Long Point Waterfowl and Wetlands Research Program

Technical Report


Pied-billed Grebe. Photo by Tim Arthur.

September 2019

By Douglas C. Tozer, PhD
Port Rowan, ON

BIRD STUDIES CANADA
ÉTUDES D'OISEAUX CANADA

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Long Point Waterfowl and Wetlands Research Program

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Contents

Summary

The Long Point Waterfowl and Wetlands Research Program is Bird Studies Canada's umbrella for all of its waterfowl and wetlands research in the lower Great Lakes. It was established in the 1980s with support from The Bluff's Hunting Club, who continues to be concerned about the long-term welfare of waterfowl and wetlands at Long Point. The program's goal is to conserve waterfowl and other wetland-associated wildlife and their habitats through research and monitoring. The program has a vision of being recognized and respected internationally as a leader in high-quality applied science for conservation planning by federal, provincial, state, and non-profit partners.

Projects undertaken by Bird Studies Canada's Long Point Waterfowl and Wetlands Research Program are selected according to the program's mission, vision, and strategic plan, and are vetted by a scientific advisory committee comprised of waterfowl and wetland specialists. This ensures high-quality projects that are relevant and useful for waterfowl and wetland conservation. The program's strategic plan currently calls for targeted research in the following areas: influence of climate change, wetland loss / degradation, diseases, contaminants, and nonnative invasive species on waterfowl and other wetland bird populations; waterfowl monitoring; and the benefits and potential improvements of waterfowl habitat management techniques for all species. The strategic plan also calls for close interaction with project partners to determine needs, diversification of long-term support, and effective outreach.

The program is committed to achieving its goal and vision by providing hands-on opportunities for young wildlife technicians, biologists, and scientists in all aspects of wildlife science. Over the past year, the program pursued 18 research projects, which involved supporting and training 9 young professionals, as well as publishing 1 and preparing 9 peer-reviewed articles on a diversity of topics. The program's all-time list of publications now sits at 87 completed or drafted peer-reviewed scientific papers, a solid testimony to the program's success. Students and staff gave presentations at academic meetings, including: Conference on Great Lakes Research, Toronto; International Ornithological Congress, Vancouver; Latornell Conservation Symposium, Alliston, Ontario; and the Long Point World Biosphere Annual Research and Conservation Conference, Simcoe, ON. Plus, two of the program's students successfully obtained permanent jobs in wildlife conservation!

The tremendous success of Bird Studies Canada's Long Point Waterfowl and Wetlands Research Program is due to its diverse partners and supporters in Canada and the U.S. These include private donors, foundations, governments, corporations, universities, non-government organizations, and various granting agencies. A heartfelt thank you to each and every one of you for your support and partnership!

In the pages that follow we highlight results from projects we worked on over the past year. We hope you like what you see!

With best regards,

Douglas C. Tozer, Ph.D.
Director, Waterbirds and Wetlands
- *Long Point Waterfowl and Wetlands Research Program*
- *Great Lakes Marsh Monitoring Program*
- *Canadian Lakes Loon Survey*

Spatially explicit network analysis reveals multi-species annual cycle movement patterns of sea ducks

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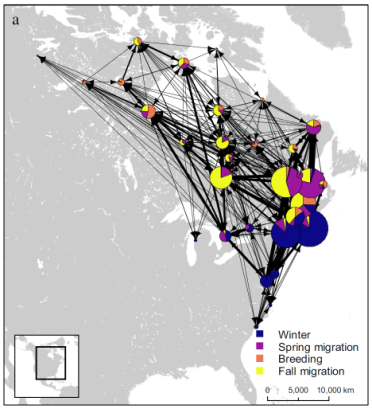
Conservation of long-distance migratory species poses unique challenges. Migratory connectivity, that is, the extent to which groupings of individuals at breeding sites are maintained in wintering areas, is frequently used to evaluate population structure and assess use of key habitat areas. However, for species with complex or variable annual cycle movements, this traditional bimodal framework of migratory connectivity may be overly simplistic. Like many other waterfowl, sea ducks often travel to specific pre- and post-breeding sites outside their nesting and wintering areas to prepare for migration by feeding extensively and, in some cases, molting their flight feathers. These additional migrations may play a key role in population structure, but are not included in traditional models of migratory connectivity. Network analysis, which applies graph theory to assess linkages between discrete locations or entities, offers a powerful tool for quantitatively assessing the contributions of different sites used throughout the annual cycle to complex spatial networks. We collected satellite telemetry data on annual cycle movements of 672 individual sea ducks of five species from throughout eastern North America and the Great Lakes. From these data, we constructed a multi-species network model of migratory patterns and site use over the course of breeding, molting, wintering, and migratory staging. Our results highlight inter- and intra-specific differences in the patterns and complexity of annual cycle movement patterns, including the central importance of staging and molting sites in James Bay, the St. Lawrence River, and southern New England to multi-species annual cycle habitat linkages, and highlight the value of Long-tailed Ducks (*Calengula haemalis*) as an umbrella species to represent the movement patterns of multiple sea duck species. We also discuss potential applications of network migration models to conservation prioritization, identification of population units, and integrating different data streams.

Published in: **Ecological Applications 29:e01919 https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1919 (2019)**



Movement network for five species of sea ducks (Black Scoter, Surf Scoter, White-winged Scoter, Long-tailed Duck, and *dresseri* Common Eider) by season within the annual cycle, 2002–2017. (a) All movements and proportional occupancy of nodes by season.

Origins of harvested Mallards from Lake St. Clair, Ontario: a stable isotope approach

Mathew D. Palumbo[1,2,*], Douglas C. Tozer[2], Keith A. Hobson[3]

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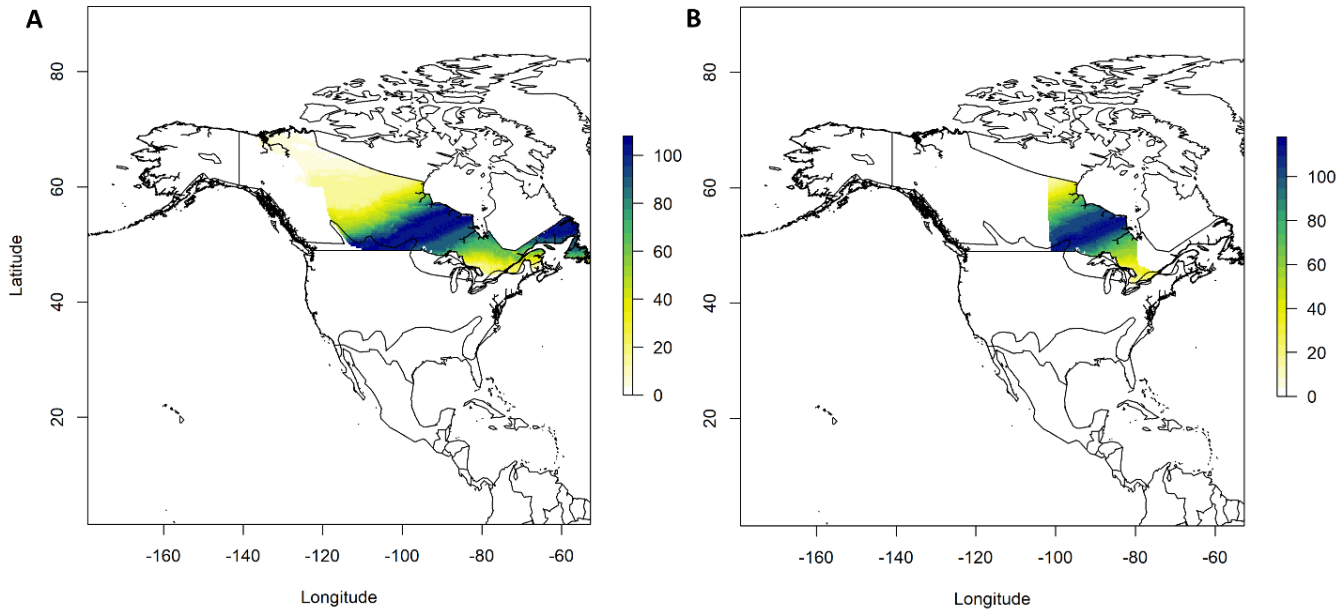
[3] Western University
**** Long Point Waterfowl and Wetlands Research Program postdoctoral researcher***

Determining origins of waterfowl is important for establishing appropriate management and conservation strategies. In North America, much information is available from long-term mark-recapture programs involving banding on breeding or molting grounds. However, this approach is less able to identify origins of individuals across broad areas where banding effort is low. We used stable hydrogen isotope analyses of feathers from Mallards (*Anas platyrhynchos*) harvested during the 2014−15 and 2015−16 hunting seasons at Lake St. Clair (LSC), Ontario, Canada (*n* = 237 individuals). We created a feather isoscape and applied Bayesian assignment approaches involving priors related to probability of origin based on banding data from the Central, Mississippi, and Atlantic flyways. The proportion of hatch-year Mallards produced locally (i.e., at the same latitude as LSC), as opposed to farther north or south of LSC, ranged from 13.1% to 22.0% with almost no difference by sex. The proportion of after-hatch-year (AHY) birds that molted locally ranged from 3.5% to 13.5%, with slightly fewer local AHY females compared to local AHY males. Nearly all birds that did not originate locally came from latitudes to the north of LSC, and only two from south of LSC. Whether this pattern is representative of locations in the Great Lakes beyond our study area is unknown, but is of great relevance for harvest management. As such, we are expanding our study with plans to examine isotope-based origins of Mallards and other harvested waterfowl species at locations throughout the Great Lakes region. Due to its unique potential to fill knowledge gaps, we advocate the use of the stable isotope technique in the management of North American waterfowl and encourage more research in this area.

