Winous Point Marsh Conservancy

2023 Research and Activities Report

February 2024

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On the cover: Sandhill cranes (Grus canadensis) at Winous Point Marsh, March, 2023. Photo credit: Art Weber

Winous Point Marsh Conservancy

Vision:

To act as a leader, facilitator, and innovator in wetland and wetland dependent wildlife conservation, education, and research in the lower Great Lakes region.

Mission:

1) *CONSERVATION: To ensure the protection and sound management of the Winous Point coastal wetlands, the greater southwest Lake Erie region, and the associated waterfowl and wildlife.*

2) *EDUCATION: To provide practical learning opportunities in wetlands and waterfowl ecology with a particular focus on training and career development of young professionals.*

3) *RESEARCH: To be a leader in delivering impactful, applied research programs and projects in wetlands ecology, with a focus on wetlands and wetland dependent plants and animals.*

Winous Point Marsh Conservancy

2023

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Executive Note

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The Winous Point Marsh Conservancy's mission is broad, but directed: Research, Conservation, and Education. Annually, we work hard to support sound scientific research, to advance local and regional wetland conservation, and to deliver meaningful education programs.

Our graduate research program is currently supporting two projects on mallard ducks, one on black ducks, and one on changing regional waterfowl distributions. Each of these projects explicitly sets out to better understand factors that are driving population and distribution trends that have implications for waterfowl harvest and population management (Pages 5, 9, 13, and 19). We are always looking to build our research program into the future, and we currently have several new proposals in the conceptual design phase. First, we are working with the University of Toledo as part of the national COMPASS (Coastal Observations, Mechanisms, and Predictions Across Systems and Scales) program that is investigating coastal ecosystem responses to climate change. We will use water-level management within our impoundments to simulate flooding conditions under climate change scenarios so that scientists can begin to predictively model the geophysical responses of wetlands to climate change. The second project in development is Ph.D. student, Dominic Hackenberry, at SUNY College of Environmental Science and Forestry who will continue ongoing research on introgression of game-farm genetics into wild North American mallard populations. Dominic's work will specifically model the persistence of game-farm genes within wild populations, giving us insights into whether these genes will persist or if they could be bred out of the wild population over time.

On the conservation front, Winous Point Marsh Conservancy (WPMC) staff are involved in a variety of local and regional on-the-ground wetlands conservation projects as well as larger-scale conservation planning initiatives. We recently collaborated with Ducks Unlimited and a suite of regional conservation partners to submit a North American Wetlands Conservation Act grant. If awarded, this funding would come to northwestern Ohio for a variety of conservation projects including the replacement of the primary water control system in our 750-acre south marshes. We are also continuing work towards a conservation project with the Ohio Department of Natural Resources H2Ohio water quality program. If awarded, this project would enhance several primary water control structures across many of our north marshes. Regionally, we have aided a suite of conservation partners to revitalize the Lake Erie Cooperative Weed Management Association. This program has been extremely successful in managing regional *Phragmites* issues, and we hope to jumpstart this program on a variety of invasive species. Finally, we are working with Ohio State University, The Audubon Society, and the Ohio Division of Wildlife to

develop a monitoring framework aimed at quantifying the use of wetlands restored by the H2Ohio water quality program by migratory waterfowl and secretive marsh birds.

WPMC received a generous donation in 2023 that allowed us to endow the new Gale-White Conservation Education Fund. This fund will provide permanent income to grow and develop our education programs as well as assisting with professional career development of our interns and students as they start their conservation careers. This fund will undoubtably increase our capacity to work with partners to deliver programs such as "Day on the Wild Side", Port Clinton middle school 7th grade science field trips, the semi-annual "Great Lakes Wetlands and Waterfowl Graduate Symposium", and other professional and public education events (Pages 44-48). These investments in youth and community are important as we inspire the next generation of conservationists and foster community support for wetlands and wildlife.

Speaking of endowments, in late 2023 the WPMC, Ohio Division of Wildlife, and Ohio State University finalized the agreement to create the *Winous Point Wetlands and Waterfowl Endowed Faculty Support Fund* at Ohio State University. This fund will ensure that dedicated academic support is permanently in place at Ohio State to deliver applied wetlands and waterfowl research for the WPMC and Ohio Division of Wildlife research programs. This is a huge step forward for both organizations to ensure there is dedicated academic support and expertise in the field of wetlands and waterfowl conservation at a Great Lakes regional university in perpetuity.

Thanks to the generosity of supportive donors, support derived from our strong network of partners, and the leadership and dedication of our board and staff, the WPMC continues to make significant contributions to wetlands science, to the careers of young professionals, and to regional management and conservation of wetlands. We look forward to the challenges and opportunities that lie ahead as we continue to further our impact on Great Lakes coastal wetlands, their wildlife, and the people that support them.

Regards,

John Simpson
Executive Director

Modeling Future Winter Waterfowl Distribution in Ohio and the Upper Mississippi River and Great Lakes Region Joint Venture

Investigators: Andrea Spurck and Dr. Robert Gates, The Ohio State University

Collaborators: Winous Point Marsh Conservancy, Waterfowl Research Foundation, and Ohio Division of Wildlife

Introduction: Increasingly milder winters have affected waterfowl distributions across North America. Previous studies have demonstrated delays in autumn migration, northern shifts in wintering ranges, and increasing winter abundance at northerly latitudes for many dabbling and diving duck species. However, most research to date has spanned a continental geographic scale and few projects have attempted to project future changes in relative wintering abundance. Increased abundance of wintering ducks across the Great Lakes region could significantly impact food and habitat resources, particularly during spring migration, and shifts in waterfowl distributions could also result in changes to waterfowl hunting and viewing opportunities.

Project objectives:

1. Use Integrated Nested Laplace Approximation (INLA) models to model historical changes (1966-2021) in relative abundance of ducks across the Upper Mississippi and Great Lakes Region Joint Venture as a function of winter weather severity (WSI index).
2. Project current trends in winter duck abundance into the future using Global Circulation Climate Change models and estimated changes in winter weather severity.

Figure 1. Andrea Spurck assisting with duck banding at Winous Point Marsh in 2022.

Summary: The Christmas Bird Count is a volunteer-based annual survey of birds that has occurred across the continent in late December since 1900. A study of the Christmas Bird Count trends in the eastern United States reported that relative abundance of waterfowl increased more at northern latitudes for most species, with mean winter temperature influencing about half of the variation in trends for 12 of 16 species. Other research predicts that there will be delayed migration for all species based on climate projections of rising temperatures and reduced snow cover. We used Christmas Bird Count data (1966-2021) to summarize observations of mallards (*Anas platyrhynchos*) and "wetland obligate duck species" which combined gadwall (*Mareca strepera*), wigeon (*Mareca americana*), and northern shoveler (*Spatula clypeata*) counts at a 100 sq. km spatial resolution grid across the entire Upper Mississippi River and Great Lakes Region Joint Venture (UMGLJV). We adjusted counts to correct for survey effort and then estimated percent change in relative abundance for mallards and wetland obligate species for each grid cell from 1966 to 2021. We also calculated a winter weather severity index (WSI) for each grid cell that combines average temperature, consecutive days below freezing, average snowfall, and consecutive days with accumulated snow >2.54 cm. This allowed us to compare how relative abundance of mallards and wetland obligate duck species has changed in relation to winter weather severity, which has been demonstrated to be an important predictor of autumn and winter duck distributions.

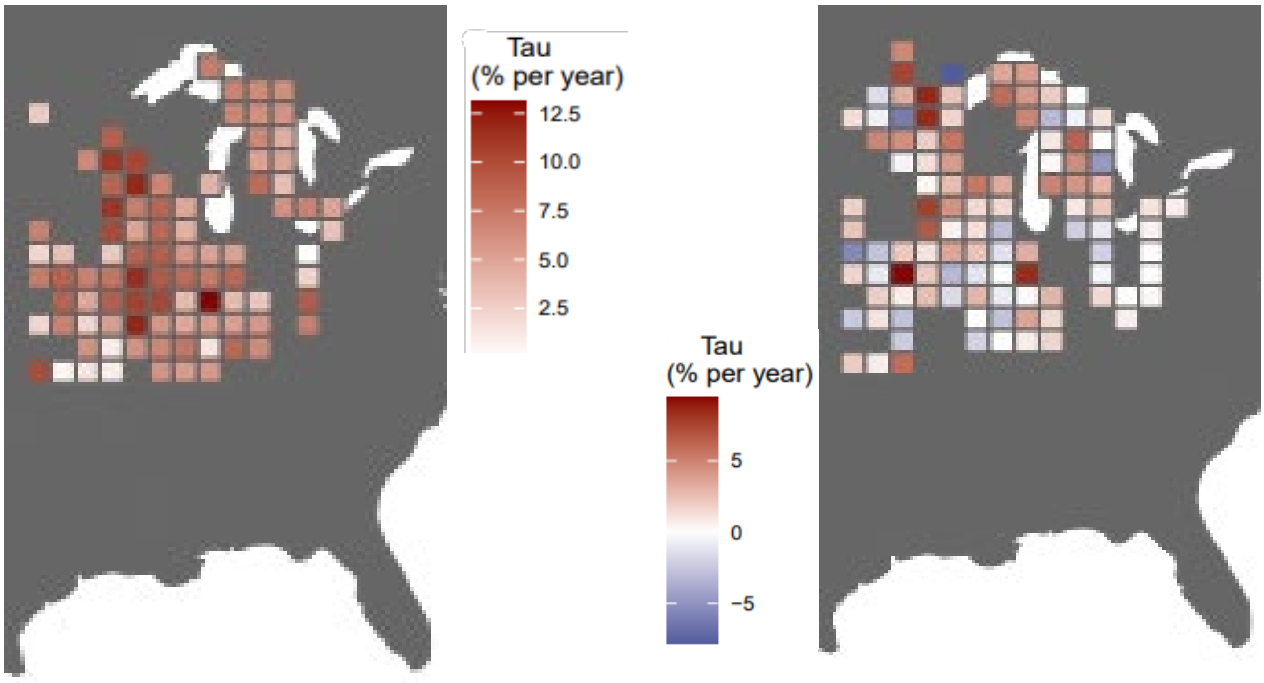

Figure 2. Percent change in relative abundance of wigeon, gadwall, and northern shovelers (left) and percent change in relative abundance of mallards (right) from 1966 to 2021 across the Upper Mississippi River and Great Lakes Region Joint Venture. Blue cells indicate areas of decreasing winter abundance and red cells indicate areas of increasing winter abundance.

Preliminary results show that relative abundance of wintering gadwall, wigeon, and northern shovelers increased across the entire UMGLJV, while relative abundance of mallards increased in some portions of the UMGLJV and decreased in other portions (Figure 2). Our post hoc correlations show gadwall, wigeon, and northern shoveler increased more so in areas with historically milder winters within our region, whereas mallards decreased in areas with historically milder winters and increased in areas with historically more severe winters (Figure 3). These findings are generally consistent with previous analyses of Christmas Bird Count data across all of eastern North America, however there are some interesting findings from this finer scale approach. First, wetland obligate species (gadwall, wigeon, and northern shoveler) increased in abundance throughout the UMGLJV but more so in traditionally milder portions of our study area. Second, the threshold where wintering relative abundance of mallards changed from decreasing to increasing occurred in the Great Lakes region. Thus, traditionally milder portions of the UMGLJV demonstrated decreasing wintering mallard abundance while traditionally harsher portions experienced increases in wintering mallard abundance. Both of these findings have important implications for waterfowl conservation planning in the region, as wetland and habitat resources need to be in place at the right time and in the right place for wintering waterfowl, especially if the observed changes continue.

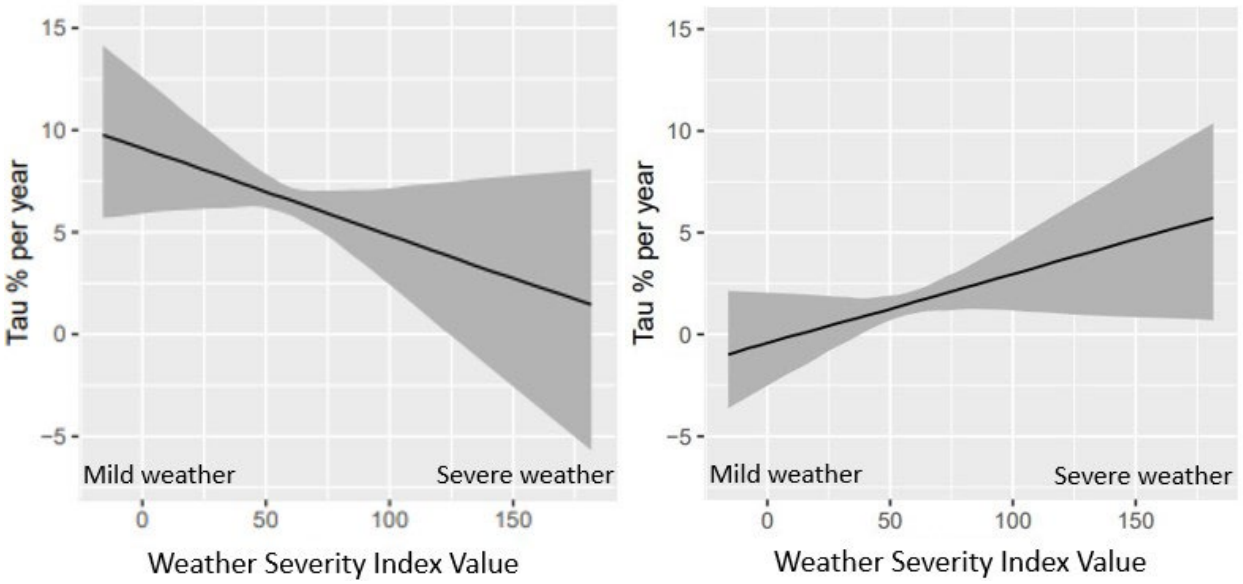

Figure 3. Percent change in relative abundance (Tau) of wintering gadwall, wigeon, and shovelers (left) and mallards (right) as function of winter weather severity across the Upper Mississippi River and Great Lakes Region Joint Venture from 1966 to 2021. Higher WSI values represent cells with more severe winters, on average. Values above zero indicate increasing duck abundance while values below indicate decreasing abundance.

