary of the Phase 3 Online Data and Information Needs Survey

Presenter: Rebecca Pearson, Great Lakes Commission

The purpose of this effort by the GLC was to assess data and information needs to ensure that data collected by the regional aerial survey efforts get used by managers and stakeholders in the region. The assessment began with a short online survey released in mid-December 2015, targeted at managers and stakeholders. Responses were received from a diverse group of stakeholders, including state agencies, federal agencies, wind energy developers and wildlife conservation organizations from across the Great Lakes region.

Question 1: What kind of activities, projects or initiatives do you work on that can be supported by bird data and information from the near-shore and open waters of the Great Lakes?

- ➔ The activities, projects or initiatives that can be supported by bird data and information from the near-shore and open waters of the Great Lakes that received the most responses were: coastal habitat conservation, wildlife conservation grants, and coastal restoration projects.

Question 2: What type of data do you use for making management decisions for near-shore and open water resources?

- ➔ The most popular types of data for making management decisions for near-shore and open water resources were: unpublished monitoring data, expert opinion and literature. This means managers generally use more than their own information stream to inform their decisions.

Question 3: How important are the following data [bird hotspots/coldspots, species richness, areas where state and federal listed birds, bird open water corridors or flyaways, other] and information to the decisions you make and questions you ask?

- ➔ When asked to pick, in order of importance for decision-making, the following data and information were ranked as the most important: bird hotspots/coldspots, bird open water corridors or flyways, and areas where state and federal listed birds.

Question 4: In an ideal world, what types of data and information would you likely use for management decisions for near-shore resources and avian fauna?

- ➔ Commons trends in responses to the open-ended question regarding the types of data and information that managers would likely use in an ideal world for management decisions for near-shore resources and avian fauna were: bird abundance and diversity, bird hotspots federally and state listed, species vulnerable to impacts to wind energy turbines, population trends in relationship to food source, geo-referenced, by and within season and year, continued monitoring, and at least 8 miles offshore.

Question 5: How important is it for you to practice adaptive management and what is the main challenge to practicing adaptive management in your institution?

- ➔ Most of the written responses to the question concerning adaptive management, and the main challenges to practicing it, mentioned that it was very important along with long-term monitoring efforts, but that securing funds and staffing were challenging.

Section 5: Case Study Breakout Outcomes

Overview of Management Use Case Studies

Three management case studies were identified to reflect the interests of the survey responders and promote communication amongst workshop participants. The first case study concerned Long-tailed ducks, a game species whose Great Lakes population is under the management of the Great Lakes Region and Upper Mississippi River Joint Ventures as well as individual states. As populations are currently in decline, this case study aimed to answer the following management question: *How should restoration activities be designed, implemented and evaluated to increase Long-tailed duck population size?* More specifically, given data on potential restoration location and estimated duck abundance in Lake St. Clair and Western Lake Erie during fall 2011, how can managers (1) select areas for restoration that are specifically useful to Long-tailed ducks and (2) evaluate the success of these restoration efforts at the scale of the restoration site as well as throughout the Great Lakes?

The second case study was to explore means to properly site offshore wind development by selecting areas of least biological conflict within Wind Resources Areas (WRAs) that were already defined by the Michigan Great Lakes Wind Council. This case study aimed to answer the following management question: *How can offshore wind development be sited within the three Central Lake Huron WRAs with the least impact to birds and bats?* The desired outcome of this case study was to ensure that the effort to meet domestic energy demands through wind power is conducted in an environmentally responsible manner that protects the health and safety of the environment and communities.

The third case study focused on the North American Waterfowl Management Program's primary goal. It aimed to answer the following management question: *How can we monitor waterfowl and habitat selection during the non-breeding season to ensure sustainable populations?* Recognized challenges and considerations – as a particular metric is developed – included food availability, human disturbance, time and geographic challenges, lack of protocol standardization for surveys and data collection, and climate change variation resulting in variability in environmental conditions and response from populations.

Breakout 1: Long-tailed duck Restoration

While some hypothetical restoration plans were proposed within the group, overall the group decided that there was not enough known about Long-tailed duck ecology to know what kind of restoration would be effective. Without the type of restoration defined, it was difficult to devise a monitoring plan that would be successful in quantifying the effects of the restoration action. Thus, the group decided to eliminate the word "restoration" from the main question. Instead, the group decided to focus more on understanding the factors that limit the populations of this species such that a plan for successful restoration could be considered.

Complicating matters further is that the declines seen in Long-tailed duck populations have been highly regional. This species is extremely common in parts of Lake Michigan but virtually unseen even in western Lake Erie. Thus, restoring the species from this decline is a regional issue where region-specific factors must be considered. The group came up with six limiting factors that could affect the non-breeding population. These factors have to be monitored to understand where the problems might be, and to see if there are differences in the Great Lakes population and the population from other regions. These factors are: control of ice water levels, harvest and bycatch, disturbance, food availability, contaminants and diseases. Aerial surveys to monitor Long-tailed duck populations that are similar to what has already occurred will be important in helping to: (1) determine the

current status of the population, (2) determine how important some of these factors are for affecting duck populations, and (3) document the population-level responses to restoration activities.

Breakout 2: Siting Offshore Wind in Central Lake Huron Wind Resource Areas

The group discussed how offshore wind could be sited with the least impact to birds and bats. The discussion focused primarily on water birds and landbirds (including raptors), and on siting projects and measuring impacts, rather than on other mitigation approaches. Metrics needed to site offshore wind in such a way as to minimize impacts to these taxa include: locations and persistence of concentration of species of interest, presence of species of concern, timing of species presence or large aggregations relative to the timing of development activities, understanding of how abundance at a proposed development site compares to overall population size at some broader scale, and flight patterns (locations, timing, flight heights) of migratory birds and bats. In addition to identifying data gaps and needs, the group also discussed management actions or approaches required to site offshore wind projects to minimize wildlife impacts. Data collection requires funding, and participants suggested building the costs of monitoring into permits so that developers pay the costs to fill identified data gaps. It was also suggested that projects that develop or use a public resource (such as Great Lakes lake bottoms, which are held in trust by the states and the provinces) should be required to make all data publicly available. A broader planning effort to assess and weight available data, including biological data, was identified as an optimal approach for project siting, though determining how best to weight information from different sources can be difficult and this process could use additional development. While discussion focused on offshore wind, participants felt strongly that similar conditions should be imposed on all types of energy development, and that development decisions should be made within a broader context that incorporates a life cycle analysis of environmental impacts from different energy sources. Lastly, breakout session participants pointed out that while state wildlife agencies can identify areas that may be better or worse to develop, these agencies often do not actually have the authority to provide (or deny) a permit.

Breakout 3: Monitoring Waterfowl during the Non-breeding Season in the Great Lakes

The group worked on developing an index that would provide some information of the general spatial and temporal use of the Great Lakes by waterfowl and water birds in the non-breeding season. The purpose of the index would not be to provide numeric values of the total populations of waterfowl/water birds using the Great Lakes during fall and winter. Rather, the index would provide a relative measure of use of areas of the Great Lakes by comparing relative values across space and time. Information that could be gathered from the index includes: important locations, changes through time, and variance in space and time. These data would help guide research (triage), trigger other research questions, gap analyses (areas in need of better surveying, including at particular times of the year), provide a sense of the large-scale behavior of waterfowl and water birds in the Great Lakes during the non-breeding season, or simply provide indications of overall health. The team acknowledged the severe logistical constraints associated with data collection during the non-breeding season. Thus, strong bias may be present in the data due to limited sampling or sampling only from preferred locations. Users of the index could be warned about possible bias, for example by providing values of relative sampling effort, and statistical corrections through the use of simple models (e.g., smoothing and additive models). Bias may be reduced through the use of large datasets. Several types of data could be used, including: eBird, Christmas Bird Count, the Mid-winter Waterfowl Survey, and other sources that would be federated to the Midwest Avian Data Center. The group had discussion about the spatial, temporal and taxonomic resolutions of the index, and the amount of data

was a factor to be considered. The team considered that temporal resolution at a monthly level could be possible. Spatial resolution would depend on the amount of data available, with the consideration to blank out areas with limited or no information rather than extrapolate to them from nearby areas. Taxonomic resolution may remain at guilds/functional ecological groups, as this would reduce issues with misidentifications. The target audience the team expected to profit from using the index would be agencies managing resources at large scales: state agencies, federal agencies, joint ventures and landscape conservation cooperatives, and conservation organizations.