Published in: **Avian Conservation and Ecology 14:3 https://doi.org/10.5751/ACE-01389-140203 (2019)**



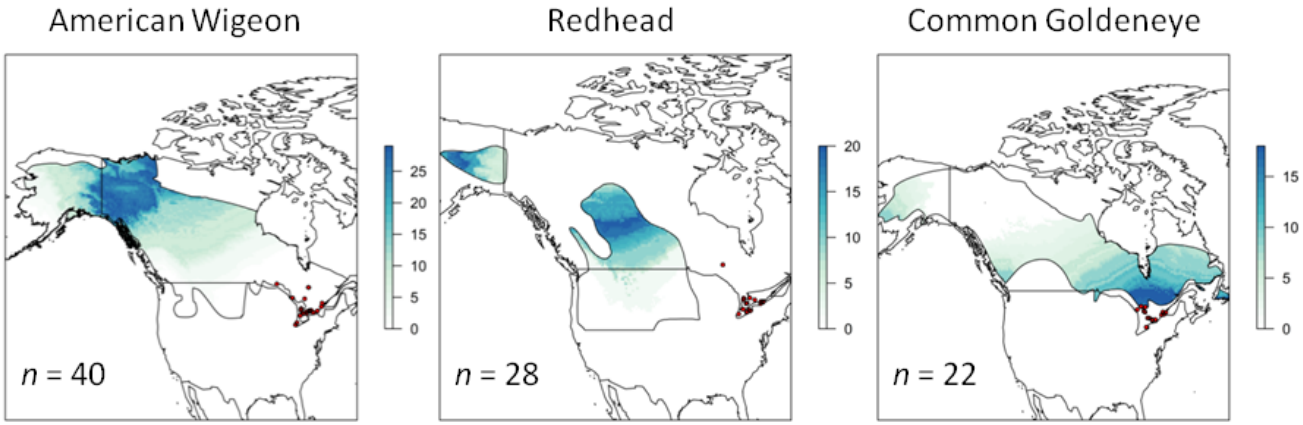
Depiction of probable origins of immigrant Mallards harvested along the eastern shore of Lake St. Clair (LSC), Ontario, 2014-2016. Legend number corresponds to number of individuals assigned at each pixel based on a 2:1 odds ratio criterion (see Methods). Figure A depicts origins without the application of a Bayesian prior. Figure B is the depiction constrained by band recovery probabilities for the Central (0.017), Mississippi (0.829), and Atlantic (0.154) flyways.

Migratory connectivity of waterfowl using the Great Lakes

Jackson Kusack[1,2,*], Douglas C. Tozer[2], Simon J. Bonner[1], Keith A. Hobson[1]

[1] Western University
[2] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
**** Long Point Waterfowl and Wetlands Research Program PhD student***

Waterfowl harvest regulations in North America are based on careful scrutiny of demographics of breeding, staging, and overwintering birds within each of four major migratory flyways. A diverse suite of information flows into this decision-making process guided by the North American Waterfowl Management Plan. The information includes extensive abundance and habitat monitoring data, as well as data from various extrinsic sources such as banding, satellite tags, and radio-transmitters, and various intrinsic sources including genetic markers and isotopes. Each of these sources of information has advantages and disadvantages depending on the research question being pursued. Taken together, they generally form for most species a reasonable understanding of which populations are being harvested, and in some cases by how much, although numerous knowledge gaps remain. Analysis of stable hydrogen isotopes in feathers of harvested waterfowl has proven to be useful and efficient for identifying harvested populations at broad scales, and in the Great Lakes region has been examined to a certain extent in Mallards, American Black Ducks, and Lesser Scaup, but to our knowledge not in other species. In this study, we analyze stable hydrogen isotope signatures of flight feathers of males and females of both hatch-years and after-hatch-years of multiple waterfowl species harvested throughout the Great Lakes region. Our main goal is to better define natal and molt origins of waterfowl harvested in the Great Lakes. We also examine origins as a function of sex, age, date, and breeding pair abundance. We include information from band recoveries as informative priors in models, and range extent as a constraint on model output. Results from the study will enhance knowledge of the origins of harvested waterfowl in the Great Lakes, and will improve the ability of waterfowl managers to make informed decisions when setting annual harvest quotas.



Preliminary depictions of probable origins of individuals of three different duck species harvested in southern Ontario. Darker blue shows most probably areas of origin; red dots show harvest locations; sample size of the number of individuals is also shown (*n*).

Origins of harvested American Black Ducks: a stable isotope approach

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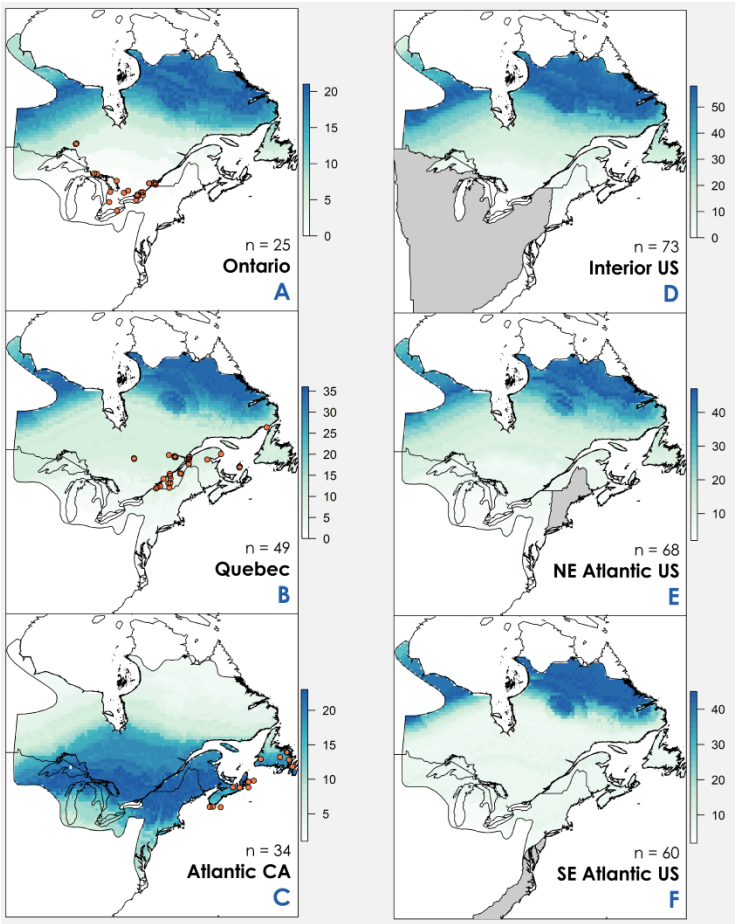
The international adaptive harvest management strategy for the American Black Duck (*Anas rubripes*) uses information from harvested and banded individuals and assumes that they originate from the same regions located throughout the species' range. However, various lines of evidence suggest otherwise. As a result, the 'flyover' hypothesis has been proposed, which states that Canadians are more likely to harvest birds from the southern portion of the breeding range and birds in the northern boreal are more likely to be harvested by Americans. To test the flyover hypothesis, we used stable-hydrogen isotope analysis of flight feathers of harvested individuals to estimate origins. We chose this method because it allows for the tracking of migratory waterfowl without the need for extrinsic markers (such as leg bands). This is because stable hydrogen values within feathers reflect those of the site of feather growth, which are in turn related to patterns of stable hydrogen in precipitation along a broad latitudinal gradient. This aspect of the method was critical for testing the flyover hypothesis because banding operations are almost entirely absent throughout the northern portion of the American Black Duck's breeding range. Using preliminary data from the 2017-2018 hunting season, we found that hatch-years harvested in the US, Ontario, and Quebec likely originated in the northern boreal, whereas individuals harvested in Atlantic Canada had more southerly or local origins. Origins of hatch-years harvested in Atlantic Canada provide preliminary support for the flyover hypothesis. It is unclear why the same pattern is not shown by individuals harvested in Ontario and Quebec. We will continue to investigate patterns in origins by increasing our sample size within and across hunting seasons, including additional covariates in assignment models, and by better refining our estimates of origin with additional data.



Probabilistic origins of harvested hatch-year American Black Ducks separated by region of harvest (A–Ontario, B–Quebec, C–Atlantic Canada, D–Interior US region, E–North Atlantic US region, F–South Atlantic US region). Colour gradients represent the number of individuals assigned to each pixel based on a 2:1 odds ratio. Harvest points for Canadian provinces are represented by red dots, whereas harvest points for US states are represented by black duck management regions shown as grey polygons.

Origins of Blue-winged Teal harvested in Ontario and Prairie Canada based on stable isotopes: implications for sustainable management

Matthew D. Palumbo[1,*], Jackson W. Kusack[1,2,*], Douglas C. Tozer[1], Shawn W. Meyer[3], Christian Roy[3], Keith A. Hobson[2,3]

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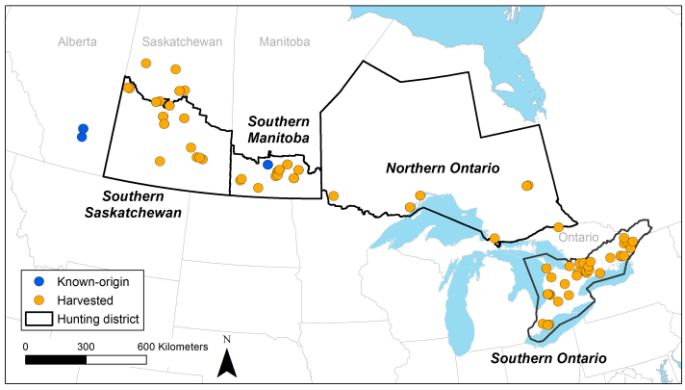
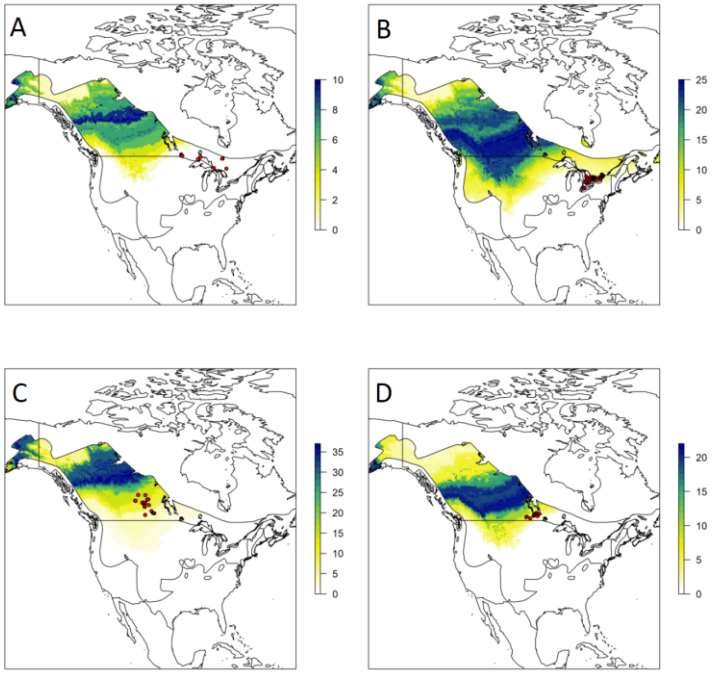
**** Long Point Waterfowl and Wetlands Research Program postdoctoral researcher / PhD student***