The next step in our research includes investigating how WSI values may have changed from 1966 to 2021 and if the observed changes in duck abundance are related to changes in winter severity. If so, we then plan to estimate future changes in WSI values using Global Circulation Climate Change models and then predict changes in future relative abundance of wintering waterfowl for the UMGLJV based on WSI values.

Figure 4. A mix of dabbling duck species wintering at Winous Point Marsh in December 2023.

Winous Point Marsh Conservancy is a co-lead investigation with Andrea and Dr. Bob Gates of Ohio State University. The project is currently funded by Ohio State University, The Waterfowl Research Foundation, Ohio Division of Wildlife, and Winous Point Marsh Conservancy. We thank Dr. Bill Peterman of Ohio State University, Mike Ervin of the Ohio Division of Wildlife, and Tim Meehan of the National Audubon Society for their help with project development and data access.

Comparisons of Morphology Among Genotypes of North American Mallards

Investigators: Hunter Collins and Dr. Michael Schummer, SUNY College of Environmental Science and Forestry

Collaborators: Winous Point Marsh Conservancy, University of Texas-El Paso, Birds Canada, and Delta Waterfowl

Schedule: 2022-2024

Introduction: Over the last 20 years, the estimated Atlantic flyway mallard (*Anas platyrhynchos*) population has declined by approximately 40% and the estimated Great Lakes mallard population has declined by 17%. At the same time, Central and Pacific flyway mallard populations have remained near or above long-term averages. Although there are numerous potential reasons for this decline, the release of domesticated, game-farm mallards is one hypothesis being investigated to better understand its implications on mallards at the population level.

Annually, an estimated 200,000-500,000 mallards are released to supplement hunting opportunities, primarily along the Atlantic coast of the United States. Game-farm mallards are also released in the Great Lakes region in much lower numbers, and it is likely that game-farm mallards also escape from backyard flocks across the continent. Although many of these birds are harvested and the remainder are assumed to not survive in the wild, genetic work has shown that many are escaping to become feral and at least survive long enough to breed with wild North American mallards. These game-farm x wild mallard hybrids are now very common in the Atlantic flyway (~92%) and Great Lakes region (~60%) and readily interbreed with each other, creating what has been termed a hybrid swarm. Introgression of game-farm mallard genes into western mallard populations is lower, yet present. This suggests that game-farm genes may be spreading westward.

Figure 1. Graduate student Hunter Collins, assisted by research technician Nate Stott, collecting a blood sample from a mallard captured at Pickerel Creek Wildlife Area in Ohio, August 2023.

Summary: Pure game-farm and pure-wild mallards are known to differ in body size and shape, but little research has been done to understand the morphological characteristics of game-farm x wild mallard hybrids. Because of this knowledge gap, it is currently not possible to assign generational genotypes to mallards captured during pre-season banding efforts in the United States simply based on the morphological characteristics of the individual. Furthermore, it is unclear if physical and behavioural traits carried by game-farm mallards are becoming more prevalent in wild mallard populations. If these knowledge gaps could be filled, this would allow researchers to use band recovery data to investigate potential differences in behavior and survival among mallards with varying generations of game-farm genes.

We sampled 517 mallards from Ohio and 241 mallards from New York in 2022 and 2023. We also received eight pure game-farm mallard samples from Georgia for a total of 766 mallards. We obtained samples through a combination of live mallards captured July through September and hunter-harvested birds taken October through December of each year. The research protocol

includes taking 13 morphological measurements and obtaining genetic samples from blood samples (live birds) or muscle tissue (hunter-harvested birds) that are sent to Dr. Phil Lavretsky's lab at the University of Texas-El Paso. We also take a series of 11 pictures, each highlighting a different morphological attribute, and plan to use artificial intelligence technology to determine if feather patterns can be used to differentiate among mallard genotypes.

Samples from our 2022 field season (n=354) have now been processed by the Lavretsky lab to determine genotype. We found that 51% of all samples were pure wild mallards, and only 2 of the sample were >50% game-farm mallard ancestry. Most birds ranged from 75%-100% wild mallard ancestry. We found few statistically significant differences in morphological measurements between the hybrid mallard genotype (50-89% wild mallard ancestry) and wild mallards (>90% wild mallard ancestry). Hybrid mallards did have slightly longer legs and slightly taller culmens consistent with the differences found between purely wild mallards and purely game-farm genotypes (Figures 2 and 3).

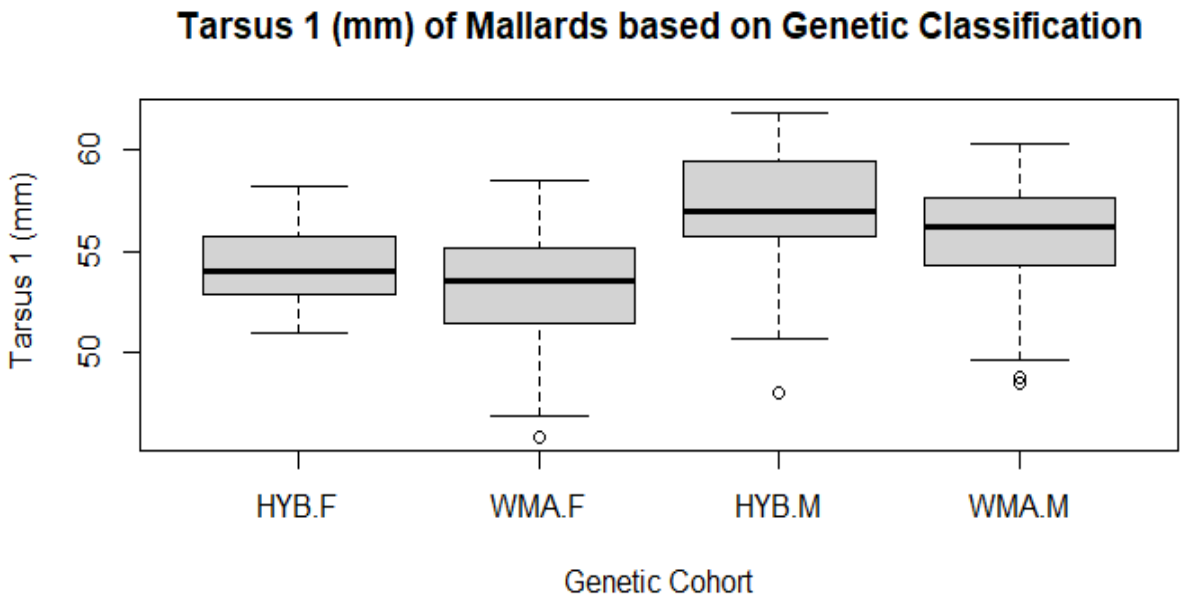

Figure 2. Differences in tarsus lengths between hybrid and wild male and female mallards (HYB.F=hybrid female, WMA.F=wild female, HYB.M=hybrid male, WMA.M=wild male) sampled in Ohio and New York in 2022.

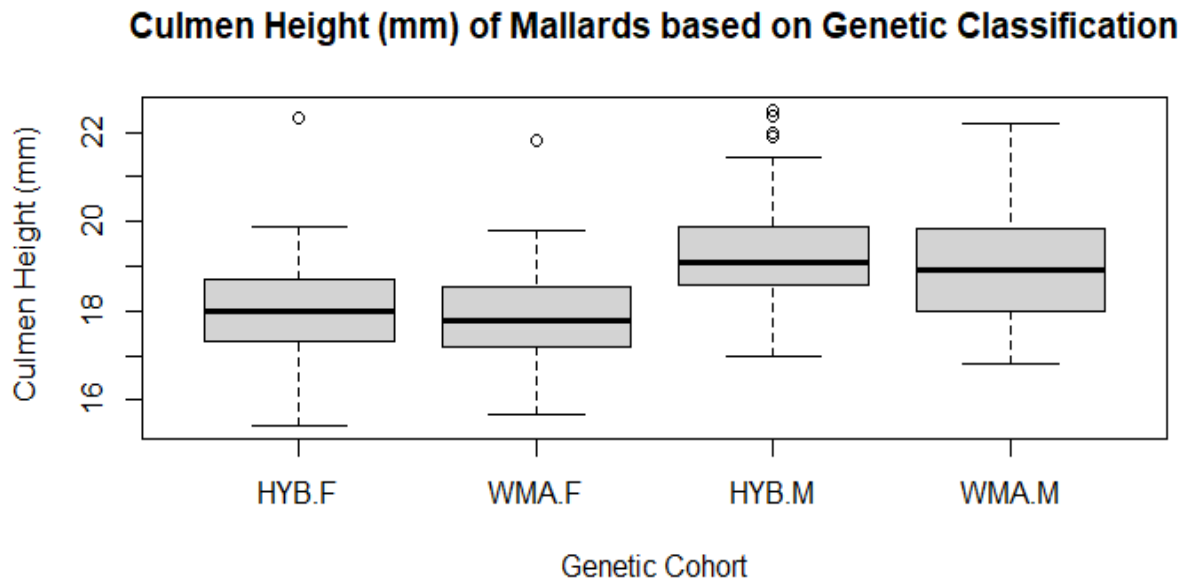

Figure 3. Differences in culmen heights between hybrid and wild male and female mallards (HYB.F=hybrid female, WMA.F=wild female, HYB.M=hybrid male, WMA.M=wild male) sampled in Ohio and New York in 2022.

Preliminary results suggest that a substantial amount of natural variation exists in morphological measurements of both hybrid and pure wild mallard genotypes. We were able to detect slight differences in leg length of hybrids vs. wild mallards (hybrids tended to have longer legs), but not enough to statistically separate the two groups. This natural variation makes it difficult to identify various generations of hybrids from each other or from wild mallards based on body measurements alone. We have yet to analyze feather and body coloration patterns and we are hopeful that feather patterns, or feather patterns in combination with morphometric measurements, may help distinguish hybrids from wild mallards.

Even if strong differences in morphological characteristics have not been detected between the two groups, there could still be strong behavioral differences (e.g., land cover use, nesting strategies, migratory patterns) that are linked to the introgression of domesticated game-farm genes into the wild mallard population in North America. Future research will continue to investigate these questions, hopefully providing insight into mallard population dynamics in eastern North America.

Winous Point Marsh Conservancy supports this project by employing and housing field staff to perform data collection as well as providing mallards for sampling during our summer banding efforts. We thank the Winous Point Shooting Club for providing access to hunter-harvested mallards each fall.

Movement, Survival, Resource Selection, and Productivity of Great Lakes Mallards

Investigators: Ph.D. candidate Ben Luukkonen, Dr. Scott Winterstein, and Dr. Dan Hayes, Michigan State University; Dr. Drew Fowler, USGS Louisiana Cooperative Fish and Wildlife Research Unit, Louisiana State University; and Dr. Philip Lavretsky, University of Texas El Paso

Collaborators:

- Winous Point Marsh Conservancy
- Ducks Unlimited
- Franklin College
- Great Lakes Fish and Wildlife Restoration Act
- Illinois Department of Natural Resources
- Illinois Natural History Survey
- Indiana Department of Natural Resources
- Michigan Department of Natural Resources
- Michigan State University
- United States Fish and Wildlife Service
- Upper Mississippi and Great Lakes Region Joint Venture
- Wisconsin Department of Natural Resources
- University of Texas El Paso

Schedule: 2021-2024

Introduction: The Great Lakes mallard (*Anas platyrhynchos*) project is a regional collaboration to learn more about factors limiting the Great Lakes mallard population. Since the early 2000s, abundance of mallards nesting in the Great Lakes region has been declining. Simultaneously, Atlantic flyway mallard populations have been in steep decline, while mid-continent (prairie and western United States and Canada) mallard populations remained stable from the early 2000s to 2016 before declining slightly from 2016 to present. Despite research and annual monitoring efforts, it is unclear what factors are limiting mallard abundance and leading to the observed population decline. Recent genetic work by the Lavretsky lab at the University of Texas El-Paso has demonstrated introgression of wild mallard and domestic game-farm mallard genes. Furthermore, the estimated release of 200,000-500,000 domestic game-farm mallards in eastern North America has generated concern that genetics could be playing a role in the observed declines in mallard breeding populations in eastern North America.