Section 6: Models to Inform Wildlife Management Decisions

One of the objectives of the Monitoring and Mapping of Avian Resources over the Great Lakes project is to develop predictive models of water bird distributions and densities across the Great Lakes, in order to support decision-making and conservation planning. The broader goal of the predictive modeling is to examine water bird occurrences and abundances in near-shore and open water areas of the Great Lakes using survey data collected over 2012-2014. Approaches to attain this goal include the identification of "hotspot" and "coldspot" locations, identification of relationships between water bird occurrences and abundances and relevant environmental covariates, and standardization of data across differing sampling protocols. The desired outcomes of the modeling are to determine the sampling and modeling priorities for the next phases of the project, to inform current water bird conservation priorities, and to inform management decisions on wind energy development in the Great Lakes. The project's modeling team includes Allison Sussman and Elise Zipkin (Michigan State University), Evan Adams (Biodiversity Research Institute and University of Washington), Beth Gardner (University of Washington) and Kate Williams (Biodiversity Research Institute). The Michigan State University team will focus on identification of "hotspot" and "coldspot" locations to determine which species and groups of species should be targeted for analysis as well as the appropriate scale. They will also identify meaningful definitions of hotspots and coldspots based on a combination of prevalence and abundance. The Biodiversity Research Institute and the University of Washington teams' will focus on hierarchical distance sampling to help resolve the problems created by differences in survey methods across the Great Lakes. Developing a global distance model using a Bayesian framework that shares information across different surveys datasets should facilitate the creation of a unified abundance model for each species.

Exploring Open Water Bird Hotspots and Coldspots

Presenter: Allison Sussman, Michigan State University

The objective of this modeling effort was to explore open water bird "hotspots" and "coldspots" in the Great Lakes using a variety of approaches. A literature review was conducted on methods to identify hotspots and coldspots to evaluate the effectiveness of these methods for the current available data. The first method used was adapted from the Biodiversity Research Institute's Mid-Atlantic Baseline Study.

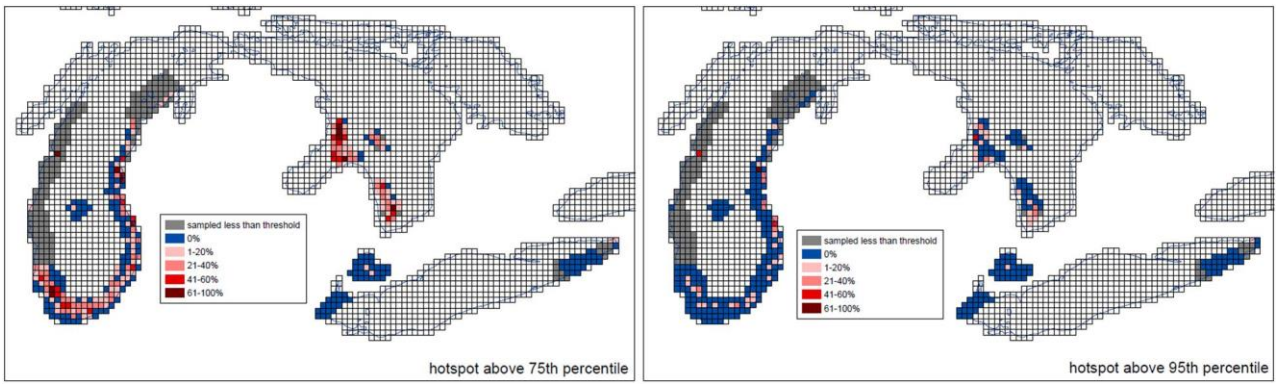


Figure 2. Map of Long-tailed duck hotspots, block sampled at least five times

As data were collected differently across the five Great Lakes surveys, data were first standardized to support the modeling analysis. Standardized data counts were then fit into a gamma distribution and each sampling event was assigned a probability. Two scenarios were explored to call a sampling event a hotspot: higher than 75th percentile and higher than 95th percentile. Using these scenarios and a threshold for the number of times a block was sampled (more than five and more than 10); maps (see figure 2 for an example) of persistent hotspot and coldspot locations across the Great Lakes were created for a test species (Long-tailed duck) and a test species group (gulls). Repeated sampling would be necessary to confirm these hotspots.

Standardizing and Integrating Aerial Surveys for Population Size Estimation across the Great Lakes

Presenter: Evan Adams, Biodiversity Research Institute

The objective of this approach was to find a way to combine data from aerial surveys together into a single modeling framework. The team also wanted to be able to correct for detection bias across all surveys and to be as accurate as possible when predicting locations of birds in the Great Lakes. Some of the challenges encountered included: different data collection methods, sparse data for some areas, skew in the counts and need for more flexible distributions or models to address large counts and zeroes, and correlation in the counts. The first part of this modeling effort looked at diversity in the surveys. As seen in Section 1 and Appendix 1 of this workshop summary, there were differences in methods used by each surveyor, resulting in different types of datasets that had to be standardized. Variables considered were the years surveyed, the transect spacing, the altitude of flights, the strip width (when no distance was provided), the distance bands and the species recorded. Having all surveys integrated within a unified dataset is important to being able to analyze the Great Lakes as a whole.

Discussion

Collaboration among modelers, but also with managers, is essential to ensure that the project survey and modeling work is supporting management decisions. This workshop was an initial effort to enable that collaboration. Future collaboration could help standardize survey designs, so that future surveys can be unified easily into one dataset. If surveys are not standardized, more details on different covariates – metadata – need to be gathered during surveys to facilitate the future integration of data into the model. Examples of important covariates to consider include: sea state, weather in general, wind, observers (single or double, for example), glare, etc. Modeling can also identify areas with potentially large aggregations of water birds that would need increased or new surveying. The integration of new technologies, such as georeferenced aerial photos, video surveys or drones could also guide the design of future surveys. Drones are currently being tested over Lake St. Clair, but those that can fly high enough for these types of surveys are relatively expensive. Nonetheless, these are tools that are worth exploring.

There can be a tension between the desire to have long-term monitoring data and the need to make immediate management decisions. Funding and resources for long-term monitoring are not necessarily available when needed. Models can expedite the delivery of information to help make these immediate decisions, so long as caveats are transparent and well-understood. As new data are made available and integrated in the models, model outputs will improve along with confidence to use those outputs in decision-making. Modeling can also help better design future short and long-term monitoring for different purposes, such as answering specific management questions, focusing on spatial data gaps or hot spots, for example. Monitoring and modeling therefore can improve in parallel and both be used as tools for management. These tools will be important as Great Lakes management needs evolve.

Section 7: Next Steps

One of the objectives of the Monitoring and Mapping of Avian Resources Over the Great Lakes project is to inform Great Lakes conservation and management decisions by engaging natural resource and wildlife managers and subject experts in detailing needs for summarizing and using survey data within relevant decision frameworks.

Moving forward, the project team will continue its data integration and modeling efforts and work on obtaining input on models from surveyors. The team will seek input from natural resources managers and others on how this data could be used to inform management decisions.

The team will also work on identifying gaps in how future surveys could be used to determine water bird distribution and abundance patterns across the Great Lakes. External input will also be sought to know what are the data and modeling needs required for better decision-making.

The work of the data integration and modeling team, as well as input from managers and other decisionmakers, will be essential to help identify management decisions that need this type of regionwide assessment.

Appendices – Survey Effort Factsheets

Section 1 of this workshop summary summarized the 2012-2014 Great Lakes Open Water bird Surveys that were coordinated by the Great Lakes Commission and the U.S. Fish and Wildlife Service. For each surveyor, a fact sheet was developed and is included in this appendix.