To achieve effective conservation and management of migratory game birds it is important to determine origins of harvested individuals. Banding has provided much information on origins, but for most species, it is nearly impossible to obtain unbiased samples of marked individuals that are representative of all potential breeding areas. To build on previous knowledge of harvest derivation based on banding and to assist with regulatory decisions, we used stable hydrogen-isotope (δ2H) techniques to estimate natal and molt origins of Blue-winged Teal (*Spatula discors*) harvested throughout parts of southern Canada. We found that birds harvested in southern Saskatchewan, southern Manitoba, northern Ontario, and southern Ontario likely originated in the prairie and boreal plains regions of Canada and the United States, which is the core production area for the species. There was low probability that a small number of birds harvested in Ontario also originated in Ontario. Our findings differed from those of a previous study based on band recovery data, which concluded that a much larger proportion of birds harvested in Ontario originated much closer to Ontario, and well outside and to the east of the core production area on the prairies. We found that nearly all birds harvested in Ontario in our study likely originated from areas outside of the province. In the spirit of adaptive management, if an early teal hunting season is implemented in Ontario, we recommend that it is used initially as an experimental season to better understand origins of harvested birds. As such, it would be an opportunity to compare contemporary harvest derivation estimates based on pre-season banding with origins based on feather δ2H. Together, these approaches likely offer the best information available on origins of harvested birds for regulatory decision making.



Locations of known-origin (n = 17) and harvested (n = 144) Blue-winged Teal. Note that some of the locations overlap on the map. Also shown is the extent of each of four hunting districts: southern Saskatchewan (Saskatchewan Hunting District No. 2), southern Manitoba (Manitoba Hunting Zone No. 4), northern Ontario (Ontario Hunting District No. 2), and southern Ontario (Ontario Hunting District No. 4).



Depiction of likely origin of Blue-winged Teal harvested in (A) northern Ontario, (B) southern Ontario, (C) southern Saskatchewan, and (D) southern Manitoba, Canada during the 2014/2015 and 2017/2018 hunting seasons. Locations where individuals were harvested are shown by red dots. Legend number corresponds to the number of individuals assigned at each pixel based on a 2:1 odds ratio. Polygon outlines the breeding range of Blue-winged Teal in North America (BirdLife International 2017).

Mallard resource selection trade-offs in a heterogeneous environment during autumn and winter

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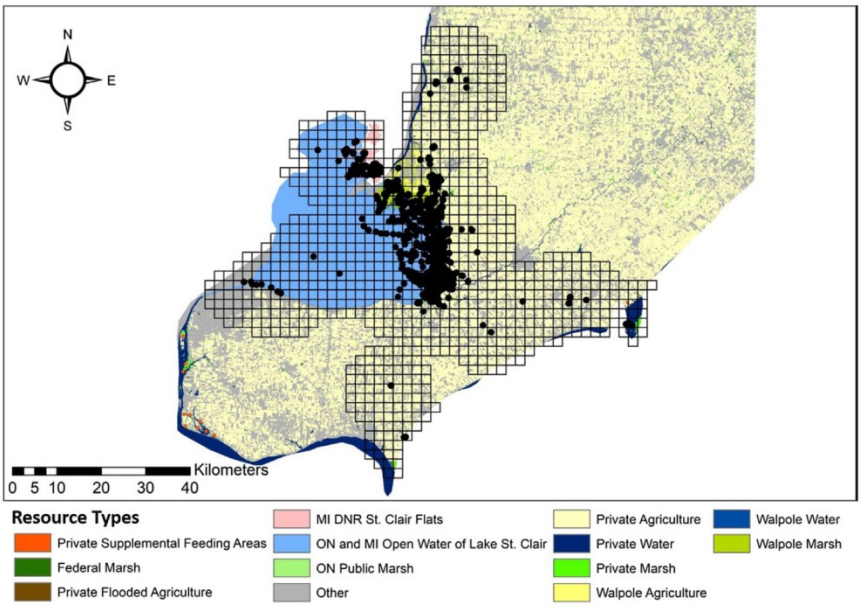
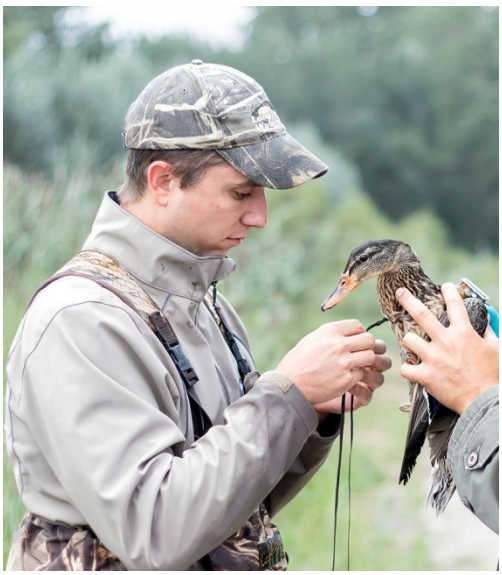
Animals select resources to maximize fitness but associated costs and benefits are spatially and temporally variable. Differences in wetland management influence resource availability for ducks and mortality risk from duck hunting. The local distribution of the Mallard (*Anas platyrhynchos*) is affected by this resource heterogeneity and variable risk from hunting. Regional conservation strategies primarily focus on how waterfowl distributions are affected by food resources during the non-breeding season. To test if Mallard resource selection was related to the abundance of resources, risks, or a combination, we studied resource selection of adult female Mallards during autumn and winter. We developed a digital spatial layer for Lake St. Clair, Ontario, Canada, that classified resources important to Mallards and assigned these resources a risk level based on ownership type and presumed disturbance from hunting. We monitored 59 individuals with GPS back-pack transmitters prior to, during, and after the hunting season and used discrete choice modeling to generate diurnal and nocturnal resource selection estimates. The model that classified available resources and presumed risk best explained Mallard resource selection strategies. Resource selection varied within and among seasons. Ducks selected for federal, state and private managed wetland complexes that provided an intermediate or relatively greater amount of refuge and foraging options than public hunting areas. Across all diel periods and seasons, there was selection for federally managed marshes and private supplemental feeding refuges that prohibited hunting. Mallard resource selection demonstrated trade-offs related to the management of mortality risk, anthropogenic disturbances, and foraging opportunities. Understanding how waterfowl respond to heterogeneous landscapes of resources and risks can inform regional conservation strategies related to waterfowl distribution during the non-breeding season.

Published in: **Ecology and Evolution 9:1798–1808 https://doi.org/10.1002/ece3.4864 (2019)**



The GPS fixes of the local movements and the grid cells of all resource units used to determine adult female Mallard resource selection within the Lake St. Clair region.



Matt attaching a transmitter to a hen Mallard. Photo by Mike Moynihan.

Hierarchical modeling to identify habitat associations of wetland-obligate birds in Great Lakes coastal wetlands

Lisa H. Elliott[1,2,*], Annie Bracey[1], Gerald J. Niemi[1], Douglas H. Johnson[1], Thomas Gehring[3], Erin E. Gnass Giese[4], Greg Grabas[5], Robert W. Howe[4], Christopher J. Norment[6], Douglas C. Tozer[2]

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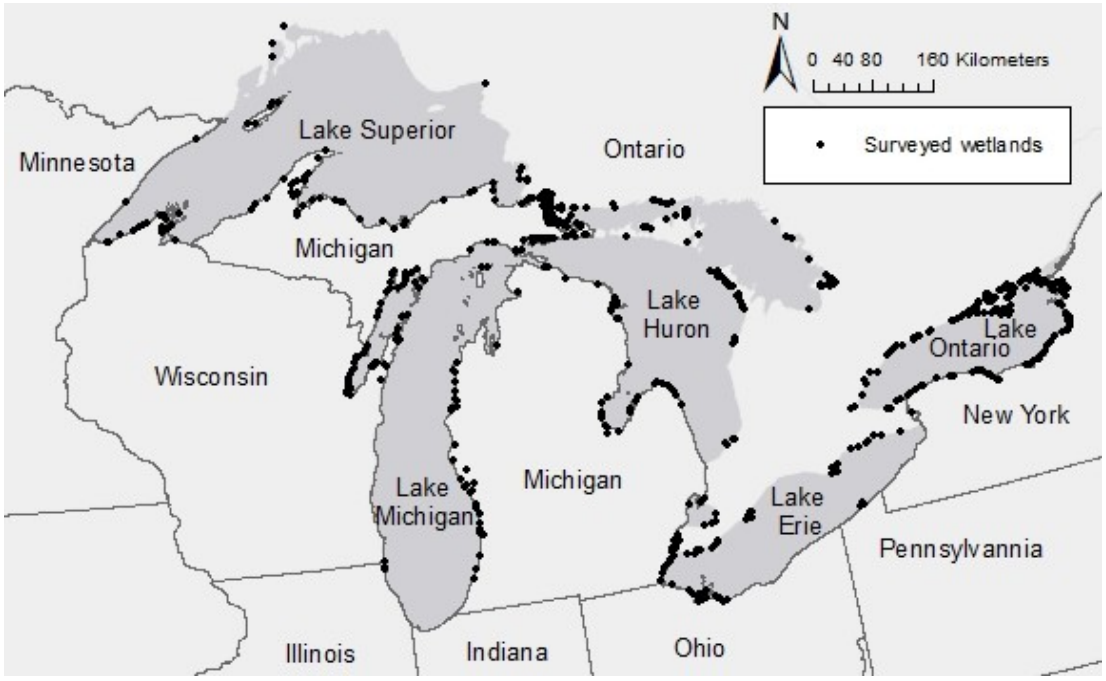
**** Long Point Waterfowl and Wetlands Research Program PhD student***

To better understand the habitat associations of rare or declining wetland birds in the North American Great Lakes basin, we used seven years (2011-2017) of bird survey data from the Great Lakes Coastal Wetland Monitoring Program and remotely sensed landscape data to develop single-species multi-scale occupancy models for eight species of regional conservation concern. The hierarchical models account for separate processes of occurrence and detection, while simultaneously accounting for spatial and temporal replication. Our results for the secretive marsh birds indicate that Pied-billed Grebe (*Podilymbus podiceps*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), Common Gallinule (*Gallinula galeata*), Least Bittern (*Ixobrychus exilis*), and American Bittern (*Botaurus lentiginosus*) are primarily eurytopic species, capable of occupying a broad range of conditions. While these species were uncommonly encountered, our hierarchical models suggest that individual species occupied 35-68% of surveyed wetlands during at least one year of the study. Detection probabilities were consistently above 80% for all six of these species and were enhanced by active listening periods using broadcast calls for all but American Bittern. Anthropogenic influences such as human population density, watershed-scale percentages of agriculture and development, and percentages of cropland and development within 200-m of a given point had little effect on the site-level and point-level occupancy for these species. These results suggest that wetland loss is more detrimental to these species than habitat degradation, and thus protection of any Great Lakes coastal wetlands will be a valuable contribution towards conservation of these eurytopic species.