Identifying limiting factors and recovering mallards is a priority for waterfowl managers. The project goal is to estimate hen mallard survival, productivity, resource selection, and breeding site fidelity to the Great Lakes region in relation to banding location, genotype, molt and natal location, and age to identify limiting factors and recommend management actions to increase Great Lakes mallard abundance.

Summary: Research partners are capturing and attaching GPS-GSM transmitters to hen mallards during spring and summer in Michigan, Wisconsin, Illinois, Indiana, and Ohio. Transmitters are attached using elastic straps and rest on the bird's back (Figure 1). Transmitters collect GPS locations and other data which are uploaded to a database via cellular networks, enabling daily monitoring of bird movements. Mallards are captured in urban and rural areas to assess potential differences in demographic rates and movement behavior for birds that select urban versus rural areas. Feather and blood samples collected from marked individuals are analyzed to estimate molt or natal origin and genotype, respectively. Analysis of stable isotope composition of feathers provides a coarse estimate of molt latitude for adults and natal latitude for juveniles. Blood samples are analyzed to determine if each bird is a pure wild mallard or a domestic game-farm x wild mallard hybrid. Pairing these results with mallard movement data will enable us to assess how use of urban areas, molt and natal origin, genotype, and body condition affect survival, productivity, fidelity, and movement. Data collected from mallards marked with transmitters will be jointly analyzed with mallard banding and population abundance data using an integrated population model.

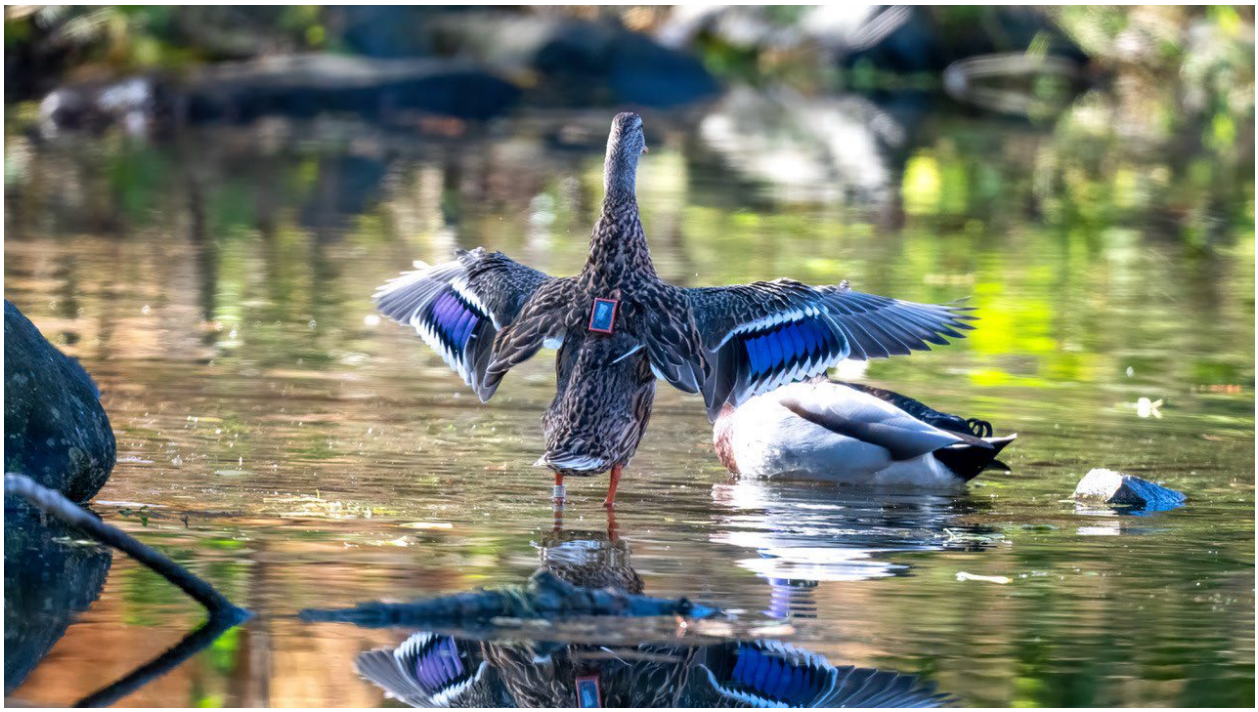

Figure 1. A GPS-marked hen mallard observed in Wisconsin in October 2022. Photo credit: Linda Deith.

Winous Point Marsh Conservancy (WPMC) personnel deployed 16 transmitters in 2021, 40 transmitters in 2022, and 39 transmitters in 2023. Together, all project partners have marked 592 hen mallards with satellite transmitters across 5 states. Blood samples from GPS-marked hen mallards yielded 590 usable samples, and genetic analyses by Dr. Phil Lavretsky at the University of Texas El Paso indicated 44% were wild mallards, while 56% were domestic game farm x wild mallard hybrids. Preliminary movement data suggests hybrid mallards tend to have lower daily movement distances (Figure 2), are more likely to select urban areas than wild mallards (Figure 3) and are less likely to make migratory movements than wild mallards (Figure 4).

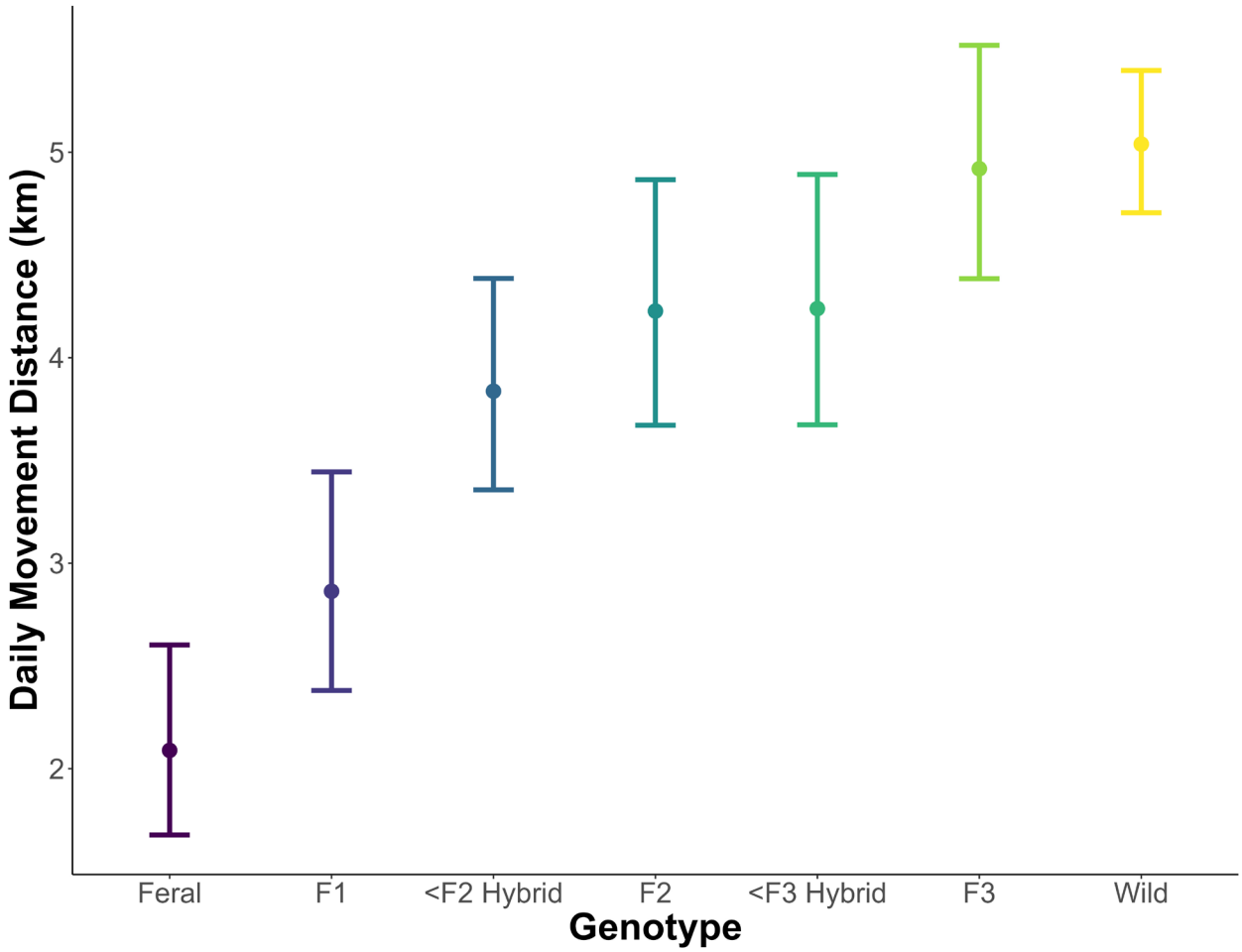

Figure 2. Predicted daily movement distance (points) and 95% confidence intervals (error bars) in relation to genotype for hen mallards marked with GPS-GSM transmitters in Ohio, Michigan, Wisconsin, Indiana, and Illinois, 2021-2023. Genotype categories Feral, F1, <F2 Hybrid, F2, <F3 Hybrid, F3, and Wild correspond to (0.00-0.43), (0.43-0.63), (0.63-0.72), (0.72-0.82), (0.82-0.86), (0.86-0.92), (0.92-1.00) proportion wild genomes, respectively.

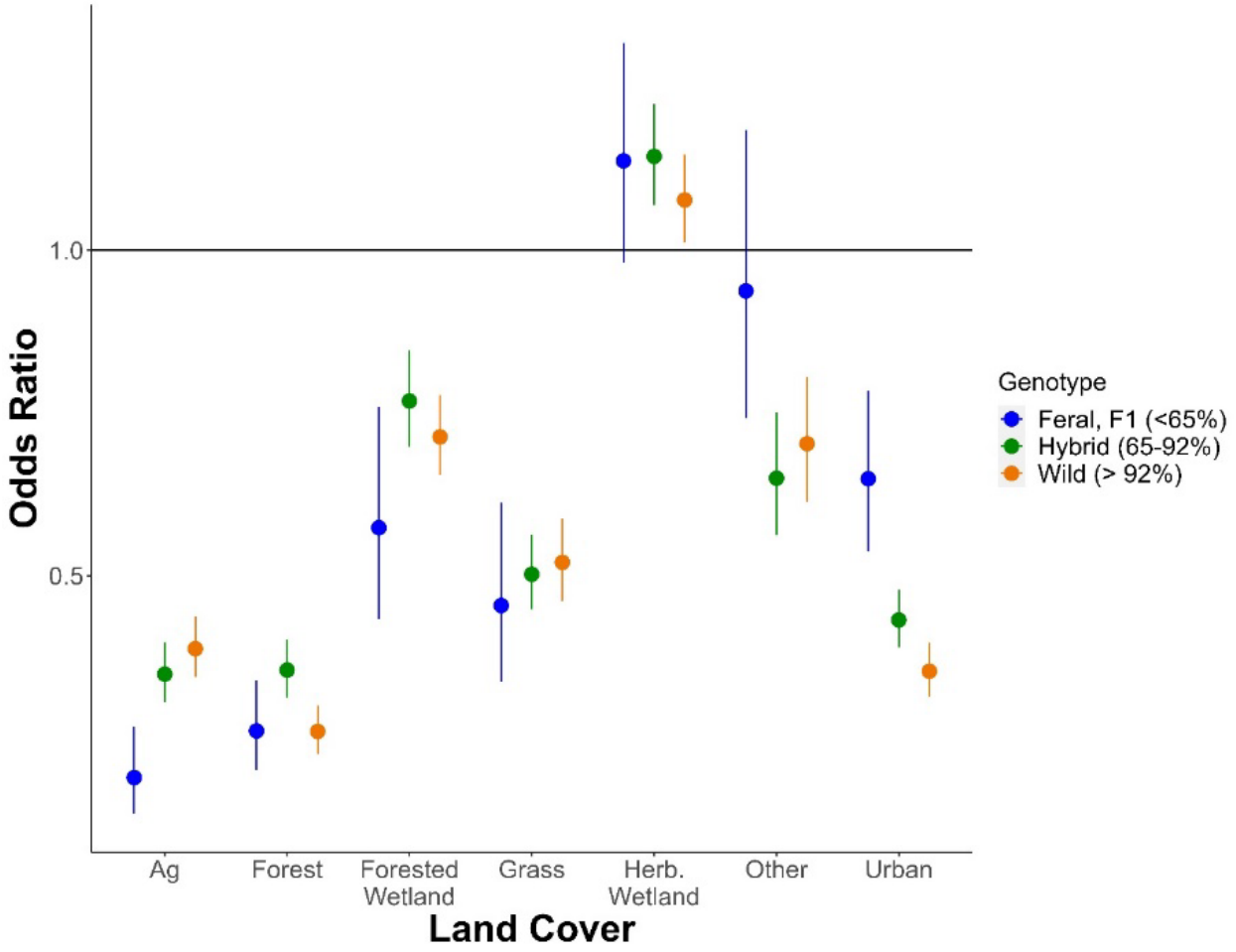

Figure 3. Odds ratios of land cover type selection relative to open water for Feral and F1 hybrid (<65% wild genome), hybrid (65-92% wild genome), and wild (>92% wild genome) hen mallards monitored with GPS-GSM transmitters during the non-breeding period (August 16-March 31) from 2021-2023 in Ohio, Michigan, Wisconsin, Indiana, and Illinois.