Appendix A: Eastern and Southern Lake Michigan Surveys – U.S. Geological Survey

Appendix B: Central Lake Huron Wind Resource Areas Surveys – Michigan Natural Features Inventory

Appendix C: Lake St. Clair, Detroit River and Western Lake Erie Surveys – Michigan Department of Natural Resources

Appendix D: Eastern Lake Erie Surveys – Biodiversity Research Institute

Appendix E: Western Lake Michigan Surveys – Western Great Lakes Bird and Bat Observatory

Appendix A: Eastern and Southern Lake Michigan Surveys

With 10,000 miles of shoreline and a watershed area of more than 300,000 square miles, the Great Lakes region provides vital breeding, feeding, and resting areas for hundreds of millions of birds. To protect these birds and the habitats that support them, we need the best possible knowledge about their dependence on the Great Lakes. To that end, the Great Lakes Commission and partners conducted aerial surveys of selected areas of Lake Michigan, Lake Huron, Lake St. Clair, and Lake Erie over the course of two years during the non-breeding season (fall, winter and spring). Armed with the better knowledge gained from these surveys, we can help natural resource managers, conservationists, and other stakeholders make better decisions to protect avian habitats from human impacts. This is a summary of the aerial survey effort covering eastern and southern Lake Michigan.

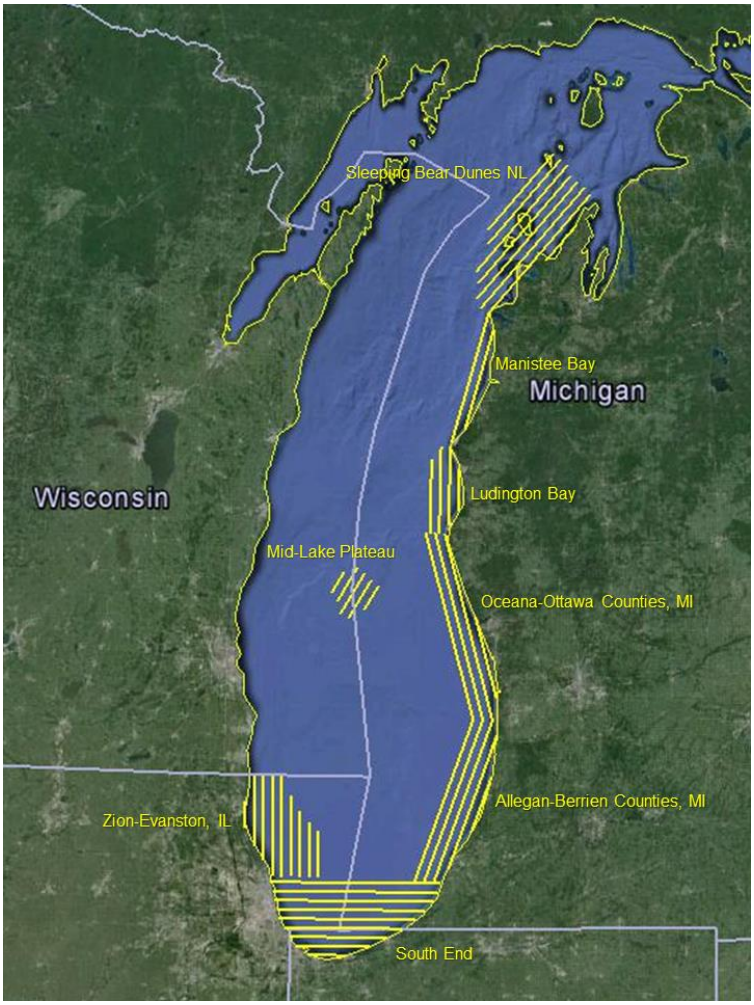


Figure 1. Survey Transects for Southern and Eastern Lake Michigan.

Lead Surveyor: Kevin Kenow, U.S. Geological Survey Upper Midwest Environmental Sciences Center, (608) 781-6278, kkenow@usgs.gov

Survey Area: 12,800 kilometer km^2

Total Length of Survey Transects: 14,761 km

Methods: Surveys were flown along fixed-width transects. Transects generally paralleled shorelines, were spaced at 4.8-km (3-mi) intervals, and extended up to 32 km (20 mi) offshore. Surveys were flown at an average air speed of about 200 km/h (125 mph) and at an altitude of about 61-76 m (200-250 ft) above the water using a U.S. Fish and Wildlife Service fixed-wing aircraft. Two observers, one on each side of the plane, identified and tallied waterbirds within 200 m-width (1/8 mi) strip transects on either side of the plane and categorized observations into one of two distance bands (observable portion of strip transect out to 100 m and 101-200 m). Distances were established using a clinometer, and the portion of the transect band beneath the plane that was not observable was estimated.

Numbers of surveys and dates:

	Phase 1 2012-2013 fall-spring seasons	Phase 2 2013-2014 fall-spring seasons	Grand Total No. of Surveys
Survey Dates	• September 25-27, 2012 • October 22-24, 2012 • November 26-29, 2012 • February 4-6, 2013 • February 24-25, 2013 • March 21-22, 2013 • April 3-5, 2013 • April 24-26, 2013	• September 18-26, 2013 • October 25-November 1, 2013 • November 19-20, 2013 • December 12-19, 2013 • January 8-9, 2014 • February 2-3, 2014 • March 24-26, 2014 • May 5-6, 2014	
Subtotal	8	8	16

Number of individual observations:

	Phase 1 2012-2013 fall-spring seasons	Phase 2 2013-2014 fall-spring seasons	Grand Total of No. Observation
No. of Observations	67,563	95,218	162,781

Summary of Results:

Phase 1 - Long-tailed Ducks (59%) were the most abundant species over the fall- winter-spring survey period, followed by mergansers (17%), gulls (11%) and scoters (5%). The Sleeping Bear Dunes National Lakeshore, Allegan-Berrien Counties, Oceana-Ottawa Counties, and the southern end of Lake Michigan tended to have the highest concentrations of water birds during the survey period.

Phase 2 - Long-tailed Ducks were the most abundant species, representing 57 percent of all birds tallied during the eight month survey period (Figure 2). Mergansers, scaup, and scoters (primarily White-winged [*Melanitta deglandi*]) were also frequently observed along transects. Record ice coverage of Lake Michigan occurred during winter 2013–2014, with maximum coverage of 93 percent occurring on about 5 March 2014. Winter ice cover affected habitat availability.

Waterbird concentrations varied temporally and spatially within the areas of Lake Michigan that were surveyed. Overall water bird abundance during Phase 2 surveys ranked highest within the Sleeping Bear Dunes National Lakeshore, Oceana-Ottawa Counties, and the southern end of Lake Michigan.

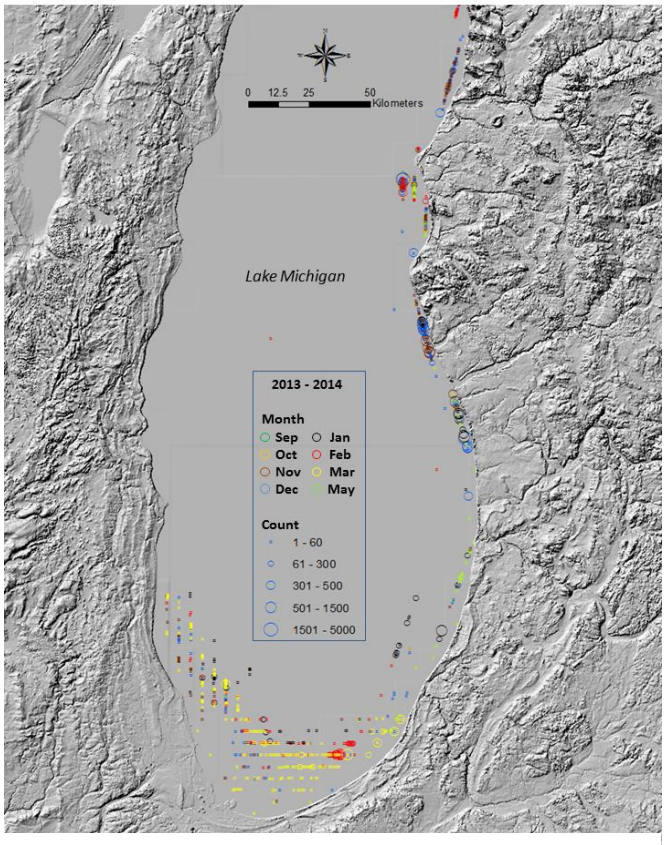


Figure 2. Long-tailed Duck observations from surveys conducted during Sept. 2013 through May 2014.