Distribution of 641 coastal wetlands in the Great Lakes basin that were sampled for birds in 2011-2017 as part of the random sample of wetlands in the Great Lakes Coastal Wetland Monitoring Program.

Regional modeling of habitat associations for wetland-obligate birds in the Upper Midwest and Great Lakes basin

Lisa H. Elliott[1,2,*], Annie Bracey[1], Gerald J. Niemi[1], Douglas H. Johnson[1], Thomas Gehring[3], Erin E. Gnass Giese[4], Greg Grabas[5], Robert W. Howe[4], Christopher J. Norment[6], Douglas C. Tozer[2]

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[4] Cofrin Center for Biodiversity, University of Wisconsin – Green Bay
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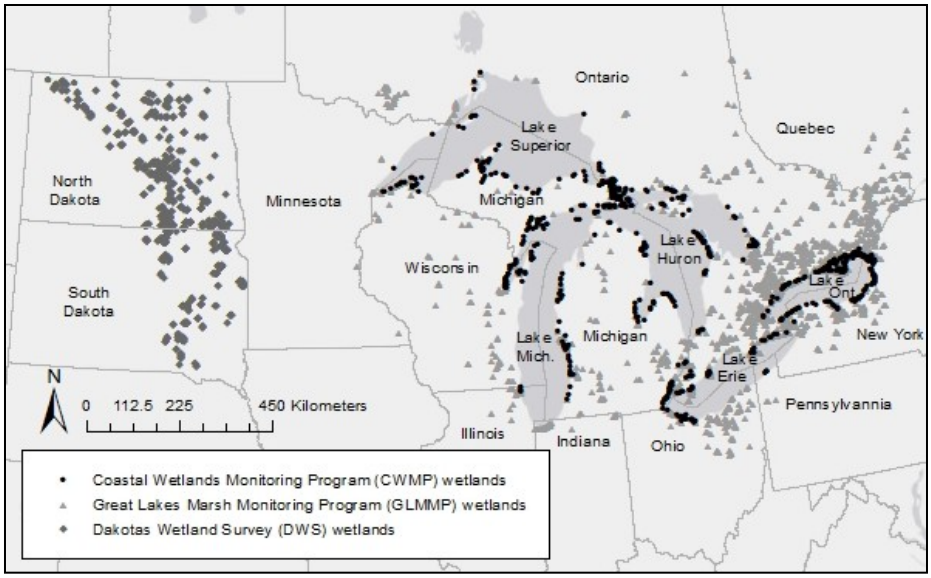
[6] The College at Brockport, State University of New York
**** Long Point Waterfowl and Wetlands Research Program PhD student***

Species exhibit regionally specific habitat associations, but it remains unclear how well models of species density based on habitat associations developed in one region may predict the density of the same species elsewhere. Three existing North American marsh breeding bird survey programs in 1) Great Lakes coastal wetlands, 2) inland Great Lakes wetlands, and 3) the Prairie Pothole Region offer an opportunity to identify characteristics of species-specific habitat use by obligate wetland-breeding birds that are consistent across regions and to test whether region-specific models are transferrable across regions. We developed Poisson models of species density for four species of secretive marsh birds: Pied-billed Grebe (*Podilymbus podiceps*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), and American Bittern (*Botaurus lentiginosus*). We developed independent, species-specific models for each of the three study regions and used adjusted pseudo-R^2 values to compare the amount of variation explained by each model when it was applied to data collected in its region and to data collected in the other regions. Habitat models consistently explained more variation in the density of a species in that respective region than did habitat models created elsewhere. However, certain habitat characteristics, such as wetland area, were consistently important across regions. When we applied a model developed in one region to data collected in another region, we found that most models still had a substantial amount of explanatory power, and models created from inland Great Lakes wetland data had the highest median levels of explanatory power when applied to other regions. Therefore, we suggest that conservation planning should emphasize the use of regionally specific habitat association models whenever possible; but, in the absence of regional data, it is feasible to apply models of habitat associations developed in one region in another region. Additionally, we found that median explanatory power was higher when local-scale habitat characteristics were included in models, which suggests that, whenever possible, these region-specific models should be based on a combination of local and landscape-scale habitat characteristics.



Distribution of wetlands surveyed as part of three monitoring programs: the Great Lakes Coastal Wetlands Monitoring Program (CWMP) and the Great Lakes Marsh Monitoring Program (GLMMP) in the Great Lakes basin and the Dakotas Wetland Survey (DWS) dataset in the Prairie Pothole Region of North and South Dakotas.

Species-habitat relationships and priority habitat areas for marsh-breeding birds in southern Ontario

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[1] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
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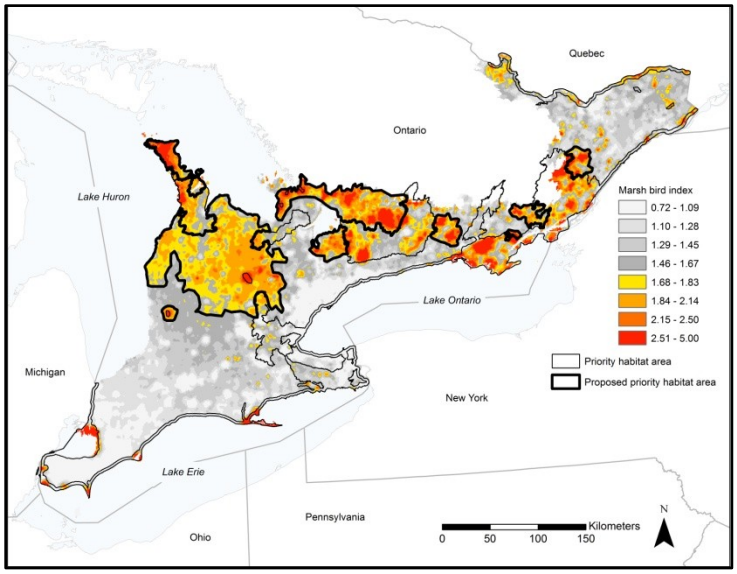
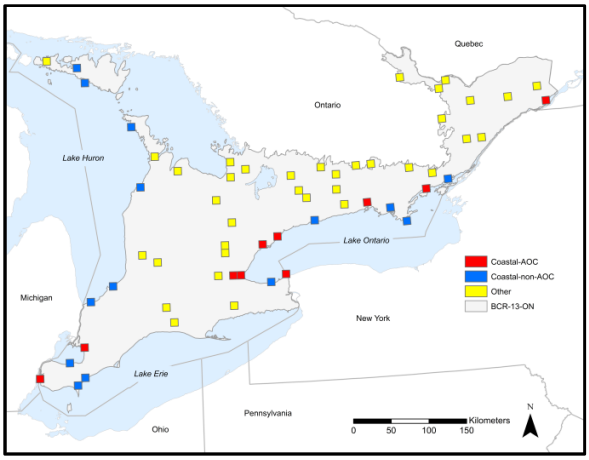
[3] Ducks Unlimited Canada

We used occupancy modeling, a regional prioritization scheme, and data from Bird Studies Canada's Great Lakes Marsh Monitoring Program (*n* = 180 randomly-chosen, spatially-balanced sample sites surveyed in each of 3 years) to describe species-habitat relationships and identify priority habitat areas for seven elusive, obligate, marsh-breeding bird species in southern Ontario, Canada: American bittern (*Botaurus lentiginosus*), common gallinule (*Gallinula galeata*), least bittern (*Ixobrychus exilis*), marsh wren (*Cistothorus palustris*), pied-billed grebe (*Podilymbus podiceps*), sora (*Porzana carolina*), and Virginia rail (*Rallus limicola*). Given these species respond to land cover at widely-varying spatial scales, we initially identified the most informative scale (buffer = 100 m, 200 m, 400 m, 800 m, 1,600 m, 3,200 m, or 6,400 m) for marsh, urban, agricultural, and forest cover to increase model performance. We also considered climate variables, whether sample sites were along a Great Lakes shoreline or inland, and covariates influencing detection. We did not consider local-scale variables (i.e., < 100 m). As expected, we found that occupancy was best explained by land cover at a wide range of spatial scales depending on the species. Six species increased with increasing marsh cover within 200–6,400 m; 2 decreased with increasing urban cover within 400–3,200 m; 3 decreased and 1 increased with increasing agricultural cover within 100–3,200 m; and 4 decreased and 1 increased with increasing forest cover within 200–6,400 m. Only two species responded to climate variables and 1 to coastal versus inland. We combined predictions from the best model for each of five species with reasonably good model fit to identify priority areas for future wetland conservation work. Thirty-one percent of priority areas were already located within existing priority areas based on waterfowl. We recommend that the Ontario Eastern Habitat Joint Venture, the regional body primarily responsible for bird conservation in the region, expand its wetland conservation work into the remainder of the priority areas. According to available data, at least 30,766 ha of marsh exist within the new priority areas, and with appropriate additional funding, conservation projects in these priority marshes will be an effective step towards all-bird conservation in the region. Some restoration activities outside but adjacent to our new priority areas will also be important for rebuilding marshes for these species across this intensively farmed and developed region.