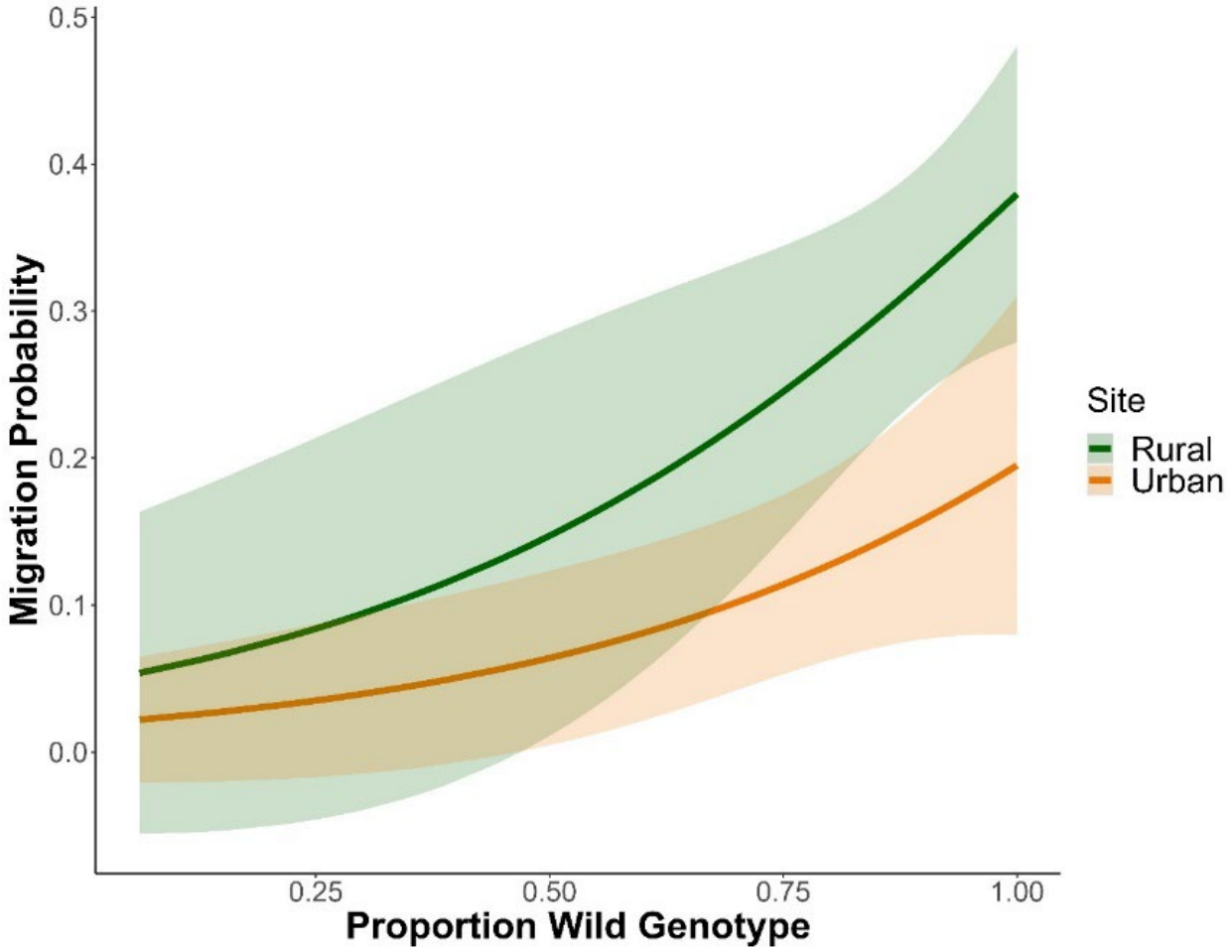

Figure 4. Predicted probability of autumn (August-February) migration in relation to proportion wild genome and capture site type for hen mallards marked with GPS-GSM transmitters in Ohio, Michigan, Wisconsin, Indiana, and Illinois, 2021-2022.

Hunters harvested one (6%), four (10%), and six (15%) Ohio-marked mallards in 2021, 2022 and 2023, respectively. WPMC was one of just a few sites to capture and mark hen mallards during spring migration. Interestingly, those hen mallards captured during March of 2021-2023 dispersed great distances across the Great Lakes, Atlantic flyway, and even as far west as North Dakota to breed (Figure 5). These movements highlight the potential emigration of mallards from eastern North America into western populations, and with it, the continued potential for introgression of domestic game-farm genes into wild populations.

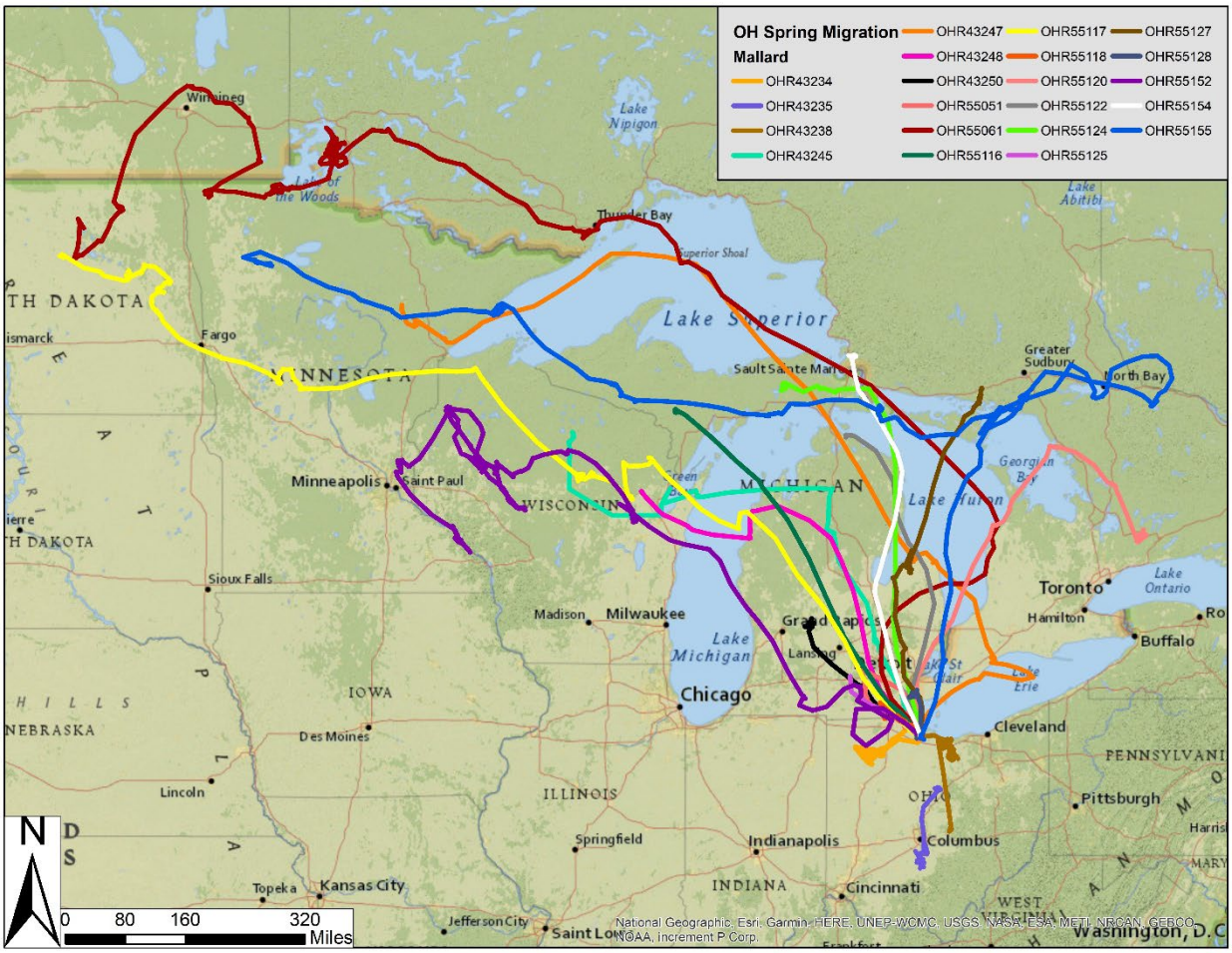

Figure 5. Spring and summer (March-August, 2022 and 2023) movements for hen mallards marked with GPS-GSM transmitters in Ohio, USA.

Winous Point Marsh Conservancy funded transmitters for this project in each of three years in addition to capturing and marking mallards and collecting genetic samples.

Quantifying the Influence of Environmental Conditions and Black Duck Behavior and Movements on Productivity

Investigators: Ph.D. Candidate Ilsa Griebel and Dr. Mitch D. Weegman, University of Saskatchewan

Collaborators:

Schedule: 2021-2025

Introduction: Black ducks (*Anas rubripes*) are a species highly valued by hunters and a flagship species for Atlantic tidal marshes. Their population decreased by 50% between the 1950s and 1980s, and while stable now, has not recovered to its early 1900s level. Over the past several decades, research on black ducks has focused on two competing hypotheses: 1) population growth in black ducks is limited by conditions on breeding areas, or 2) population growth in black ducks is limited by conditions on wintering areas. Although extensive research has been completed addressing the latter of these two hypotheses, an equivalent assessment of the former hypothesis has not been possible due to the financial and logistical challenges of accessing the boreal region where black ducks breed. Previous research found that survival did not fully explain the lack of recovery currently displayed by black duck populations, and therefore, productivity could instead be the proximate mechanism for population change in black ducks. Thus, research on black duck productivity in the boreal region is a crucial next step to inform management of the black duck population in Canada and the U.S.A.

To overcome previous challenges of collecting data on breeding black ducks in the boreal region, we are using state-of-the-art GPS-ACC devices to remotely collect spatiotemporal data on black duck movement and behaviour (Figure 1). GPS locations are collected once an hour and ACC fixes (behavioural data) every 10 minutes. We will investigate how habitat use, behaviour, migratory movements and energy expenditure explain variation in productivity.

Figure 1. University of Saskatchewan Ph.D. student, Ilsa Griebel, holding a black duck newly fitted with a tracking device just before release (left; photo credit: Mathieu Tetreault). A black duck hen that received a tracking device as part of this study photographed swimming in Ontario (right; photo credit: Ryan Campbell).

Objectives:

1) Quantify movements and use of wetlands by black ducks during the breeding season.

2) Develop detailed time activity budgets of black duck behaviour (feeding, flight, resting/stationary, preening) throughout the annual cycle for different time periods (late winter before spring migration, spring migration, breeding season, fall migration).

3) Quantify reproductive metrics, such as nesting attempts, full-term incubation and brood-rearing, in black ducks by using daily displacement data and a proxy for energy expenditure from ACC data.

4) Use a hierarchical modelling approach to assess 1) the extent to which migration characteristics (e.g., number of stops, duration of stops), proportion of time feeding, energy expenditure, past mercury exposure and habitat used during wintering, staging and the reproductive period explain variation in reproductive metrics and 2) the extent to which precipitation and temperature explain variation in behaviour and energy expenditure during wintering, staging and breeding periods.

Summary: During January-March 2023, project partners deployed 189 GPS-ACC tracking devices (150 in the Atlantic Flyway and 39 in the Mississippi Flyway) on female black ducks, including Connecticut (*n*=9 devices deployed), Delaware (4), Kentucky (7), Maine (9), Maryland (23), Massachusetts (9), New Jersey (25), New York (27), Ohio (28), Pennsylvania (21), Tennessee (4), and Virginia (23) (Figure 2). Previously, we deployed 50 and 150 units in 2021 and 2022 and will deploy the last round of ~200 devices this winter (January-March 2024).