Top Three Most Abundant Species by Fall and Spring Seasons:

Phase 1 2012-2013 fall-spring seasons				Phase 2 2013-2014 fall-spring seasons			
Fall 2012	**Species**	**Number**	**% of Total Observed**	**Fall 2013**	**Species**	**Number**	**% of Total Observed**
	Long-tailed Duck	8282	43.5		Long-tailed Duck	32400	51.1
	Gull	4099	16.0		Scaup	6423	10.1
	Merganser	2583	13.6		Gull	4967	7.8
Spring 2013	Long-tailed Duck	14351	58.9	**Spring 2014**	Long-tailed Duck	5411	60.5
	Merganser	3894	16.0		Merganser	1477	16.5
	Gull	2669	11.0		Gull	1214	13.6

Appendix B: Central Lake Huron Wind Resource Areas Surveys

With 10,000 miles of shoreline and a watershed area of more than 300,000 square miles, the Great Lakes region provides vital breeding, feeding, and resting areas for hundreds of millions of birds. To protect these birds and the habitats that support them, we need the best possible knowledge about their dependence on the Great Lakes. To that end, the Great Lakes Commission and partners conducted aerial surveys of selected areas of Lake Michigan, Lake Huron, Lake St. Clair, and Lake Erie over the course of two years during the non-breeding season (fall, winter and spring). Armed with the better knowledge gained from these surveys, we can help natural resource managers, conservationists, and other stakeholders make better decisions to protect avian habitats from human impacts. This is a summary of the aerial survey effort covering the Wind Resources Areas[3] in central Lake Huron.

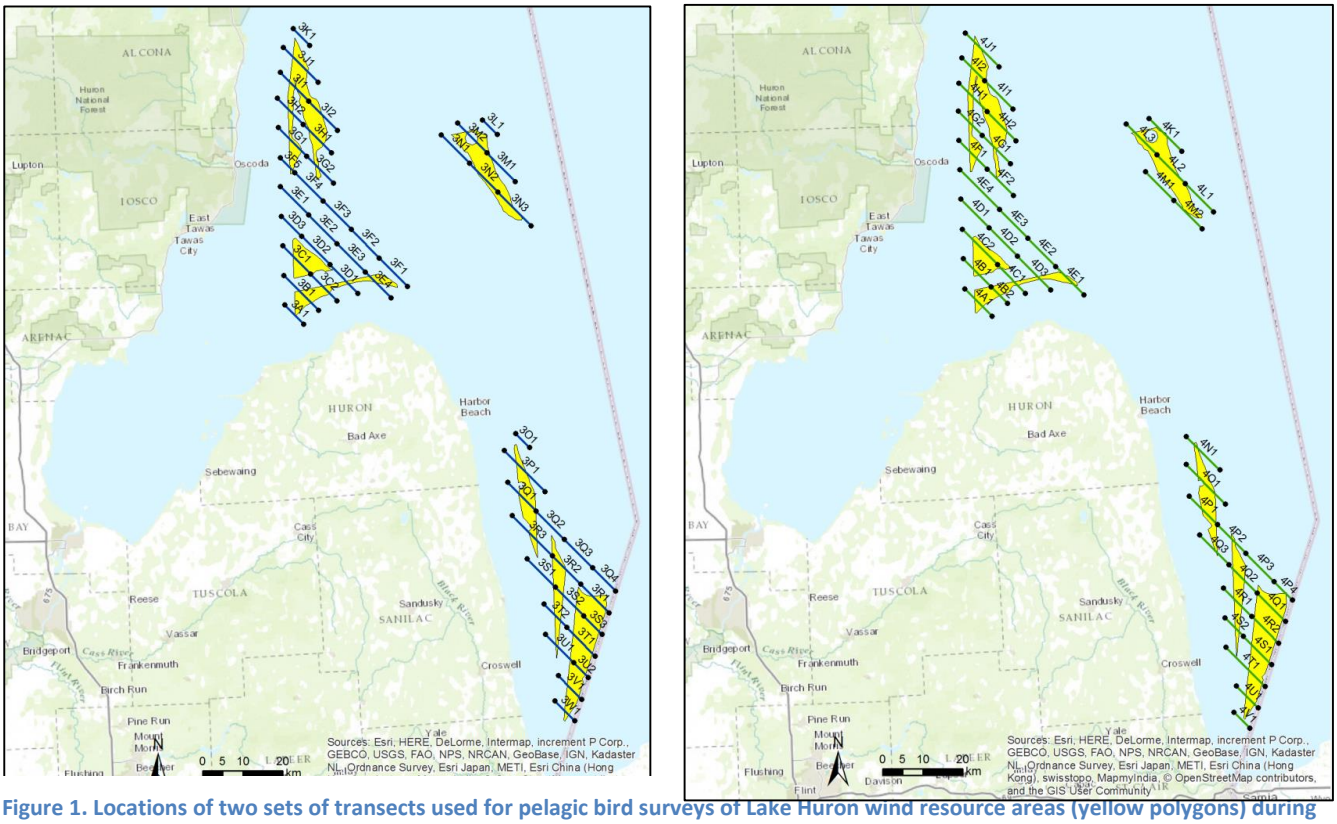


Figure 1. Locations of two sets of transects used for pelagic bird surveys of Lake Huron wind resource areas (yellow polygons) during Phases 1 and 2. One set of transects (i.e., blue – left graphic, or green – right graphic) was surveyed on a given day and the set covered was rotated every other survey. Transects were divided into approximately 10 km segments, with identifiers indicating transect set (number 3 [blue] or 4 [green]), transect (letter), and segment (number).

Lead Surveyor: Michael Monfils, Michigan Natural Features Inventory (MNFI), (517) 284-6205, monfilsm@msu.edu

Survey Area: 2,200 km^2

Total Length of Survey Transects: 881 km

[3]Wind Resource areas were identified by the Michigan Great Lake Wind Council in 2010 to be most favorable to the development of offshore wind energy. The council developed a set of 22 criteria related to biological, cultural and other features and uses of the lakes to define these areas.

Methods: Surveys were conducted along two sets of parallel transects traversing the Wind Resource Areas (Figure 1) and immediate vicinity. Transects within each set were 5 km apart, thus 2.5 km separated the full set of transects. MNFI used a Partenavia P68C twin-engine fixed-wing aircraft for all surveys. Surveys were flown at approximately 91 m above water level and speeds of 130-200 km/hr. Two observers conducted surveys (one on each side of the aircraft). For each flock or individual bird, MNFI recorded the species (or lowest taxonomic group), number observed, latitude and longitude (using GPS receiver), and the distance band in which it was first detected (0 – 100 m, 101 – 200 m, 201 – 300 m, 301 – 412 m, and >412 m).

Number of surveys and dates:

	Phase 1 **2012-2013 fall-spring seasons**	**Phase 2** **2013-2014 fall-spring seasons**	**Grand Total No. of Surveys**
Survey Dates	• October 26, 2012 • November 2 and 13, 2012 • December 6, 2012 • February 12 and 26, 2013 • March 1, 4 and 29, 2013 • April 17 and 30, 2013 • May 14, 2013	• October 25, 2013 • November 5 and 19, 2013, • December 19,2013 • April 18 and 24, 2015 • May 5 and 14, 2014	
Subtotal	12	8	20

Number of individual bird observations:

	Phase 1 **2012-2013 fall-spring seasons**	**Phase 2** **2013-2014 fall-spring seasons**	**Grand Total of No. Observation**
No. of Observations	12,402	7,143	19,545

Summary of Results: MNFI documented results from Phase 2 surveys that were largely consistent with the Phase 1 findings. Sea ducks and gulls dominated bird detections, with Long-tailed Duck being the most common species observed. Despite Canada Goose being rarely observed during Phase 1, MNFI commonly detected the species during spring 2014, which may have been a result of the late spring and/or later timing of surveys. None of the transect segments were devoid of birds and MNFI detected small flocks of birds widely distributed throughout the survey area. Although particular portions of the survey area had significantly greater bird densities, overall densities were low in both phases and seasonal differences were not observed.