Predicted marsh-breeding bird occupancy index throughout the Ontario portion of Bird Conservation Region 13. Hotspots are shown with warm colours (yellow, orange, red). Existing priority habitat areas based on waterfowl are shown (Priority habitat area) along with recommended priority habitat areas based on the marsh-breeding bird occupancy index (Proposed priority habitat area).



Squares (each 10 x 10 km; *n* = 60 squares) containing 100-m-radius circular plots referred to as sites (not shown; 1-8 sites per square; *n* = 190 sites), selected using a two-stage, randomly stratified, cluster procedure throughout the Ontario portion of Bird Conservation Region 13 (BCR-13-ON). Strata consisted of squares containing Great Lakes coastal marshes located within Great Lakes Areas of Concern (Coastal-AOC), Great Lakes coastal marshes located outside of Great Lakes Areas of Concern (Coastal-non-AOC), and squares containing neither of these wetland types (Other).

Bird community response to changes in wetland extent and lake level in Great Lakes coastal wetlands

Tara Hohman[1,2,*], Erin E. Gnass Giese[1], Amy T. Wolf[1], Robert W. Howe[1], Gerald J. Niemi[3], Douglas C. Tozer[4], Thomas M. Gerhing[5], and Christopher J. Norment[6]

[1] Cofrin Center for Biodiversity, University of Wisconsin – Green Bay
[2] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[3] Natural Resources Research Institute, University of Minnesota – Duluth
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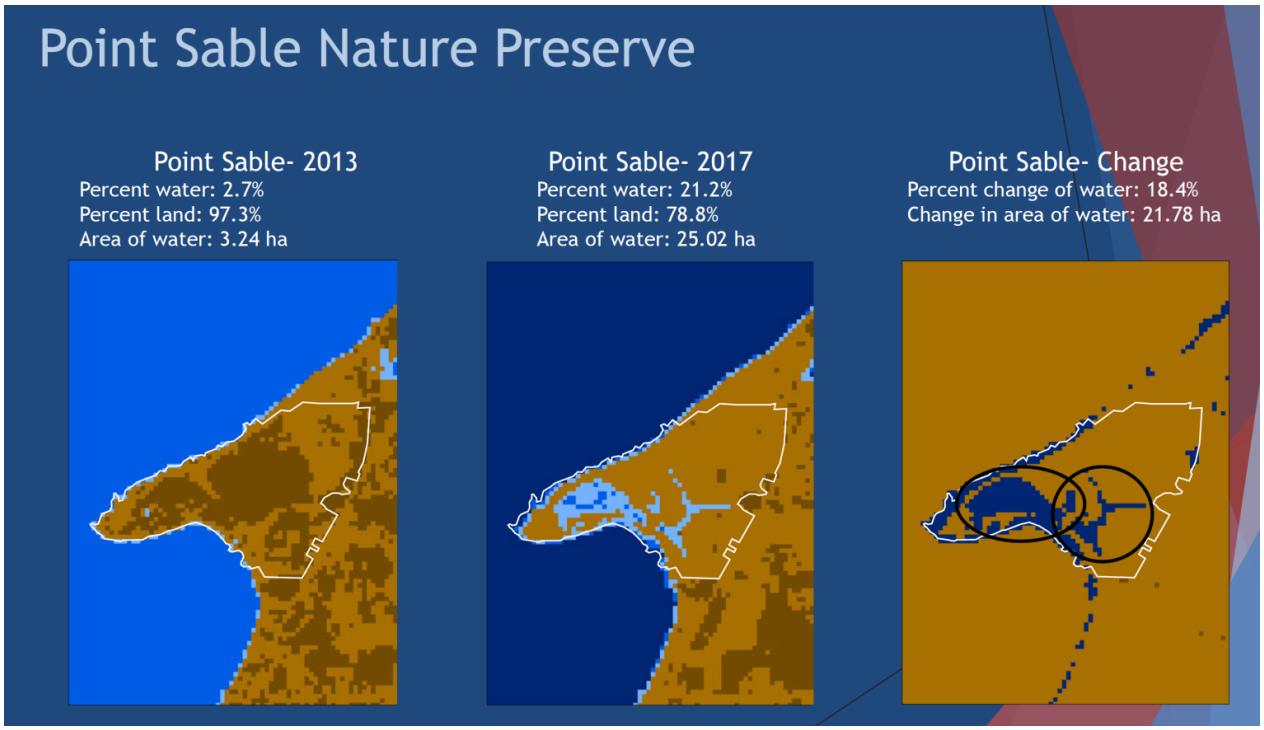
[6] The College at Brockport, State University of New York
**** Long Point Waterfowl and Wetlands Research Program MSc student***

Coastal wetlands in the Laurentian Great Lakes undergo frequent, sometimes dramatic physical changes at varying spatial and temporal scales. Changes in lake levels and subsequent changes in the juxtaposition of vegetation and open water greatly influence biota that use coastal wetlands. Several regional studies have shown that changes in vegetation and lake levels lead to predictable changes in the composition of coastal wetland bird communities. We report new findings of wetland bird community changes at a much broader scale, covering the entire Great Lakes. Our results indicate that water extent and interspersion increased in coastal wetlands across the Great Lakes basin between low (2013) and high (2018) lake-level years, although variation in the magnitude of change occurred within and among lakes. Increases in water extent and interspersion resulted in a general increase in marsh-obligate and marsh-facultative bird species richness across the basin. Species like American Bittern, Common Gallinule, American Coot, Sora, Virginia Rail, and Pied-Billed Grebe were significantly more abundant during high water years. Lake Huron and Lake Michigan showed the greatest increase in water extent and interspersion among the five Great Lakes, while Lake Michigan showed the greatest increase in marsh-obligate bird species richness. These results suggest that effective management, restoration, and assessment of wetlands must account for fluctuations in lake levels. Although high lake levels generally provide the most favorable conditions for wetland bird species, variations in lake levels and bird species occurrences produce an ecosystem that is both spatially and temporally dynamic.



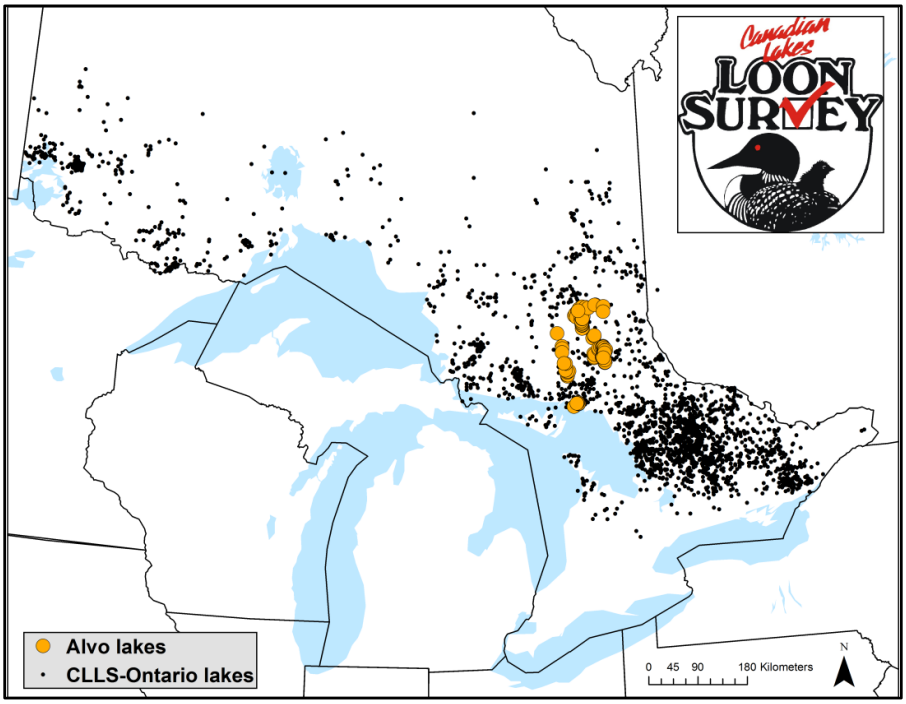
An example of measuring change in extent of open water in a Great Lakes coastal wetland between a low water year (2013) and a high water year (2017) to be used as an explanatory variable in models of marsh breeding bird occurrence and abundance.

Recovery of Common Loon populations on acid-stressed Ontario lakes

Kristin Bianchini[1,2,*], Douglas C. Tozer[2], Robert Alvo[3], Mark L. Mallory[1]

[1] Acadia University
[2] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[3] Ottawa, Ontario
**** Long Point Waterfowl and Wetlands Research Program postdoctoral researcher***

The Common Loon (*Gavia immer*) is a ubiquitous, large water bird found on lakes across Canada, and is a cherished symbol of wilderness and cottage country. Studies initiated in the 1980s found that breeding success of loons was negatively affected by acidification of lakes, along with other threats like mercury in food chains, and cottage development on lakes. This project will use loon survey data collected at different scales over 30+ years from Ontario (Canadian Lakes Loon Survey [CLLS], Canadian Wildlife Service [CWS] water bird monitoring program, Rob Alvo's central Ontario lake survey), along with novel loon survey and water chemistry sampling, to test whether lake chemistries have changed in response to Canadian and American reductions in acidifying emissions, and whether loon reproduction has changed over this period. Using the CLLS database, we will examine whether there has been a directional change in loon reproductive success across the province, and given knowledge of many other variables (water chemistry, shoreline development, bathymetry), will permit a broad analysis of the relative impact of water chemistry compared to other parameters. The CWS dataset will allow for a much more regionalized examination of loon reproduction, specific to central Ontario, and with strong companion data on fish presence and water chemistry status and trends for those lakes. Finally, the Alvo dataset is the best, most comprehensive tracking of loon reproduction on the same lakes over the years and will permit a precise comparison of inter-annual variation. We will resurvey as many of the Alvo and CWS lakes as possible, and will include new water sampling (as many of these lakes won't have been sampled in more than a decade), so we will provide up-to-date assessments of change in water chemistry and loon reproduction. The project will deliver the most state-of-the-art analysis of the relationship between (possibly) recovering lakes and loon breeding success, the possible confounding effects of cottage development, and other anthropogenic factors, and novel information on changes in water chemistry for many of the sites. The implications are great for environmental health of lakes across the northern Great Lakes region, and for a Canadian iconic species, as a test of the long-term response of aquatic environments to government actions on acid rain.