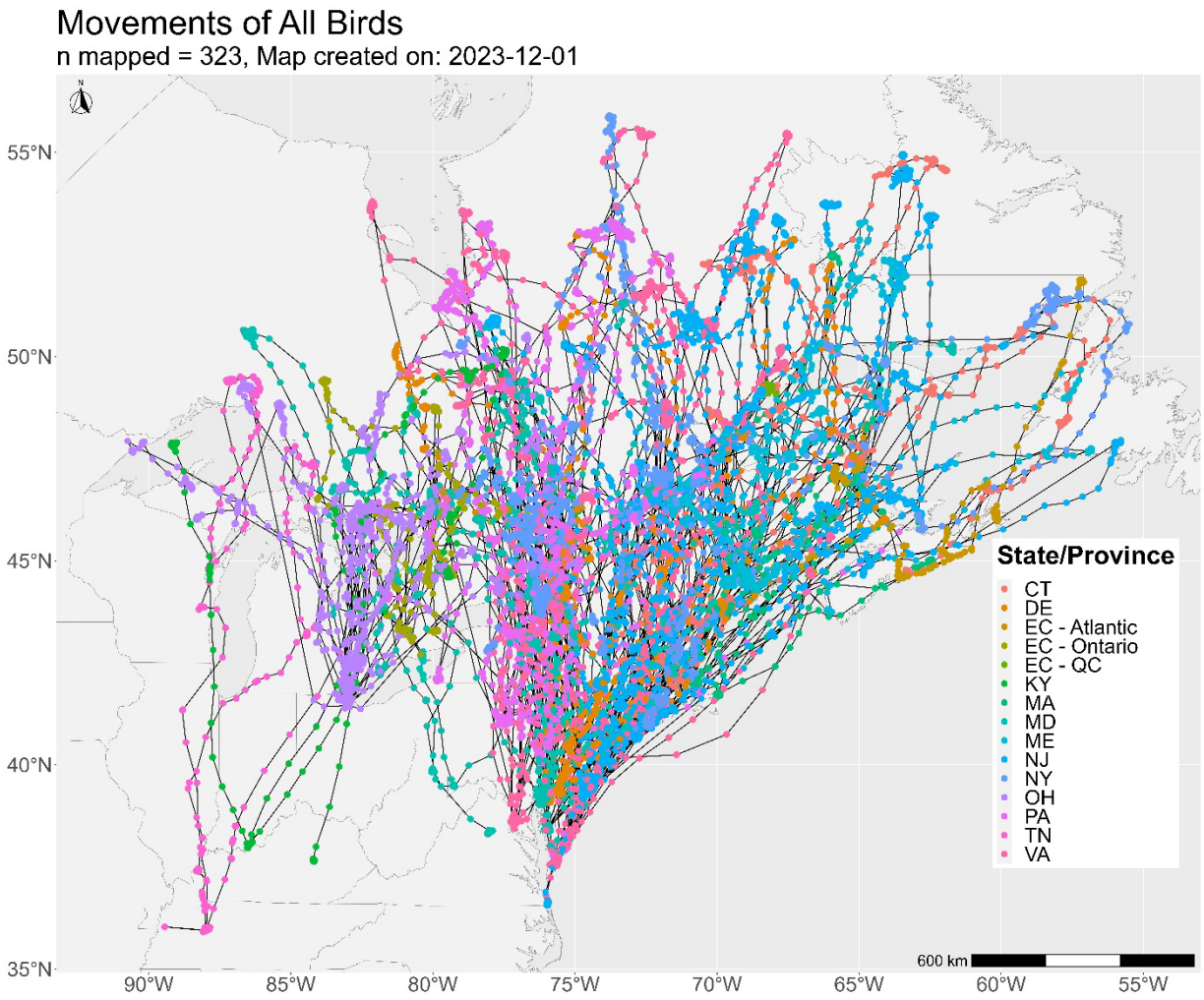

Figure 2. Movements from January 1 to December 1, 2023, of all tracked black ducks. Colour of points indicate the state or province where each device was deployed.

In total, 28 devices have been deployed at Winous Point Marsh Conservancy (WPMC) as part of this project (all in winter 2023). At this time, 21 hens are currently alive and 7 have died. Post-deployment movements of all birds from WPMC are shown in Figure 3.

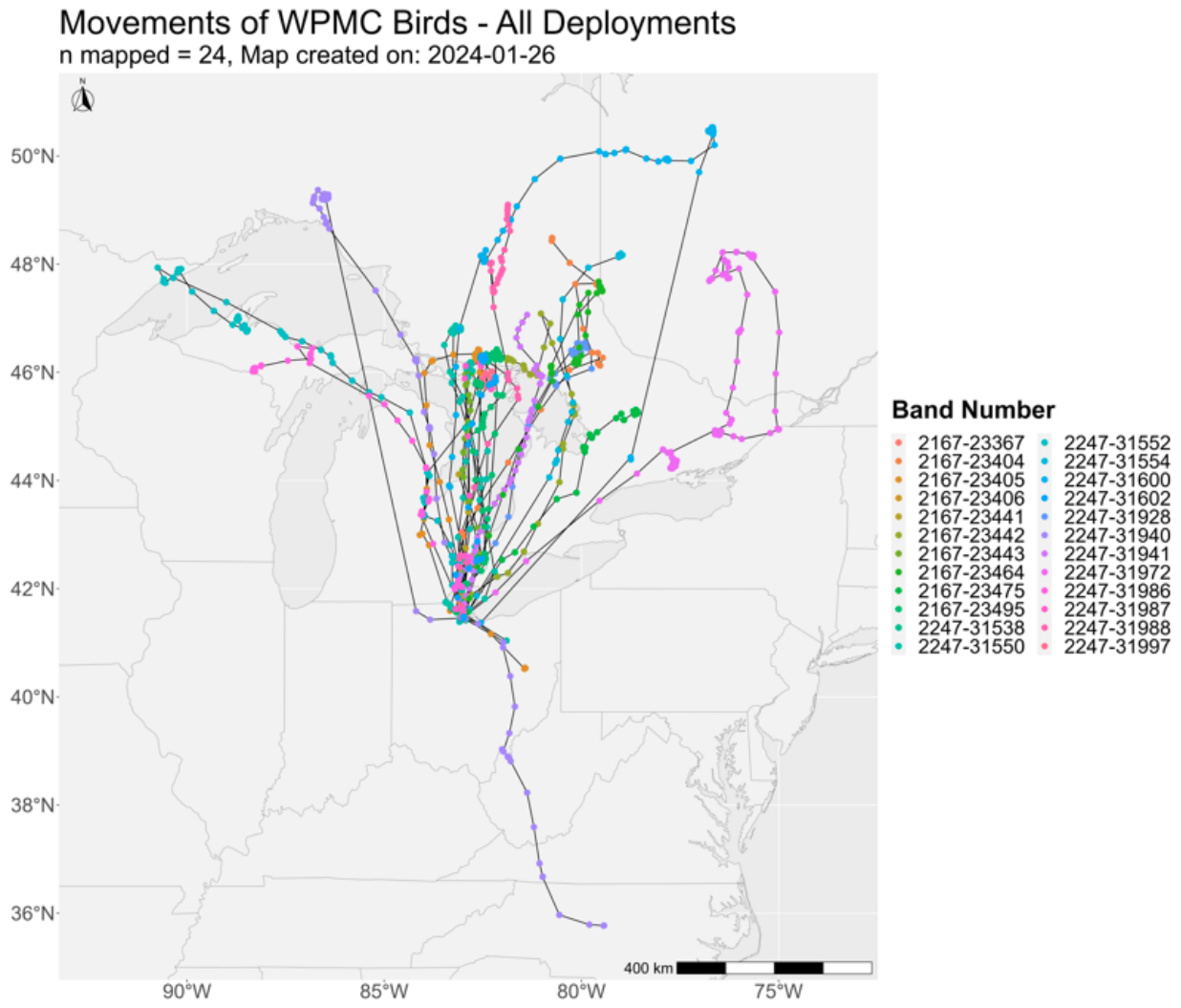

Figure 3. All movements of black ducks marked at Winous Point Marsh Conservancy in winter of 2023 through January 26, 2024. Colour of points indicate individual ducks.

We conducted a preliminary analysis investigating how proportion of time spent feeding before, during and after migration varied with spring migration characteristics, and if there were consistent trade-offs with other behaviours when feeding increased or decreased. Birds undertaking migration strategies that we presume would be more energetically costly (e.g. longer distances, fewer and/or shorter stopovers) spent more time feeding after migration and traded-off more time spent feeding with less time spent resting (Figure 4).

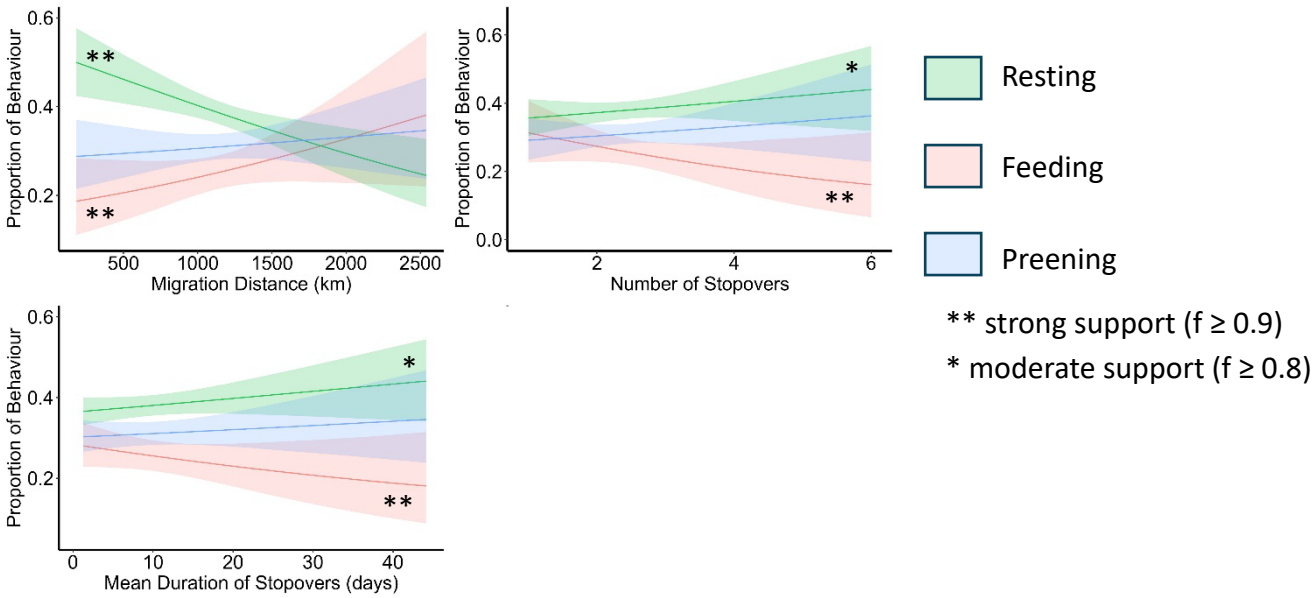

Figure 4. Relationship between the proportion of three behaviours (resting, feeding and preening) and three spring migration metrics (total migration distance, number of stopovers and mean duration of stopovers) of GPS-ACC marked black ducks.

We developed a machine learning approach to classify incubation and brood rearing behaviour remotely for black ducks. For this approach, we need known occurrences of the behaviour we are trying to classify to train the machine learning algorithms. With the help of our partners on a sister project on eastern mallards (*Anas platyrhynchos*), we have been locating nests of GPS-marked mallards and confirming the fate of the nests for known incubation behaviour. We are also confirming the presence of a brood with marked mallard hens using both human observers and drones for known brood rearing behaviour (Figure 5).

Our most recent attempts using the incubation algorithm have achieved an algorithm accuracy of classifying one day as incubation vs. non-incubation of 96%. After the algorithm classifies each day as either incubating or not, we count consecutive days classified as incubating and apply a ruleset (e.g., > 23 consecutive days = full-term incubation) to determine breeding outcome. Our final accuracy of classifying breeding outcome to full-term incubation vs. failure prior to full-term incubation is 90%. For classifying brood rearing, our algorithm accuracy for classifying one day as brood rearing vs. not brood rearing is at 86%. The training dataset for brood rearing is still small and we are hoping to do a more intense drone survey effort of broods this summer to increase our sample size.