Top Three Most Abundant Species by Season:

Phase 1 2012-2013 fall-spring seasons				Phase 2 2013-2014 fall-spring seasons			
Fall 2012	**Species**	**Number**	**% of Total Observed**	**Fall 2013**	**Species**	**Number**	**% of Total Observed**
	Long-tailed Duck	2,087	86%		Long-tailed Duck	3,584	81%
	Large Gulls	146	6%		Large Gulls	420	9%
	Unidentified Loons	59	2%		Unidentified Sea Ducks	144	3%
Spring 2013	Long-tailed Duck	2,798	77%	**Spring 2014**	Long-tailed Duck	869	32%
	Large Gulls	432	12%		Canada Goose	818	30%
	Swans	153	4%		Large Gulls	430	16%

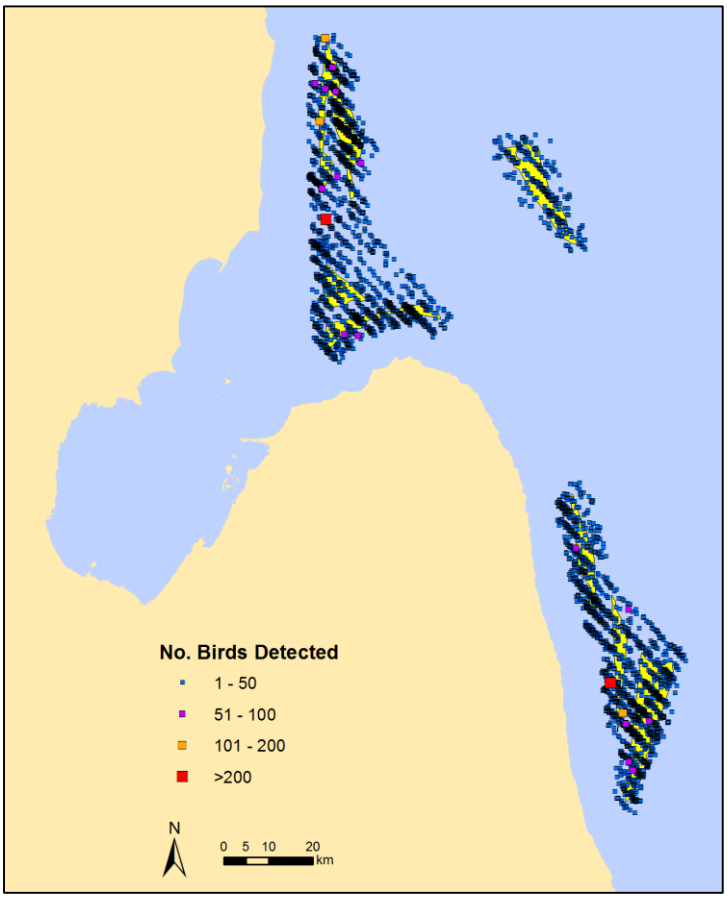


Figure 2 Approximate locations and relative abundances of all birds observed during aerial surveys conducted over central Lake Huron in 2012-2014. Lake Huron Wind Resource Areas as identified by the Great Lakes Wind Council are indicated by yellow shading.

Appendix C: Lake St. Clair, Detroit River, and Western Lake Erie Surveys

With 10,000 miles of shoreline and a watershed area of more than 300,000 square miles, the Great Lakes region provides vital breeding, feeding, and resting areas for hundreds of millions of birds. To protect these birds and the habitats that support them, we need the best possible knowledge about their dependence on the Great Lakes. To that end, the Great Lakes Commission and partners conducted aerial surveys of selected areas of Lake Michigan, Lake Huron, Lake St. Clair, and Lake Erie over the course of two years during the non-breeding season (fall, winter and spring). Armed with the better knowledge gained from these surveys, we can help natural resource managers, conservationists, and other stakeholders make better decisions to protect avian habitats from human impacts. This is a summary of the aerial survey effort covering eastern Lake Erie.

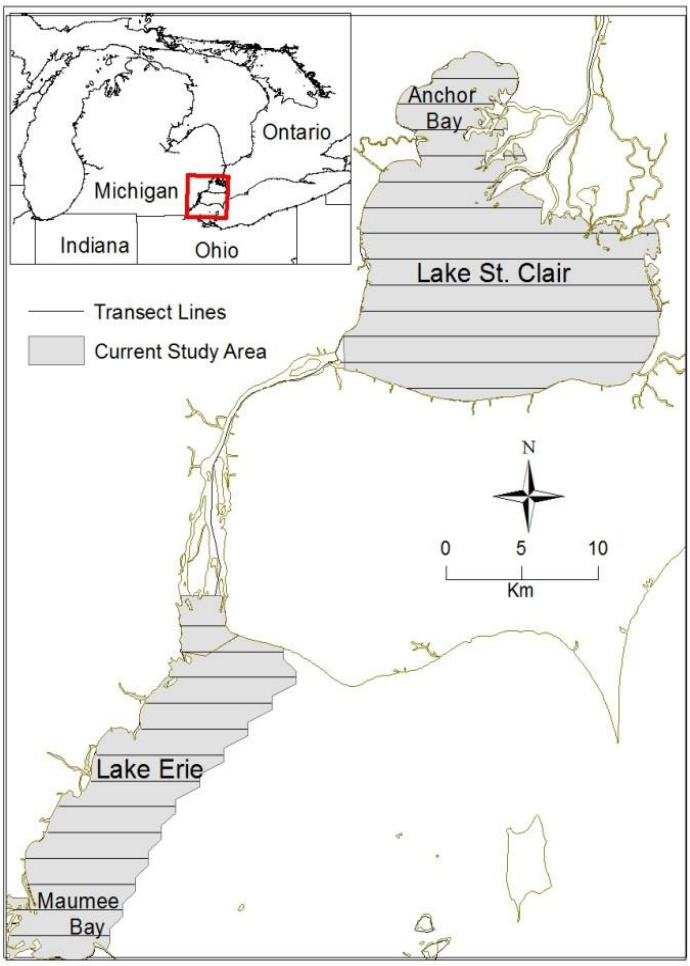


Figure 1. Map of Lake St. Clair and western Lake Erie diving duck survey area with east-west survey transects shown as solid lines

Lead Surveyor: David Luukkonen, Michigan Department of Natural Resources (MDNR), (517) 641-4903, ext. 250, luukkonend@michigan.gov

Survey Area: 1,770 km^2

Total Length of Survey Transects: ? km

Methods: Using Hawth's tools in ArcGIS, MDNR established 26 east-west transects spaced 3.2 km apart. MDNR recorded avian flocks in 5 distance categories extending out from the beginning of the visible portion (that area beyond the portion obscured by airplane floats - amphibious Cessna 185) of the transect line on each side of the airplane 0-50, 51-125, 126-225, 226-425, and >425 m. MDNR used a target flight altitude of 90 m and a clinometer to establish declinations from horizontal to associated distance bands and used 3 mm strips of masking tape to mark windows and 25 mm strips of masking tape to mark struts of the plane. Observers aligned window and strut marks when recording observations to prevent inaccurate distance measurements caused by a shift in the observer's line of sight. MDNR used two observers on each flight with each observer being responsible for one side of the plane. MDNR used data loggers with voice recording capabilities to record all observations for most flights.