Locations of lakes targeted for intensive field study of breeding loons and lake chemistry (Alvo lakes) and lakes being used in broader-scale analyses (CLLS-Ontario lakes).

Standardizing marsh breeding bird point count data from humans and acoustic recorders

Laura Stewart[1,2,*], Kiel L. Drake[2], Laura A. Tranquilla[2], Douglas C. Tozer[1]

[1] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
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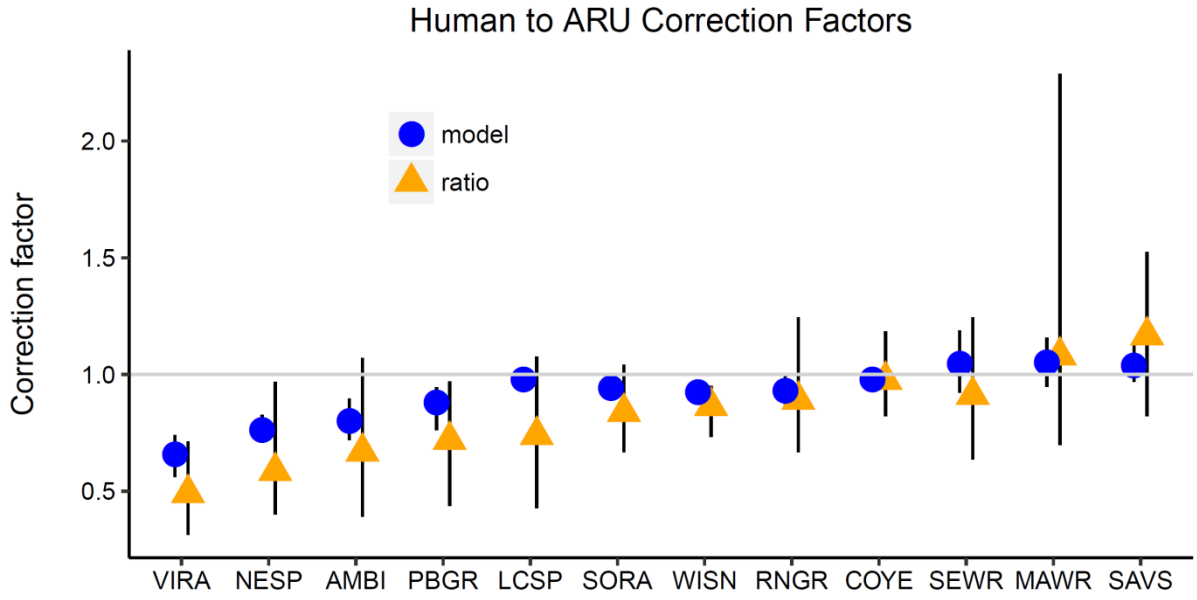
**** Long Point Waterfowl and Wetlands Research Program research intern***

Autonomous recording units (ARUs) are increasingly being used to survey marsh breeding birds compared to a decade ago. The units are weatherproof and can be left in place in the field to record at pre-programmed times. The recordings are interpreted later by humans or automated bird-call-recognizing software. The units afford several advantages, including operation by most field personnel, compared to relatively hard-to-find observers with highly skilled bird call identification knowledge, and the ability to survey over water at night when detection of many marsh breeding bird species is highest, which avoids night time safety issues. Given the use of ARUs continues to increase, it is important to develop the means to combine ARU-collected and human-collected survey data together for analysis. This is especially important for marsh breeding bird species because occurrence generally tends to be very low, so combining ARU-derived and human-derived point count data maximizes sample sizes to achieve higher statistical power. It also allows contemporary data to be combined with historical data, which tends to be entirely human-derived—having been collected prior to the widespread use of ARUs. In this study, we will develop species-level correction factors to transform ARU-collected marsh breeding bird point count data so it is comparable to human-collected data. We will base our analysis on several hundred human point counts simultaneously paired with ARU recordings that will be interpreted later by the same human observers. Point counts will be conducted by technicians during the breeding season in 2018 throughout Prairie Canada, the lower Great Lakes, and the Maritime Provinces as part of Bird Studies Canada's Marsh Monitoring Program. Observers will be blind to the date and location of the recordings at the time of interpretation. The analysis will use generalized linear mixed models to develop the correction factors, according to a process that has already been developed and vetted using boreal songbird data. We expect that ARUs will be effective in detecting individuals of targeted marsh breeding bird species, but will consistently detect lower abundance compared to human observers due to absence of visual information and shorter detection distances. The results will be immediately useful for advancing conservation of marsh breeding birds throughout southern Canada and elsewhere.



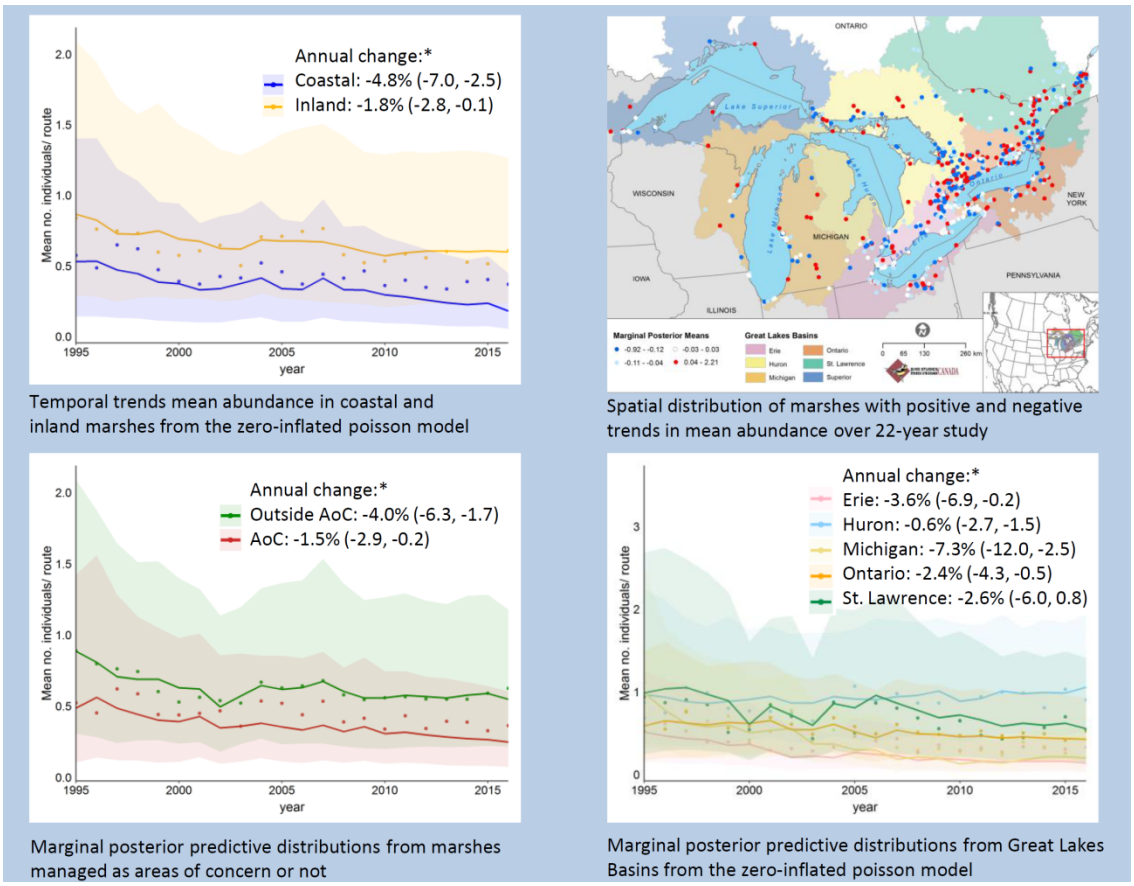
Preliminary human-to-ARU correction factors for some marsh breeding bird species. Error bars are 95% CIs. Factors are estimated in two ways: via model coefficients (model) and ratios of mean counts (ratio). VIRA = Virginia Rail; NESP = Nelson's Sparrow; AMBI = American Bittern; PBGR = Pied-billed Grebe; LCSP = LeConte's Sparrow; WISN = Wilson's Snipe; RNGR = Red-necked Grebe; COYE = Common Yellowthroat; SEWR = Sedge Wren; MAWR = Marsh Wren; SAVS = Savanah Sparrow.

Modeling 22-year trends in marsh breeding bird abundance using the spatially explicit INLA approach

Sonya Richmond[1], Tara L. Crewe[1], Douglas C. Tozer[2]

[1] Bird Studies Canada
[2] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada

Temporal trends in abundance are used to assess the status of wildlife populations, and are particularly useful when they are accurate and at spatial scales relevant for conservation. We used the INLA (Integrated Nested Laplace Approximation) approach to model trends in the mean abundance of seven marsh breeding bird species at various spatial scales in the Great Lakes Basin using data collected through Bird Studies Canada's Great Lakes Marsh Monitoring Program (1995-2016). Separate trends were calculated for American Bittern (*Botaurus lentiginosus*), Black Tern (*Chlidonias niger*), Common Gallinlue (*Gallinula chloropus*), Least Bittern (*Ixobrychus exilis*), Pied-billed Grebe (*Podilymbus podiceps*), Sora (*Porzana carolina*), and Virginia Rail (*Rallus limicola*) in the Erie, Huron, Michigan, Ontario, and St. Lawrence lake basins; for Great Lakes coastal and inland marshes; and for marshes designated as Great Lakes Areas of Concern or not. These spatial scales link directly to reporting required under the Canada-US Great Lakes Water Quality Agreement, or are of interest to bird conservation organizations active in the region. Trends were highly variable among lake basins both within and among species. By contrast, negative trends were steeper at Great Lakes coastal locations compared to inland marshes for most species, and trends were more negative at locations within Areas of Concern compared to not for some species. The INLA approach provided a flexible, straightforward, and computationally inexpensive method of modelling trends for marsh birds at scales relevant for conservation in the Great Lakes Basin.