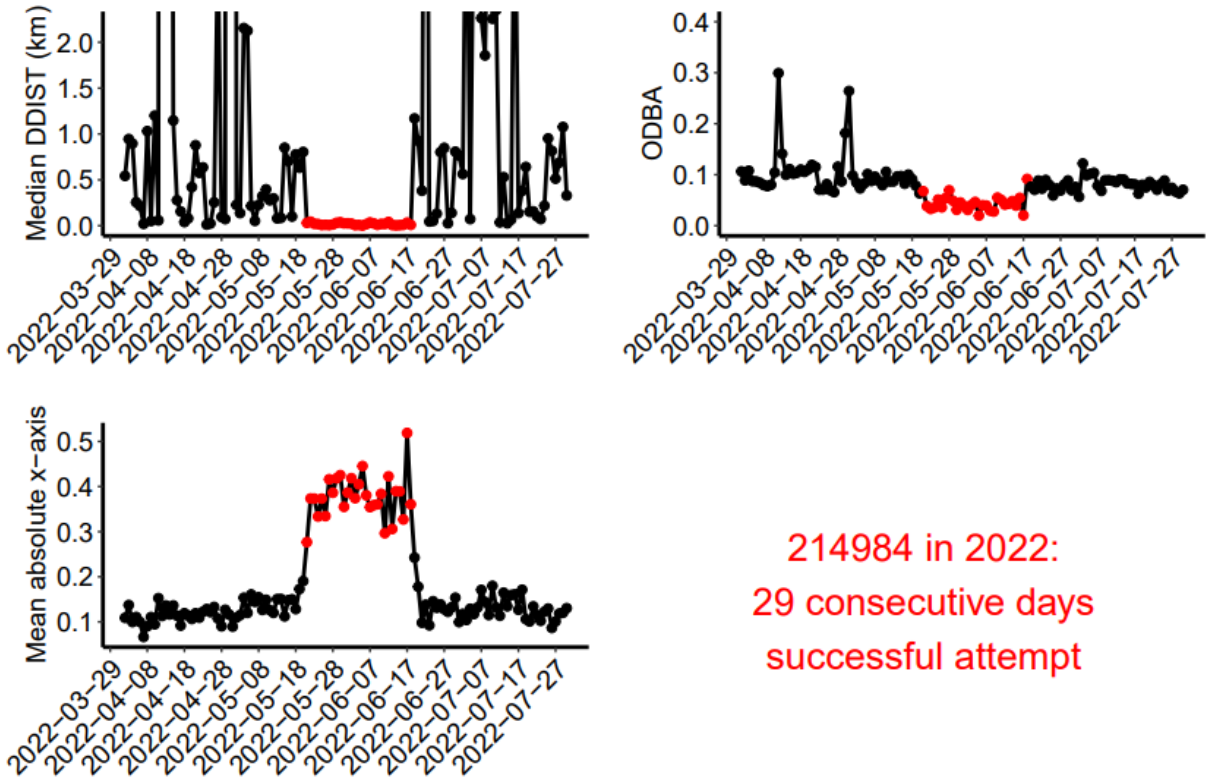

Figure 5. Daily summary metrics from April to August of a marked black duck that had 29 consecutive days classified as incubating (red points) and therefore, was deemed to have a successful nesting attempt. Daily summary metrics include median displacement distance (DDIST), which describes the distance moved between days, overall dynamic body acceleration (ODBA), a proxy for energy expenditure, and mean absolute x-axis, a measure of one axis of the acceleration data.

Winous Point Marsh Conservancy supports this project through the purchase of GPS-ACC transmitters as well as trapping and marking female black ducks in 2023 and 2024.

Wild Celery Restoration at Winous Point Marsh Conservancy

Investigators: Winous Point Marsh Conservancy and Sara Sweeten, SAVY Aquatic Restoration LLC.

Introduction: Wild celery (*Vallisneria americana*) is a submerged aquatic plant native to eastern North America. Historically, this plant was extremely abundant in shallow, slow-moving water systems and provided tremendous ecological benefits. Both the leaves and tubers were attractive food to waterfowl and other wildlife, the dense mats of submerged leaves helped improve water clarity by slowing the transport of suspended sediment and preventing the re-suspension of fine sediments, and the expansive beds of this aquatic plant were excellent nursery habitat for fish, crabs, and aquatic insects. Unfortunately, wild celery has disappeared from much of its historic range. Pre-European settlement, wild celery was also locally common at Winous Point Marsh Conservancy (WPMC) as evidenced from vegetation surveys conducted in the late 1800s, but is not found today, likely due to increased turbidity, competition from invasive plant species, and herbivory by invasive fish species.

Figure 1. SAVY Aquatic Restoration researcher, Sara Sweeten, and WPMC Intern, Darienne Purtz, planting wild celery at Winous Point Marsh in June 2023.

Summary: Many wild celery restoration efforts have been undertaken in the past, but Sara Sweeten, Ph.D., has taken a novel approach to reintroduction. Most past reintroduction efforts have focused on planting tubers or very young plants with little success, however Sara is using aquaculture techniques to grow large mature plants that are then transplanted into the wild. Sara has also been experimenting with a variety of enclosures to protect these newly established adult plants to establish "founder" colonies. As these colonies establish and grow outside of their enclosure, the hypothesis is that these adult plants will have gained enough of a foothold to deal with the stressors of their natural environment, including herbivory.

Sara has already demonstrated success with the technique. Since her research began in 2019, Sara has established wild celery in over 20 waterbodies across four states from Virginia to Minnesota. These transplanted wild celery plants have amazing growth potential. Sara has transplanted over 1,600 sq. ft. of wild celery through the course of the project. The transplants have expanded to approximately 9,200 sq. ft. or 8 times the original footprint of the plantings. WPMC staff met with Sara during the winter of 2023 and identified two potential sites for reintroduction, one inside of our dike impoundments and one on the outside of the dikes in Muddy Creek Bay. WPMC staff assisted Sara with the planting of 60 sq. feet of wild celery at the two sites. In the fall, plants were surviving in both enclosures, and the planting outside the dike had doubled in footprint after the first growing season. We are excited to see the growth of the plants this upcoming year.

Figure 2. WPMC Intern, Andrea Spuck, with wild celery ready for planting in Muddy Creek Bay.

Sara's research is still in the early stages, and she has found success to be highly variable among sites. The drivers behind this variability (e.g., herbivory, turbidity, wave energy etc.) are still not well understood, and WPMC hopes to partner with Sara on future research to better understand what causes success or failure of wild celery restoration sites.

Figure 3. Wild celery enclosure at Winous Point Marsh in July 2023.

Winous Point March Conservancy supports this project by providing supplies, field staff, time, and materials to install and maintain the enclosures in addition to providing housing and logistical support for staff needed to plant wild celery. We also thank Mr. Mike Mooney, Mr. Tim Robertson, and Mr. John Childs for their financial support of this project.

Winous Point Marsh Conservancy and Ohio Division of Wildlife Cooperative Waterfowl Banding

Investigators: Brendan Shirkey, Nate Stott, and John Simpson, Winous Point Marsh Conservancy; Michael Ervin, Ohio Division of Wildlife

Collaborators: Black Duck Joint Venture; Mark Shieldcastle, Black Swamp Bird Observatory

Schedule: Long-term

Introduction: Band recovery data is used to inform harvest management strategies to ensure sustainable harvest of waterfowl populations. Winous Point Marsh Conservancy (WPMC) has assisted the Ohio Division of Wildlife with waterfowl and bird banding operations informally and formally since the early 1950s. Our current partnership started in 2010 to assist with statewide black duck (*Anas rubripes*) banding quotas. In the years that have followed, WPMC's role has grown to meet banding goals for black ducks, wood ducks (*Aix sponsa*), and mallards (*Anas platyrhynchos*) as well as supporting a wide variety of additonal research projects in concert with our banding operations.

Our banding program offers young professionals the opportunity to hone a wide variety of field skills they will need throughout their careers and provides youth with an opportunity to connect directly with wetlands and wildlife. Maybe most importantly, our banding program has been used by 5 graduate level research projects in the last several years, contributed significantly to highly pathogenic avian influenza surveillance during the most recent outbreak, and directly contributed to several published scientific manuscripts authored by WPMC staff.

Summary: 2023 was another successful year year for our waterfowl banding program. We banded 819 ducks, leaving us just five birds short of 10,000 banded since 2010 (Table 1). During the course of banding these individuals we were able to take genetic samples and mark 39 hen mallards with GSM satellite transmitters for Ben Luukkonen's Ph.D. research that is, in-part, investigating the linkages between mallard genotype and migration probability and movement patterns (Page 13). We also marked 28 hen black ducks for Ilsa Griebel's Ph.D. research aimed at quantifying nesting success of black ducks in the boreal forest of Canada (Page 19). In addition, we used 40 of our summer banded mallards for Hunter Collins M.Sc. research into morphological differences between game-farm, hybrid, and wild mallard genotypes (Page 9).

Figure 1. WPMC Research Technician, Nate Stott, with a hen mallard captured at the Oak Harbor Conservation Club in April 2023 (left). WPMC Intern, Darienne Purtz, and volunteer, Charlie Treadwell, banding a wood duck at Winous Point Marsh in July 2023 (right).

Figure 2. Volunteer, Trent Williams, and WPMC Research Technician, Nate Stott, with mallards and black ducks captured at Winous Point Marsh in March 2023.

Table 1. Total number of waterfowl banded by species by Winous Point Marsh Conservancy from 2010 to 2023.

Year	Mallard	Wood Duck	Black Duck	Redhead	Gadwall	Canvasback	Ring Neck	Scaup	Shoveler	Pintail	Wigeon	Hooded Merganser
2010	3	0	41	0	0	0	0	0	0	0	0	0
2011	186	39	42	0	0	0	0	0	0	0	0	0
2012	49	143	125	0	0	0	0	0	0	0	0	0
2013	237	140	51	123	0	1	0	10	9	0	0	0
2014	181	164	23	7	341	5	2	5	1	7	6	0
2015	582	232	9	126	0	35	32	13	0	0	0	0
2016	679	307	127	80	10	0	2	0	0	1	0	0
2017	575	266	84	148	0	13	0	11	0	0	0	0
2018	71	150	169	0	0	0	0	0	0	0	0	0
2019	440	67	64	143	0	0	0	2	0	0	0	0
2020	306	245	86	0	0	0	0	0	0	0	0	2
2021	304	246	110	0	0	0	7	0	0	0	0	0
2022	784	498	201	8	0	0	0	0	0	0	0	0
2023	244	381	194	0	0	0	0	0	0	0	0	0
Totals	**4641**	**2878**	**1326**	**635**	**351**	**54**	**43**	**41**	**10**	**8**	**6**	**2**
										Grand Total		**9995**

Banding data from WPMC illustrates the migratory strategies of two different species of Great Lakes breeding waterfowl. Mallards banded at WPMC tend to migrate only as far south as needed in late fall, and winter band recoveries are infrequent south of Tennessee and North Carolina (Figure 3). In contrast, wood ducks, the second-most common Great Lakes breeding duck, migrate to wintering areas much further south and winter band recoveries are clustered in South Carolina, Georgia, and Alabama (Figure 3). This pattern is consistent with what we see from our satellite transmitter projects and from larger, regional analyses of waterfowl distributions.

Andrea Spurck's M.Sc. thesis (Page 5) is investigating changing winter waterfowl distributions, and her hypotheses were driven by some of the mallard band recovery data displayed in Figure 3. Andrea will use Christmas Bird Count data from 1960 to 2023 to look for changes in winter mallard and other dabbling duck distributions over time, and if that change has been occurring, attempt to model future changes in waterfowl distributions.

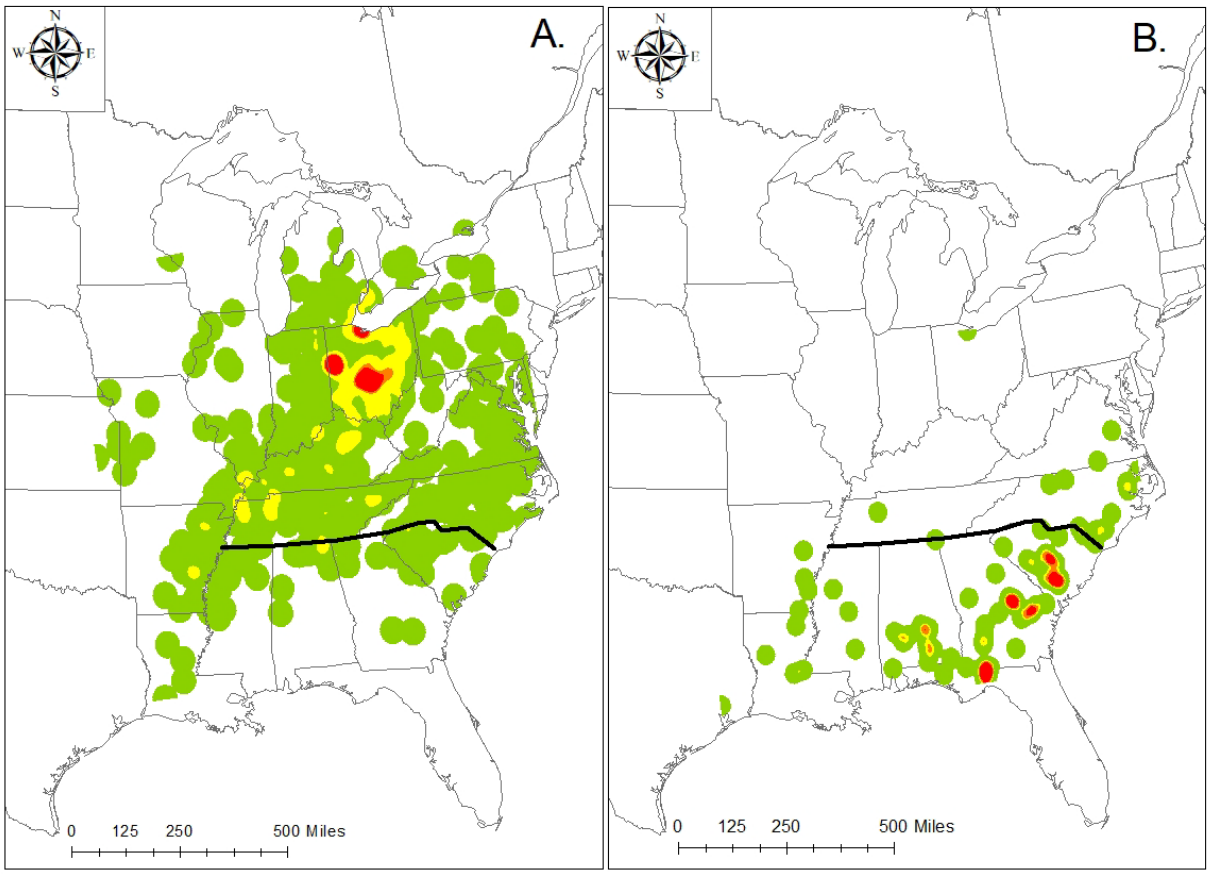

Figure 3. Density maps of winter (December-February) band recoveries for mallards and black ducks (A. left) and wood ducks (B. right) banded at Winous Point Marsh from 2011 to 2022. Red indicates higher densities of band recoveries relative to areas to areas of green which indicate lower densities of band recoveries. The black line along the southern boundary of Tennessee and North Carolina highlights the difference in wintering latitude between mallards/black ducks and wood ducks.