Number of surveys and dates:

	Phase 1 **2012-2013 fall-spring seasons**	**Phase 2** **2013-2014 fall-spring seasons**	**Grand Total No. of Surveys**
Survey Dates	• October 22 and 30, 2012 • November 5 and 20, 2012 • December 5 and 12, 2012 • January 8 and 23, 2013 • February 6 and 12, 2013 • March 7 and 22, 2013 • April 3, 21 and 26, 2013 • May 1 and 8, 2013	• October 22 and 30, 2013 • November 8 and 19, 2013 • December 12, 2013 • January 21, 2014 • February 13, 2014 • March 31, 2014 • April 9, 16 and 21, 2014 • May 6, 2014 • June 10, 2014	
Subtotal	17	13	30

Number of individual bird observations:

	Phase 1 **2012-2013 fall-spring seasons**	**Phase 2** **2013-2014 fall-spring seasons**	**Grand Total of No. Observation**
No. of Observations	1,172,832	534,069	1,706,901

Summary of Results:

Phase 1- In all 3 monitored seasons' canvasbacks were the bird species with the highest observed count (51% of fall 2012 observations, 54% winter 2013, 42% spring 2013), and canvasbacks, scaup, redhead, and swans were 4 of the 5 most abundant bird species observed during all 3 seasons. Based on our empirical count data, waterfowl (i.e., diving ducks, dabbling ducks, sea ducks, swans, and geese) were the most abundant avian group on Lake St. Clair, western Lake Erie, and lower Detroit River. MDNR also documented significant use of the study area by bald eagles, especially in winter (215 birds) when extensive ice coverage inland likely concentrated birds around remaining open water on Lake Erie and Lake St. Clair.

Phase 2 - Diving ducks were the most abundant species group and reached the highest densities of any bird group on the study area (peak diving duck estimate was 321,258 birds on November 2013-Figure 2). For all 4 major waterfowl groups (diving ducks, dabbling ducks, sea ducks, and swans) observed densities were highest during fall migration and lowest during winter migration. Conversely, densities for gulls were highest during spring migration and bald eagle densities peaked during the wintering period. Concentrations of diving ducks and sea ducks were often detected well offshore (> 5 miles) in comparison to dabbling ducks, swans, gulls, and bald eagles that often occurred at high densities in the near-shore waters of Lake St. Clair and western Lake Erie.

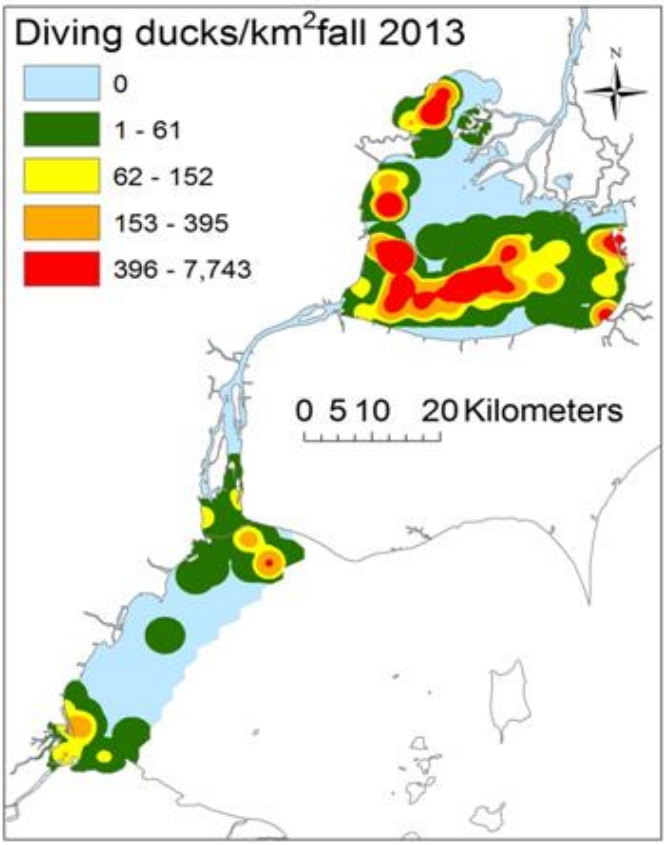


Figure 2. Kernel density map developed from MDNR aerial survey observations for diving ducks on Lake St. Clair, western Lake Erie and the Detroit River Fall 2013

Top Three Most Abundant Species by Fall and Spring Seasons:

Phase 1 **2012-2013 fall-spring seasons**				**Phase 2** **2013-2014 fall-spring seasons**			
Fall 2012	**Species**	**Number**	**% of Total Observed**	**Fall 2013**	**Species**	**Number**	**% of Total Observed**
	Canvasback	393,245	48%		Canvasback	112,828	37%
	Scaup	178,628	22%		Scaup	87,943	29%
	Readhead	2,317	5%		Readhead	45,935	15%
Spring 2013	Canvasback	40,877	39%	**Spring 2014**	Scaup	59,066	41%
	Scaup	64,632	33%		Unknown diver	33,392	23%
	Readhead	11,428	11%		Canvasback	16,872	12%

Appendix D: Eastern Lake Erie Surveys

With 10,000 miles of shoreline and a watershed area of more than 300,000 square miles, the Great Lakes region provides vital breeding, feeding, and resting areas for hundreds of millions of birds. To protect these birds and the habitats that support them, we need the best possible knowledge about their dependence on the Great Lakes. To that end, the Great Lakes Commission and partners conducted aerial surveys of selected areas of Lake Michigan, Lake Huron, Lake St. Clair, and Lake Erie over the course of two years during the non-breeding season (fall, winter and spring). Armed with the better knowledge gained from these surveys, we can help natural resource managers, conservationists, and other stakeholders make better decisions to protect avian habitats from human impacts. This is a summary of the aerial survey effort covering eastern Lake Erie.

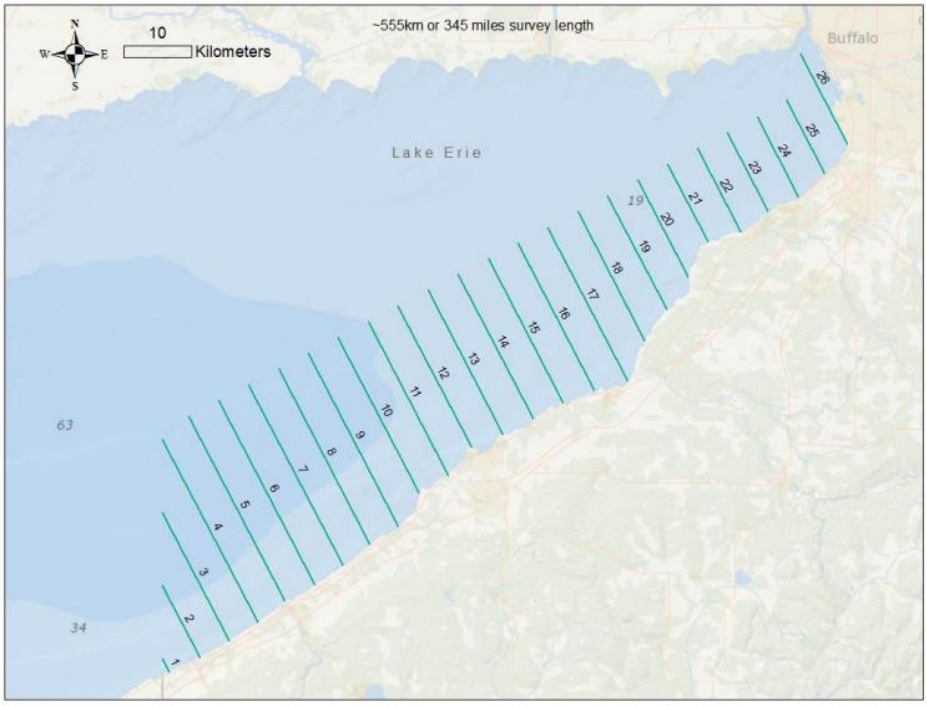


Figure 2. Map of the eastern Lake Erie survey area with survey transects shown as solid lines.