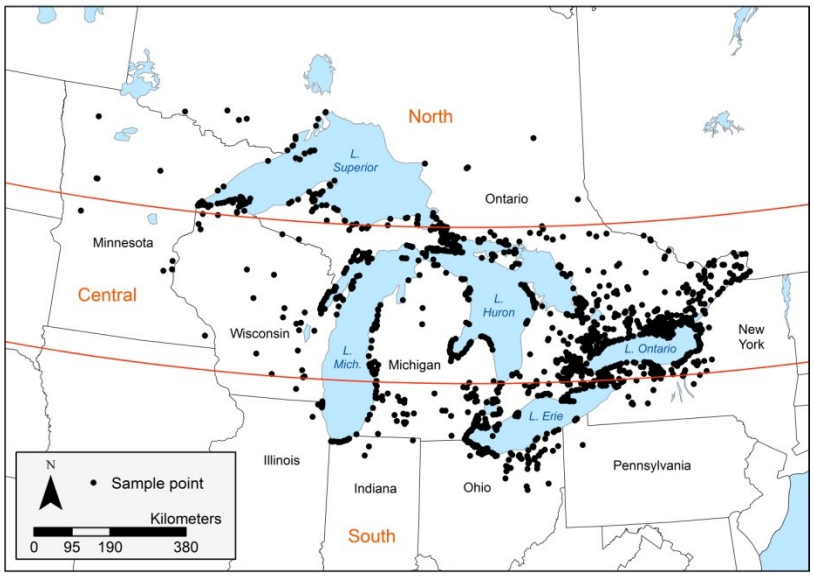
Model output for Virginia Rail, showing the types of predictions that are possible using the spatially explicit INLA approach.

Modeling detection probability to improve marsh-breeding frog surveys in the Great Lakes region

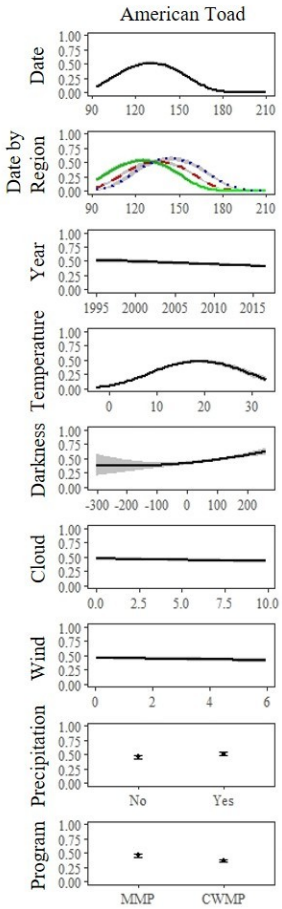
Hayley J. Roberts[1,*], Douglas C. Tozer[1]

[1] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
**** Long Point Waterfowl and Wetlands Research Program research intern***

Broad-scale population monitoring programs targeting marsh-breeding frogs (i.e., Anurans) have been active throughout the Great Lakes region for decades, including Bird Studies Canada's Marsh Monitoring Program and Central Michigan University's Great Lakes Coastal Wetland Monitoring Program. These efforts have provided high-quality, critical information on the temporal and spatial distribution and habitat use of each of the common-occurring frog species in the region. It is important to ensure, however, that detectability of each of the targeted species is maximized during surveys, which can be challenging to achieve simultaneously across multiple species due to high variation among species. We used data from over 47,000 point count surveys conducted across the Great Lakes region and species-specific occupancy models to describe the probability of detection of 8 commonly-occurring marsh-breeding frogs as a function of various covariates known to influence frog detection. We found that on average across most species detection was influenced by temperature, time of day, and date, whereas cloud, precipitation, and wind had little influence. The lack of influence of precipitation and wind was likely due to strict constraints imposed by field survey guidelines (little or no precipitation and wind < 20 km/hr). We use our results to suggest improvements to the standard multi-species frog survey field protocol currently used throughout the Great Lakes region. Our results are also useful for developing species-specific field survey guidelines when planning field studies focusing on single species or groups of a small number of species. As such, our results will improve monitoring of frogs at various scales across the Great Lakes and ultimately help further conservation of this important group of animals.



Locations of 47,000 frog point counts conducted throughout the Great Lakes region. Note that each point represents multiple point counts. Also shown are the north, central, and south regions as depicted in the Great Lakes Marsh Monitoring Program frog survey field manual.



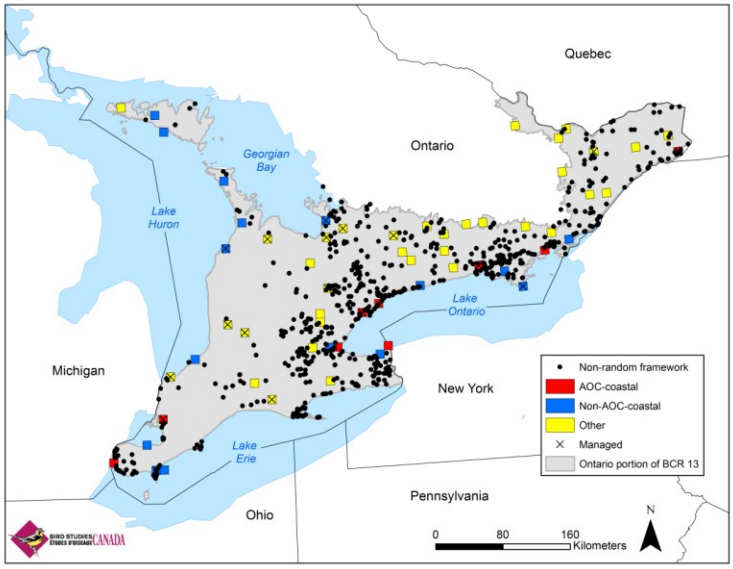
An example of results for one of the species, showing the probability of detection of American Toads as a function of several covariates.

Marsh bird monitoring by trained citizen scientists who choose sample sites is comparable to professionals at random sites

Douglas C. Tozer[1] and Rebecca L.M. Stewart[2]

[1] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[2] Bird Studies Canada

Marsh-breeding birds tend to be elusive and difficult to detect. As such, they require additional targeted survey effort in the field to accurately estimate species distributions, abundances, and associated indices of wetland health. Marsh bird monitoring programs often recruit citizen scientists to boost spatial and temporal survey coverage and associated statistical power. In the case of Bird Studies Canada's Great Lakes Marsh Monitoring Program (GLMMP), trained citizen scientists are permitted to choose sample sites opportunistically, which also substantially increases participation and fosters widespread public engagement and education. However, it is unknown whether this approach creates bias. To help answer this question, we modeled 1) species richness, 2) occupancy or abundance of 10 marsh-breeding bird species, 3) a bird-based index of ecological condition, and 4) local, wetland, and landscape-scale vegetation and habitat based on data collected by citizen scientists participating in the GLMMP compared to data collected by professionals who surveyed pre-assigned randomly-selected spatially-balanced sample sites using the same field protocol. The study took place in each of three years (2016-2018) throughout the Ontario portion of Bird Conservation Region 13. Overall, we found few differences between the two groups of observers. Both citizen scientists and professionals reported similar results for abundance of each of four common songbird species, species richness of bitterns and rails, and occupancy of five of the six elusive marsh-breeding bird species that the GLMMP is designed to track. Citizen scientists detected fewer non-target species than professionals, and citizen scientists selected relatively more Great Lakes coastal and relatively fewer inland sample sites compared to randomly-selected sample sites. A post-hoc exploratory analysis revealed that all but one bird-based difference between citizen scientists and professionals occurred only at inland sample sites and not at coastal sample sites, probably because sampling coverage was more similar between the two groups in coastal areas, showing that GLMMP citizen science data is especially reliable within coastal wetlands. Overall, our findings show that marsh bird monitoring by trained citizen scientists who choose sample sites is comparable to professionals who survey pre-assigned randomly-selected sample sites, provided that citizen scientists survey at or above the spatial and temporal frequency of survey coverage achieved during our study. Our study adds to the growing base of evidence supporting the validity, utility, and cost effectiveness of citizen science for tracking bird populations and other wildlife.



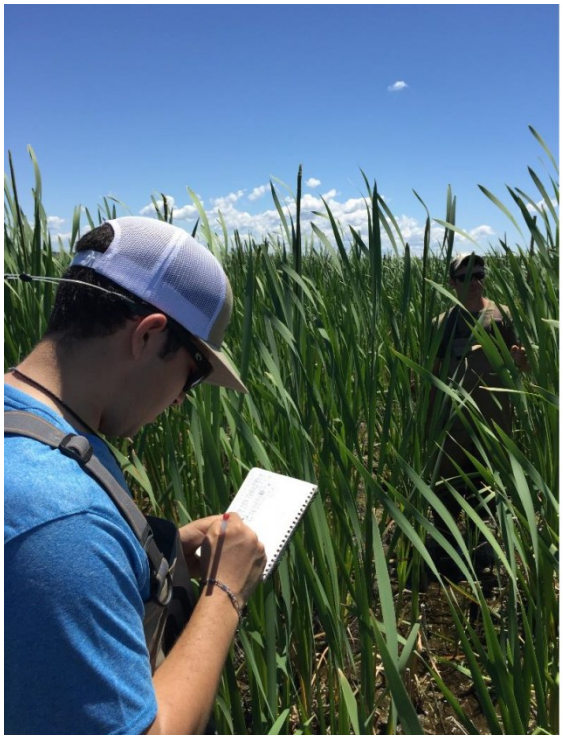
Survey site locations in the non-random framework, about 60% of which are surveyed each year, as well as 10 x 10 km squares containing survey site locations in the random framework. Random framework locations were stratified according to Great Lakes Area of Concern (AOC), Great Lakes coastal wetlands (coastal), and whether water level management was being performed (managed).