Winous Point Marsh Conservancy supports this project through a Cooperative Agreement with the Ohio Division of Wildlife whereby WPMC supplies field staff, time, and materials to band waterfowl and analyze data. Additional project funding is also provided by the Black Duck Joint Venture. Black Swamp Bird Observatory provides additional banding staff and resources. We thank the many volunteers that assist us with our banding operations each year.

Winous Point Marsh Conservancy and Ohio Division of Wildlife Cooperative Common Tern Monitoring

Investigators: Brendan Shirkey and Nate Stott, Winous Point Marsh Conservancy; Laura Kearns, Ohio Division of Wildlife; Caleb Wellman, USDA Wildlife Services and Dennis Franklin, Toledo Metroparks

Introduction: Common terns (*Sterna hirundo)* have been listed as state endangered in Ohio since 1974 and are state endangered or threatened in many of the states and provinces surrounding the Great Lakes. Common terns were previously extirpated in Ohio due to loss of their natural beach and island nesting habitat along the shores of Lake Erie. As a result, the Ohio Division of Wildlife started deploying artificial nesting platforms in the 1990s. Two breeding colonies now exist in Ohio, one at Toledo Metroparks Howard Marsh (Lucas County) and one at the Winous Point Marsh Conservancy (WPMC) Metzger wetland (Sandusky County). U.S. Department of Agriculture (USDA) Wildlife Services manages predation at both colonies by equipping platforms with electric fencing to deter land-based predators, elevated gridding to deter aerial predators, and trapping and removal of Great-horned owls (*Bubo virginianus*) and other predators.

Figure 1. WPMC Intern, Andrea Spurck, marking common tern nests at Howard Marsh in June 2023.

Summary: The Ohio Division of Wildlife, Toledo Metroparks, WPMC, and USDA Wildlife Services staff deployed six artificial nesting platforms at Howard Marsh and six platforms at WPMC's Metzger wetland. Early in the field season, one platform sunk at Howard Marsh and had to be removed for repairs leaving that colony with five platforms for the season. Two of the platforms at the Metzger wetland were taking on water early in the year and were removed, repaired, and re-deployed prior to the breeding season.

The total number of successful nests has remained relatively constant since 2018 (Figure 3). In 2023, we observed a total of 258 successful nests between both colonies with 210 successful nests on five platforms at Howard Marsh (87.1%) and 48 successful nests on six platforms at WPMC (41.7%, Table 1). The observed low nesting success at the WPMC colony was largely driven by racoon (*Procyon lotor*) predation that occurred early during the nesting season.

Fledging success was down significantly from what was observed in 2018-2021, but was higher than in 2022, when mink (*Mustela vison*) predation decimated the Howard Marsh colony (Figure 1). The Howard Marsh colony successfully fledged 87 chicks in 2023 (40.5%) and the Winous Point colony successfully fledged 28 chicks (30.4%, Table 2). Great-horned owl predation continued to be an issue at both colonies, and USDA also noted some mortality that was likely not a result of predation.

Figure 2. WPMC Research Technician, Nate Stott, anchoring a common tern nesting platform at WPMC's Metzger wetland in May 2023.

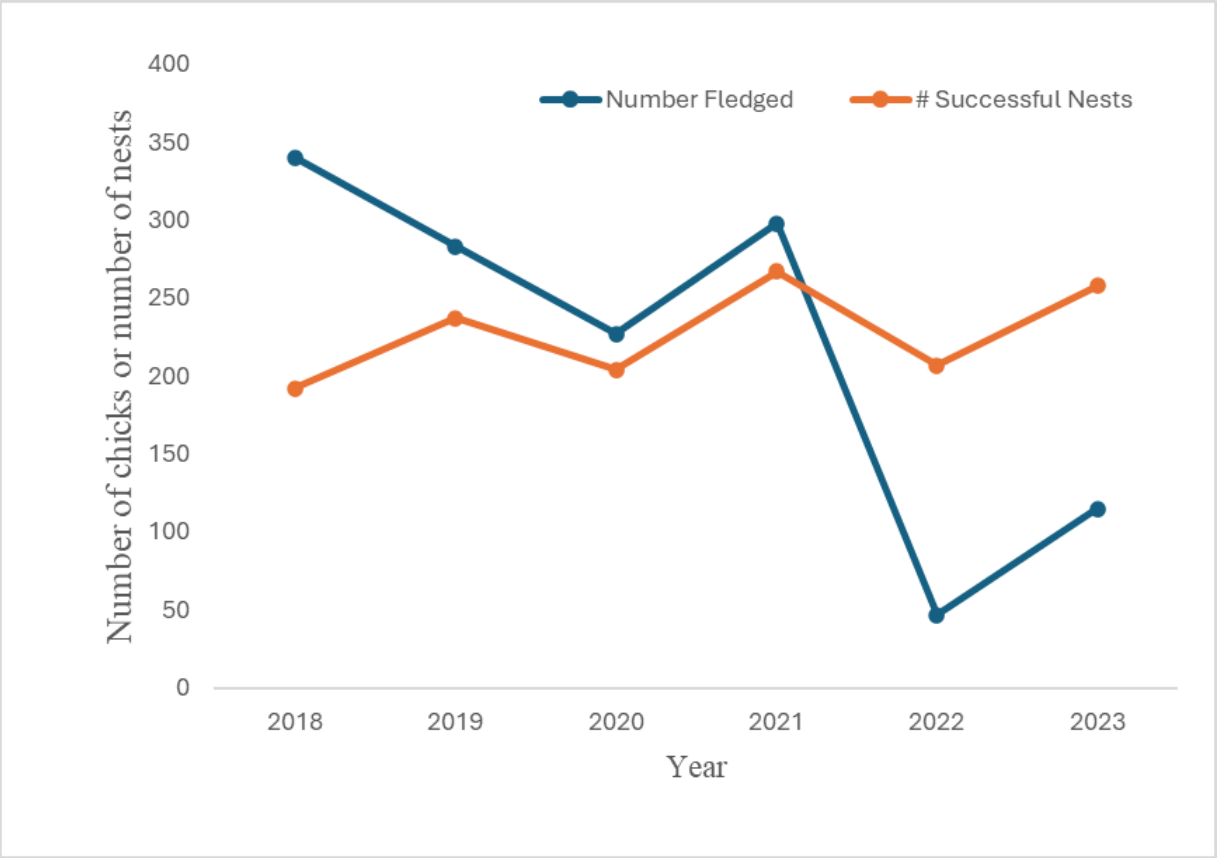

Figure 3. Total number of successful nests (orange) and successfully fledged chicks (blue) at artificial common tern nesting colonies in Ohio from 2018 to 2023.

Table 1. Total number of nests, number of succesful nests, and the success rate by platform at the Howard Marsh and Metzger wetland common tern colonies during the summer of 2023.

Howard Marsh Nests			
Platform ID	Total Nests	Successful Nests	Success Rate
1	9	0	0.000
2	55	47	0.855
3	55	51	0.927
4	50	47	0.940
5	31	27	0.871
6	41	38	0.927
Total	**241**	**210**	**0.871**
Metzger Wetland Nests			
Platform ID	Total Nests	Successful Nests	Success Rate
1	18	12	0.667
2	20	9	0.450
3	18	6	0.333
4	12	1	0.083
5	19	0	0.000
6	28	20	0.714
Total	**115**	**48**	**0.417**

Table 2. Number of tern chicks banded, the number of confirmed and presumed mortalities, and the estimated fledging rate of common tern chicks at the Howard Marsh and WPMC Metzger colonies in 2023.

Fledging Rates			
Colony		Howard Marsh	WPMC Metzger
Birds Banded		215	92
Mortalities		129	64
	Assumed Mortalities	*48*	*28*
	Confirmed Mortalities	*81*	*36*
Fledged		87	28
Fledging Rate		**0.405**	**0.304**

WPMC supports this project through a cooperative agreement with the Ohio Division of Wildlife whereby WPMC supplies field staff, time, and materials to monitor chick and nesting success and to host one of the tern colonies. The project is also supported by Toledo Metroparks and USDA Wildlife Services.

Additional Research Supported by WPMC in 2023

Community Purple Martin Monitoring and Citizen Science

The purple martin (*Progne subis*) is a colonial cavity nesting swallow that readily uses artificial nesting cavities during the breeding season. The Winous Point Marsh Conservancy (WPMC) has provided purple martin housing since the 1940s as part of early bird banding programs. In 2018 and 2019, with the help of the Green Creek Wildlife Society and Ohio Division of Wildlife Diversity grant funds, WPMC replaced our unmaintained nesting structures with eight new nesting towers totaling 144 nesting cavities. We use these nesting towers to facilitate volunteerism, support our educational programs, and as a self-sufficient research opportunity for local high school students interested in pursuing wildlife and conservation degrees.

Figure 1. Purple martins at Winous Point Marsh nesting structures, 2022.

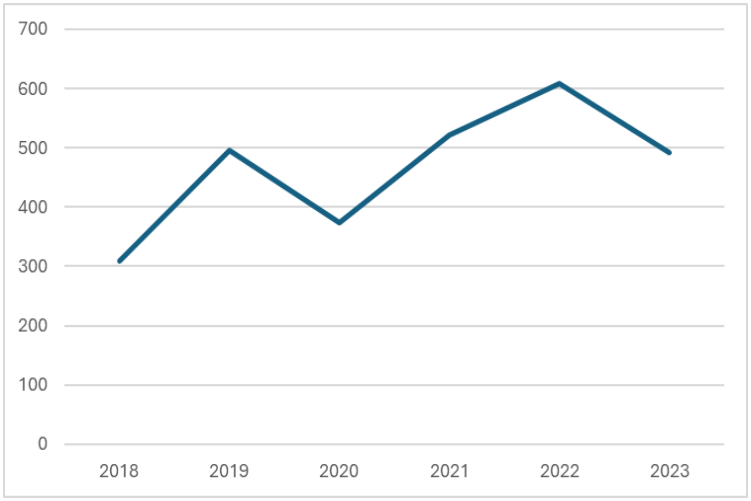

Figure 2. Number of purple martin chicks banded at Winous Point Marsh, 2018-2023.

Estimating Crippling Loss Using a Novel Methodology

The United States Fish and Wildlife Service (USFWS) currently uses an estimate of 20% crippling loss to adjust harvest and harvest rate estimates to account for waterfowl that are shot by hunters but not retrieved. A variety of previous research has been conducted to estimate crippling loss using self-reported hunter questionnaires that provided the results used by the USFWS. However, other studies that have used observers at a distance have resulted in crippling loss estimates higher than 20%, suggesting there may be self-reporting bias on hunter questionnaires.

Winous Point Marsh Conservancy examined self-reporting bias by collecting data from Winous Point Shooting Club guided hunts that allow for close-range observers (hunting guides) to track downed and wounded ducks by hunters they guide. At the same time, these guides self-report wounded and crippled ducks on their own hunts, thus allowing us to test for observer bias between self-reporting and observer-based estimation methods. Preliminary results from data collected 2021 through 2023 suggest that a self-reporting bias is present (Figure 1).