Lead Surveyor:
Kate Williams, Biodiversity Research Institute,
(207) 839-7600 x108,
kate.williams@briloon.org

Survey Area: 2786 km^2 (approximately 333 km^2 surveyed, assuming a 300m transect strip on either side of the plane)

Total Length of Survey Transects: 555km

Methods: Transects were spaced 5 km apart from each other and were flown perpendicularly to the coastline (Figure 1). A US Fish and Wildlife Service (FWS) pilot biologist served as an observer and recorded objects on the left side of the plane; the second observer from Biodiversity Research Institute (BRI) recorded objects on the right side of the plane. Survey protocols were based on breeding waterfowl surveys conducted by FWS pilots and recommendations for aerial surveys distributed by the Great Lakes Commission (GLC) in October 2013. A large portion of the survey area was iced over in winter, including during the February 2014 survey, and surveys were not initiated during a period in February-March 2014 when the survey area was almost entirely iced. Transects were flown at ground speeds of 90-105 mph (78-90 kts) and 200 feet (61 m) aboveground level (AGL). Reference marks were applied to the aircraft's wing struts to delineate transect widths of 100, 200, and 300 meters from the center of the aircraft for observations. All data were recorded into the voice/GPS survey program RECORD, developed by Jack Hodges (FWS).

Numbers of surveys and dates:

	Phase 2 **2013-2014 fall-spring seasons**
Survey Dates	• November 20-21, 2013 • February 8, 2014 • April 2, 2014 • May 5, 2014
Total No. of Surveys	4

Note: data from a January 2014 FWS midwinter waterfowl survey, using a different transect design, are included in Figure 2, but are otherwise excluded from the below summary

Number of individual bird observations: 10,046

Summary of Results: The most common species groups across all surveys were mergansers, scaup, gulls (particularly Bonaparte's and Herring Gulls), Canada Geese, and Canvasbacks. Excluding the January FWS survey, which flew along the shoreline, most commonly observed species were mergansers, gulls, and scaup. Notable observations included several Bald Eagles, Common Terns, Caspian Terns, and an Iceland Gull. Figure 2 displays all observations from all surveys.

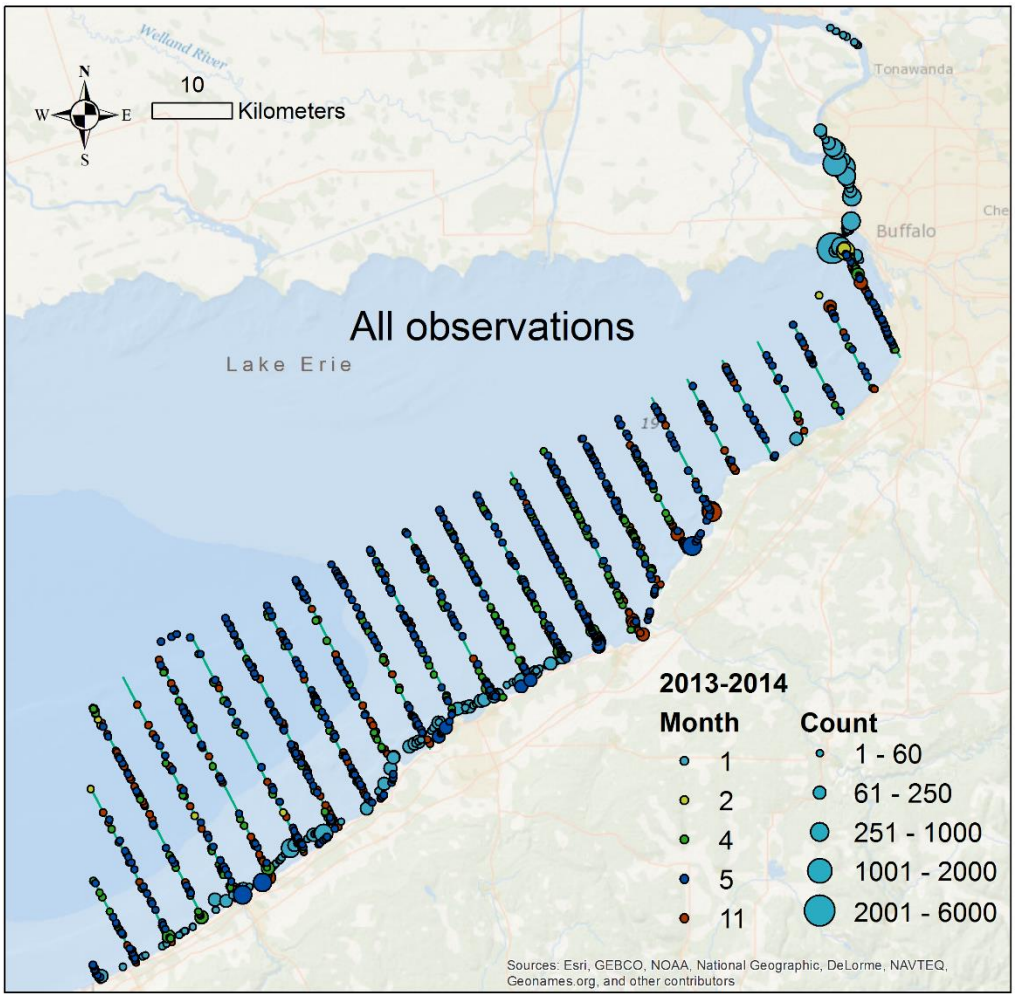


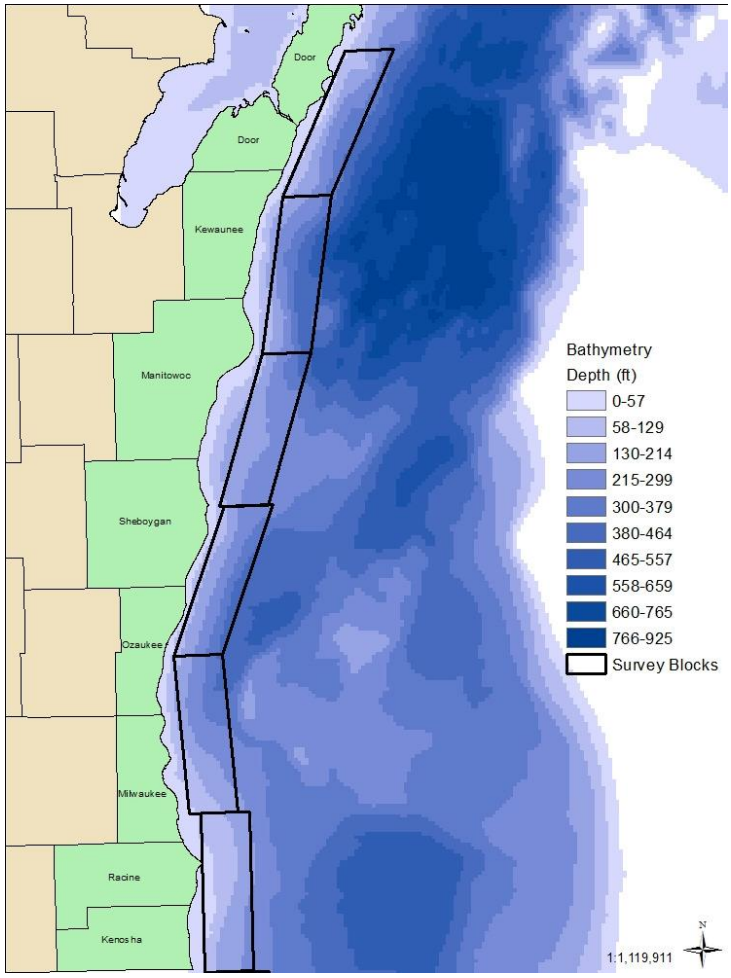
Figure 3. All observations, from all surveys. Colors indicate the month of survey (e.g., 1=January) and size indicates the size of the count (e.g., number of individuals observed).