Ecological assessment of wetland management techniques in restored wetlands of the Montezuma Wetlands Complex

Edward Farley[1,2,*], Michael L. Schummer[1], Don Leopold[1], John M. Coluccy[3], Douglas C. Tozer[2], James Eckler[4], Linda Ziemba[5]

[1] College of Environmental Science and Forestry, State University of New York
[2] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[3] Ducks Unlimited
[4] Northern Montezuma Wildlife Management Area
[5] Montezuma National Wildlife Refuge
**** Long Point Waterfowl and Wetlands Research Program MSc student***

Large numbers of wetlands have been drained, filled, and developed to make way for growing human populations throughout the Great Lakes region. In some areas, the loss of wetlands exceeds 90% of the original extent. Given that only a fraction of the original wetlands can be restored means that productivity and biodiversity of at least some of the remaining wetlands should be maximized. Determining the effectiveness of wetland restoration for achieving such maximization is important for refining and improving conservation strategies and management techniques. However, post-restoration monitoring is uncommon or typically collects data on only a limited number of metrics. As a result, wetland conservation stakeholders, especially those focused on wildlife, often have little information to aid in refinement of strategies. In this study, we measure plant, invertebrate, and wildlife response to different wetland management techniques on restored wetlands in New York State. Responses include species-level abundance of breeding, staging, and migrating birds; structure, biomass, and coverage of submergent and emergent plants; density and species richness of invertebrates; and seed and tuber density and diversity. Management techniques include: 1) passive management – water held at or near full-service level (maximum designed capacity) throughout the growing season with no active drawdown of water; 2) partial draw down – exposure of 20% to 50% of the basin using active water drawdown; and 3) full drawdown – nearly 100% exposure of the basin. Results will be used to develop best management practices for increasing wetland productivity and biodiversity that will be applicable throughout the lower Great Lakes region.



Sampling vegetation. Photo by Edward Farley.

Sampling invertebrates. Photo by Edward Farley.

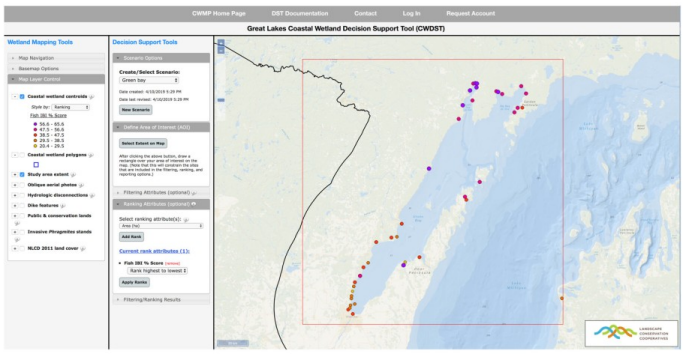
Leveraging a landscape-level monitoring and assessment program for developing resilient shorelines throughout the Laurentian Great Lakes

Donald G. Uzarski[1], Douglas A. Wilcox[2], Valerie J. Brady[3], Matthew J. Cooper[1,4], Dennis A. Albert[5], Jan J. H. Ciborowski[6], Nicholas P. Danz[7], Anne Garwood[8], Joseph P. Gathman[9], Thomas M. Gehring[1], Greg P. Grabas[10], Robert W. Howe[11], Lucinda B. Johnson[3], Gary A. Lamberti[12], Ashley H. Moerke[13], Gerald J. Niemi[3], Todd Redder[14], Carl R. Ruetz III[15], Alan D. Steinman[15], Douglas C. Tozer[16], T. Kevin O'Donnell[1]

[1] Institute for Great Lakes Research, Central Michigan University
[2] College at Brockport, State University of New York
[3] Natural Resources Research Institute, University of Minnesota
[4] Burke Center for Freshwater Innovation, Northland College
[5] Oregon State University
[6] University of Windsor
[7] University of Wisconsin-Superior
[8] Michigan Department of Environmental Quality
[9] University of Wisconsin-River Falls
[10] Environment and Climate Change Canada
[11] University of Wisconsin-Green Bay
[12] University of Notre Dame
[13] Aquatic Research Laboratory, Lake Superior State University
[14] LimnoTech Corporate HQ
[15] Annis Water Resources Institute, Grand Valley State University
[16] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[17] U. S. Environmental Protection Agency

Traditionally, ecosystem monitoring, conservation, and restoration have been conducted in a piecemeal manner at the local scale without regional landscape context. However, scientifically driven conservation and restoration decisions benefit greatly when they are based on regionally determined benchmarks and goals. Unfortunately, required data sets rarely exist for regionally important ecosystems. Because of early recognition of the extreme ecological importance of Laurentian Great Lakes coastal wetlands, and the extensive degradation that had already occurred, significant investments in coastal wetland research, protection, and restoration have been made in recent decades and continue today. Continued and refined assessment of wetland condition and trends, and the evaluation of restoration practices are all essential to ensuring the success of these investments. To provide wetland managers and decision makers throughout the Laurentian Great Lakes basin with the optimal tools and data needed to make scientifically-based decisions, our regional team of Great Lakes wetland scientists developed standardized methods and indicators used for assessing wetland condition. From a landscape perspective, at the Laurentian Great Lakes ecosystem scale, we established a stratified random-site-selection process to monitor birds, anurans, fish, macroinvertebrates, vegetation, and physicochemical conditions of coastal wetlands in the US and Canada. Monitoring of approximately 200 wetlands per year began in 2011 as the Great Lakes Coastal Wetland Monitoring Program. In this paper, we describe the development, delivery, and expected results of this ongoing international, multi-disciplinary, multi-stakeholder, landscape-scale monitoring program as a case example of successful application of landscape conservation design.

Published in: **Wetlands https://link.springer.com/article/10.1007/s13157-019-01139-w (2019)**



Great Lakes Coastal Wetland Decision Support Tool interface showing a ranking result based on Fish Index of Biotic Integrity scores for wetlands in Green Bay, Lake Michigan. Cooler colored dots indicate higher Fish IBI scores.

Control of invasive *Phragmites* increases marsh birds but not frogs

Douglas C. Tozer[1], Stuart A. Mackenzie[2]

[1] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada
[2] Long Point Bird Observatory, Bird Studies Canada

The non-native invasive form of common reed (*Phragmites australis australis*; hereafter "invasive *Phragmites*") negatively affects certain flora and fauna throughout North America. As a result, much effort is spent in some locations controlling invasive *Phragmites*, although few estimates of the expected benefits of these efforts are available. We used data from Bird Studies Canada's Great Lakes Marsh Monitoring Program and Central Michigan University's Great Lakes Coastal Wetland Monitoring Program to estimate changes in 1) species richness, 2) total abundance, and 3) occurrence of 9 breeding marsh bird species and 8 breeding marsh frog species before and after control of invasive *Phragmites*. Our study took place between 2011 and 2018 throughout 3 Great Lakes coastal wetland complexes located on Lake Huron and Lake Erie in southern Ontario. We found at sample sites where invasive *Phragmites* was controlled that species richness of 5 breeding marsh bitterns (e.g., *Botaurus* sp.) and rails (e.g., *Rallus* sp.) of conservation concern increased by 1.1 species, and that total abundance of these species combined increased by 1.8 individuals. By contrast, we observed no change in these responses at nearby sample sites where no *Phragmites* control occurred. We found no change in occurrence of any frog species or species richness or crude calling frequency of all frog species combined in relation to control of *Phragmites*, although we lacked the ability to detect subtle changes in abundance of frogs, so more information would be helpful before firm conclusions can be made in relation to frogs and control of invasive *Phragmites* in our study system. Our study shows that control of invasive *Phragmites* has a significant positive effect on breeding marsh bird species of conservation concern and suggests that continued effort to restore habitat for these species is warranted, particularly in areas where former breeding marsh bird biodiversity was high.

Published in: **Canadian Wildlife Biology and Management 6:66–82 http://cwbm.name/control-of-invasive-phragmites-increases-marsh-birds-but-not-frogs/ (2019)**

Rolling and compressing invasive *Phragmites* in preparation for a prescribed burn to remove biomass and permit re-growth of native vegetation. Photo by Janice Gilbert.

Response of marsh-breeding bitterns and rails of conservation concern 1-5 years before and 1-5 years after removal of invasive *Phragmites* at sample sites with removal (Removal) and at nearby sample sites without removal (No removal) within three wetland complexes on Lake Huron and Lake Erie in southern Ontario between 2011 and 2018.

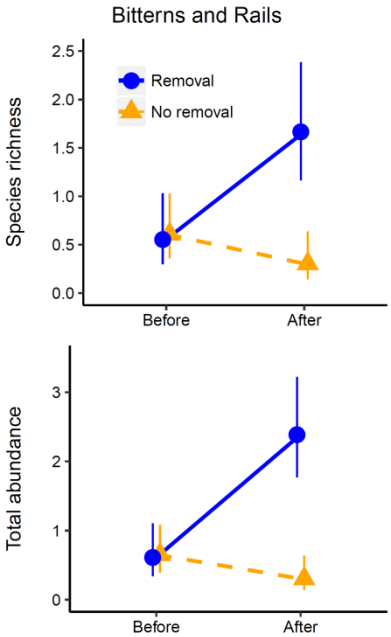


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Photo: Blue-winged Teal. By Theodore Smith.

Inset photo: Putting transmitter on a Mallard. By Mike Moynihan.

Impactful results:

- Invasive, non-native mussels are not transferring the element selenium at harmful levels to ducks (scaup); resources redirected to address other factors driving population declines.
- More ducks are overwintering in the Great Lakes due to climate change, with less food for waterfowl in remaining wetlands; on-the-ground actions are being implemented.
- First-ever marsh breeding bird "hotspot" maps for southern Ontario identify new priority areas for wetland securement; helps Canada uphold all-bird conservation obligations.
- Wildlife-based prioritization reveals the best and worst Great Lakes coastal wetlands; wetland protection and restoration being done where it counts.
- Invasive vegetation management on Long Point, Ontario benefits numerous wildlife species; spearheads broad-scale *Phragmites* control program—waterfowl and wetlands are rebounding.

Photo: Mallards. By Theodore Smith.

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EHJV Eastern Habitat Joint Venture
PCHE Le plan conjoint des habitats de l'est

Great Lakes RESTORATION

Assistance for this project was provided by the Government of Ontario.

Ontario

This project was undertaken with the financial support of the Government of Canada.

Ce projet a été réalisé avec l'appui financier du gouvernement du Canada.

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