Top Five Most Abundant Species or Species Groups, by Season (>500 individuals in the 4 BRI surveys):

Species group	Total Count	Fall	Winter	Spring	% of Fall Total	% of Winter Total	% of Spring Total
Red-breasted Merganser	**2197**	664	454	1079	25%	68%	16%
Bonaparte's Gull	**1594**	690	0	904	26%	0%	13%
Unidentified Gull	**1400**	146	47	1207	6%	7%	18%
Unidentified Merganser	**1248**	716	53	479	27%	8%	7%
Herring gull	**1067**	49	5	1013	2%	1%	15%

Appendix E: Western Lake Michigan Surveys

With 10,000 miles of shoreline and a watershed area of more than 300,000 square miles, the Great Lakes region provides vital breeding, feeding, and resting areas for hundreds of millions of birds. To protect these birds and the habitats that support them, we need the best possible knowledge about their dependence on the Great Lakes. To that end, the Great Lakes Commission and partners conducted aerial surveys of selected areas of Lake Michigan, Lake Huron, Lake St. Clair, and Lake Erie over the course of two years during the non-breeding season (fall, winter and spring). Armed with the better knowledge gained from these surveys, we can help natural resource managers, conservationists, and other stakeholders make better decisions to protect avian habitats from human impacts. This is a summary of the aerial survey effort covering western Lake Michigan.



Lead Surveyor: William Mueller, Western Great Lakes Bird and Bat Observatory (WGLBBO), (414) 698-9108, wpmueller1947@gmail.com

Survey Area: 4194.6 km^2

Total Length of Survey Transects: 1738.1 km

Methods: WGLBBO flew parallel transects north and south along the west shore of Lake Michigan. Surveys were conducted along transects oriented north-south and spaced 3.2 km apart throughout the surveyed region, using a double-observer protocol. A fixed-wing aircraft flying at 148 km/h (92mph) followed the mapped transects in alternating directions, within a 48.28 kilometer-long (30 mile) transect block. Surveys were flown at a 100 m aircraft altitude level.

Bird concentrations outside of the survey blocks after a block was done were counted as part of an additional transect nearer the shore. These data are displayed on maps as records of birds nearer to shore than the one mile survey block boundary.

Figure 4. Map of the survey transects for western Lake Michigan

Numbers of surveys and dates:

	Phase 1 2012-2013 fall-spring seasons	Phase 2 2013-2014 fall-spring seasons	Grand Total No. of Surveys
Survey Dates	• October 2, 16 and 19, 2012 • November 2, 9, 13, 27and 29, 2012 • December 4 and 14, 2012 • March 4, 8, 13, 14 and 22, 2013 • April 3, 16 and 24, 2013	• October 7, 17 and 242013 • November 5, 8, and 21, 2013 • December 2, 6 and 18, 2013 • March 24 and 26, 2014 • April 2, 7, 15, 18, and 22, 2014 • May 6, 2014	
Subtotal	18	19	**37**

Number of individual bird observations:

	Phase 1 2012-2013 fall-spring seasons	Phase 2 2013-2014 fall-spring seasons	Grand Total of No. Observation
No. of Observations	53,881	84,444	138,325

Summary of Results: Consistently, the survey blocks located offshore from the Door, Kewaunee, and Manitowoc County shoreline areas hold the highest numbers of waterfowl, especially Long-tailed Duck, the most abundant species. Other species however were consistently high in number depending on the month of each migratory season – especially Red-breasted Merganser and all gull species. These waterfowl and gulls were distributed all along Wisconsin's Lake Michigan shoreline, changing in number and location depending on the timing of migration within each season.

Top Three Most Abundant Species by Season:

Phase 1 2012-2013 fall-spring seasons				Phase 2 2013-2014 fall-spring seasons			
Fall 2012	**Species**	**Number**	**% of Total Observed**	**Fall 2013**	**Species**	**Number**	**% of Total Observed**
	Long-tailed Duck	29,152	60%		Long-tailed Duck	23,796	35%
	Red-breasted Merganser	8,721	18%		Merganser, species	16,731	24%
	Scaup, species	2,317	5%		Duck, species	12,105	18%
Spring 2013	Red-breasted Merganser	4,471	30%	**Spring 2014**	Long-tailed Duck	12,125	39%
	Long-tailed Duck	4,042	27%		Bonaparte's Gull	7,872	26%
	Common Goldeneye	1,693	11%		Scaup, species	2,358	8%

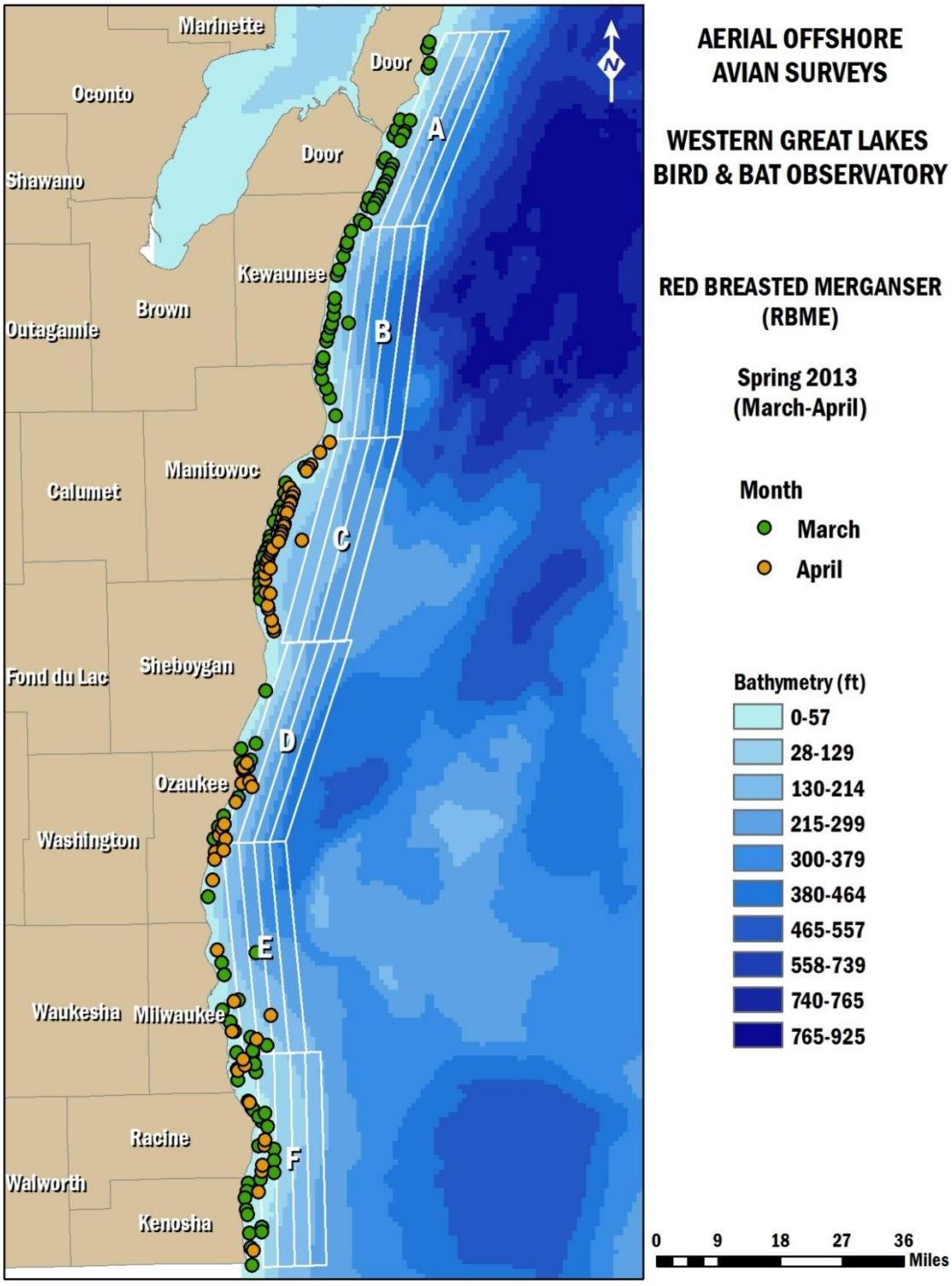


Figure 5 Distribution of the most common species, Red-breasted Merganser in the spring 2013