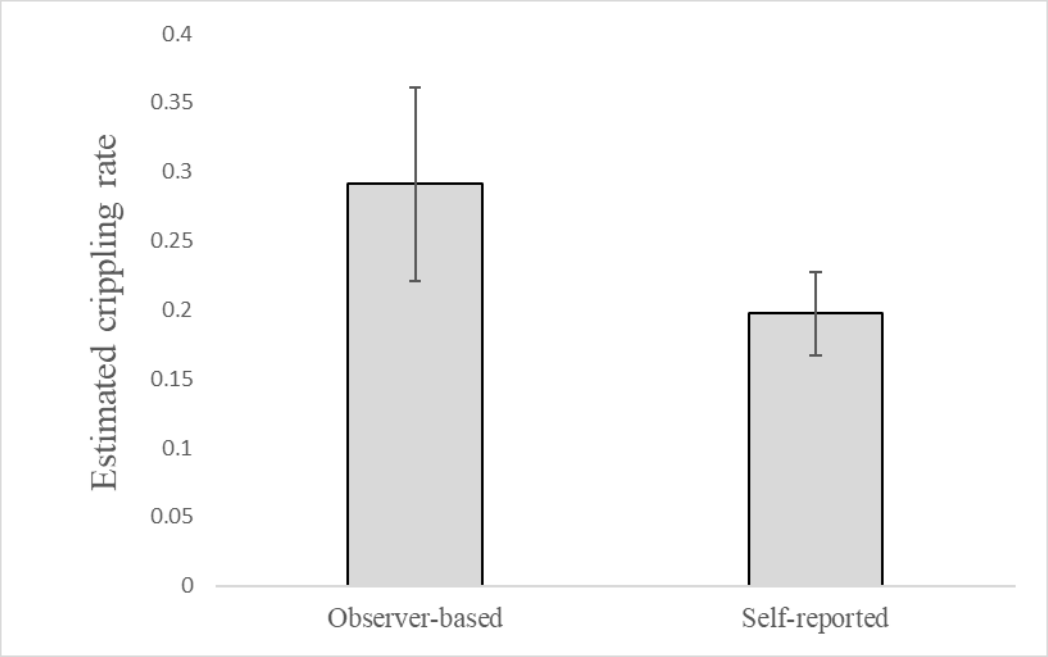

Figure 1. Crippling rate estimates from 2021-2023 for observer-reported hunts (29%) and self-reported hunts (20%).

Specials thanks to technicians and students Trey McClinton, Hunter Collins, and Nate Stott who led data collection efforts.

Investigating Duck Antibody Response to Influenza Viruses

Aquatic birds, including ducks, are the natural reservoir of influenza A viruses, which can jump into humans to cause pandemics. Influenza A viruses are highly variable with multiple types and variants within these types that can cause infection. While influenza A viruses can be incredibly dangerous to humans and other animals, ducks are constantly exposed to different types of influenza A virus without getting sick. The goal of our study is to understand what makes ducks unique by studying how they generate immunity against influenza A viruses. We are focusing our studies on antibodies, which function to recognize and eliminate foreign invaders. Studying antibodies from ducks that control infection can provide valuable insight for developing therapeutics and vaccines against influenza A viruses. However, our understanding of duck antibody response to influenza A virus is extremely limited due both to lack of adequate samples and tools to study immunity within ducks.

In 2023, Winous Point Marsh Conservancy was contacted by Nicholas C. Wu and Huibin Lv, University of Illinois at Urbana-Champaign, and Jenna J. Guthmiller, University of Colorado Anschutz Medical Campus to initiate a collaborative program in collecting blood and colon samples from wild, free-ranging ducks during the hunting seasons. During November and December 2023, 19 blood samples and 18 colon samples from hunter-harvested ducks were collected. Samples were sent to the University of Colorado Anschutz Medical Campus for processing. In the new year, researchers at the University of Illinois at Urbana-Champaign are analyzing B cells within these samples, with the goal of isolating anti-influenza monoclonal antibodies to study how they are distinct from human antibodies. We expect this collaborative project will lead to the discovery of monoclonal duck antibodies with broad virus binding capacity. The results will not only provide important insights into the interplay between influenza virus and the immune system of ducks, but also reveal how duck antibodies provide protection.

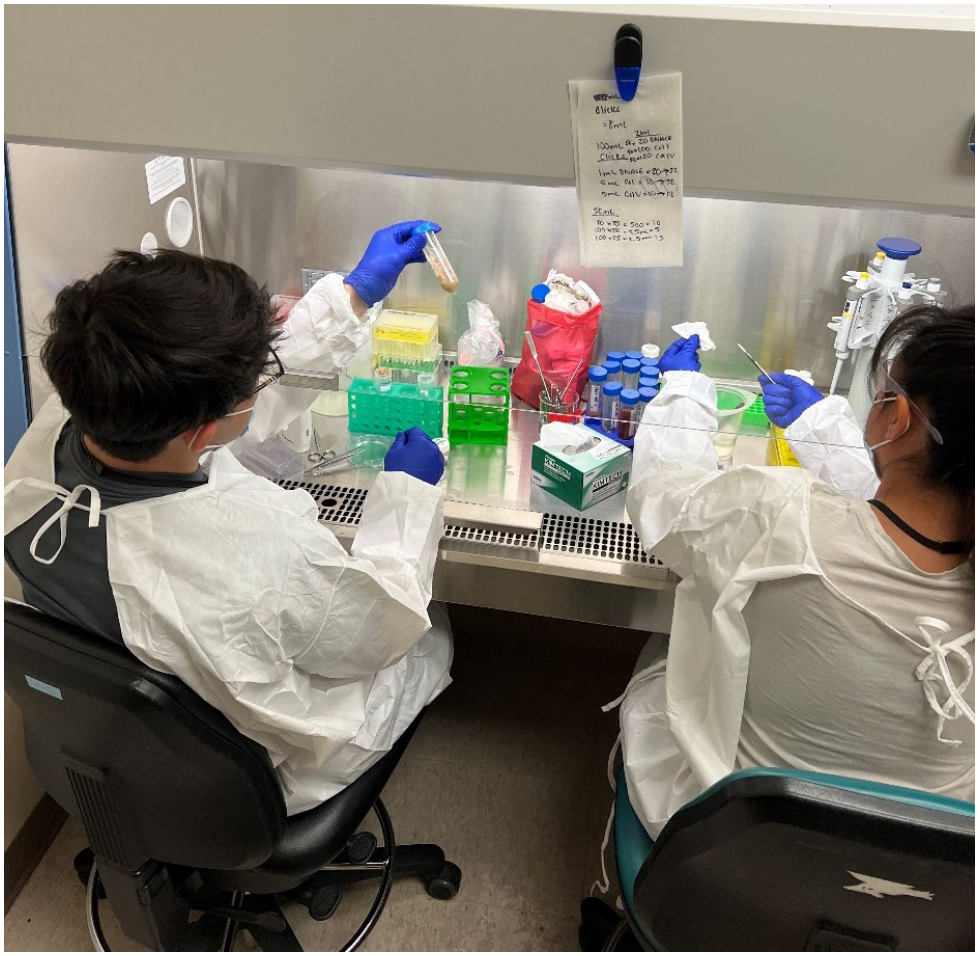

Figure 1. Lab Technicians Edgar Ayala and Alyssa Monterrosso handling mallard blood and intestines collected at Winous Point Marsh during autumn of 2023.

This project is funded by Howard Hughes Medical Institute's Emerging Pathogens Initiative. Winous Point Marsh conducts field collections of wild ducks and samples from wild ducks.

2023 Interns and Technicians

Darienne Purtz, Internship 2023: Darienne made her first trip to Winous Point Marsh in October 2022 as a participant in our Delta Waterfowl University Hunt Program. She returned in May 2023 for a summer internship with WPMC where she got her hands into all of our research and conservation projects as well as helping maintenance staff prepare for the fall hunting season. Darienne is currently wrapping up her Environmental Science (Ecosystem Restoration) degree at Ohio State University and planning the next step in her conservation career.

Nate Stott, Research Technician 2023: After completing his Ph.D. in Biology at Bowling Green State University in 2023, Nate started with us as our research technician, overseeing WPMC's graduate and partnership research projects. Nate is currently continuing to work here in a shared post-doctoral position with Ohio State University where he will develop and implement a bird monitoring program to evaluate how wetlands restored by Ohio's H2Ohio water-quality program also provide additional value for wetland-dependent birds.

Andrea Spurck, Internship 2022 and 2023: Andrea returned for a second internship at Winous Point Marsh Conservancy in 2023, where she led our summer duck banding program and assisted with our other research projects in addition to working on her graduate thesis. Andrea is also our first graduate student under the new Winous Point Endowed Professorship at Ohio State University and a Brown Fellowship Student. Andrea is scheduled to complete her research and degree in December 2024.

2023 WPMC Activities and Presentations

January	Attended Ohio Wildlife Management Association Conference, Columbus, OH
January	Hosted Mississippi Flyway Black Duck Trapping and Transmitter Attachment Workshop
February	Attended North American Wetlands Conservation Act Grant Proposal Workshop, Ottawa National Wildlife Refuge, OH
February	Hosted Wild Celery Site Evaluation Meeting
March	Presented at Ohio Wildlife Diversity Conference, Columbus, OH
March	Hosted Lake Erie Marsh Association Winter Meeting
March	Hosted Port Clinton Women's Club Meeting and Tour
March	Attended Long Point Waterfowl Scientific Advisory Committee Meeting, Virtual
March	Attended Ottawa County Soil and Water Conservation District Partners Breakfast, Oak Harbor, OH
April	Attended Frogbit Invasive Species Research and Control Webinar
April	Hosted Ohio Wildlife Officer Training "Birding Academy"
April	Attended Upper Mississippi River/Great Lakes Joint Venture Meetings, Columbus, OH
April	Hosted Ohio Decoy Carvers and Collectors Annual Meeting
May	Attended Great Lakes Marsh Bird Conservation Network Meeting, Lansing, MI
May	Attended Dustin Brewer's Ph.D. Dissertation "Developing Habitat Occupancy Models and Addressing Call-Response Biases for King Rails in the Great Lakes Region", Virtual
May	Attended Bayesian Statistics Workshop, Columbus, OH
May	Hosted Port Clinton Middle School 7th Grade Science Classes (3)
May	Presented at Firelands Audubon Society Meeting, Sandusky, OH
May	Hosted WPMC Annual Meeting
May	Hosted Ohio Department of Natural Resources Governor's Bird Ohio Field Trip
May	Hosted Black Swamp Bird Observatory "Biggest Week" Birding Tours (3)
May	Hosted Naturalist Journeys Birding Field Trip
June	Attended "Structured Decision Making to Address Climate Change" Workshop, Ottawa National Wildlife Refuge, OH
June	Assisted with Toledo Public School Wetland Field Trip, Bayview, OH
July	Hosted Fremont High School Outdoor Education Event and Field Trip
July	Attended Mississippi Flyway Collaborative Wood Duck Research Meeting, Virtual
July	Hosted "Day on the Wildside" Youth Education Event
July	Hosted "Women in Conservation" Field Day and Tour
July	Attended Hunter Collin's M.Sc. Thesis Proposal Committee Meeting, Virtual
July	Hosted Local "Plein Air" Artists Field Day

August	Attended Lake Erie Cooperative Weed Management Association Planning Meeting, Oak Harbor, OH
August	Hosted US Fish and Wildlife Service and Ohio Division of Wildlife Regional Staff Orientation Tour
September	Hosted U.S. Department of Energy COMPASS Research Project Site Visit
September	Attended Ohio Division of Wildlife State Wildlife Action Plan Meeting, Mohican State Park, OH
October	Guest Lecture for Ohio University Ornithology Class, Virtual
October	Hosted National Wild Pheasant Technical Committee Field Tour
October	Attended Mississippi Flyway Collaborative King Rail Research Project Meeting, Virtual
October	Hosted Delta Waterfowl University Hunt Program Field Day
October	Attended Ohio Ducks Unlimited Partnership Hunt Dinner, Port Clinton, OH
November	Attended The Wildlife Society Conference, Louisville, KY
November	Hosted Ohio University Ornithology Class Field Tour
December	Attended "Ruffling Feathers: Implications of Sanctuary Disturbance on Mallard Behavior and Waterfowl Harvest Opportunity" Webinar

See Figures 1 – 12 on the next several pages for photographs from some of the educational events at Winous Point Marsh Conservancy in 2023.

Figure 1. Participants learn to tie fly-fishing lures during "Day on the Wildside", 2023.

Figure 2. Participants learn about snakes and other herptiles at "Day on the Wildside", 2023.

Figure 3. Punt boat trips to learn about marsh ecosystems are part of each "Day on the Wildside".

Figure 4. Learning safe gun handling and shooting at "Day on the Wildside", 2023.

Figure 5. Volunteers teach archery to middle-schoolers during "Day on the Wildside", 2023.

Figure 6. Unhooking a fish during the fishing session at "Day on the Wildside", 2023.

Figure 7. Port Clinton 7th grade science students learning about wetlands and water quality, May 2023.

Figure 8. Port Clinton 7th grade science students learning about migratory songbirds, May 2023.

Figure 9. Port Clinton 7th grade science students observe wetlands and wetlands wildlife, May 2023.

Figure 10. Port Clinton 7th grade science students compare nutrients and sediments in water samples, May 2023.

Figure 11. Participants in the Delta Waterfowl University Hunt Program sponsored by WPMC, Toussaint River Watershed Conservancy, Ohio State University, and Ohio Division of Wildlife, October 2023.

Figure 12. Participants in the Delta Waterfowl University Hunt Program sponsored by WPMC, Toussaint River Watershed Conservancy, Ohio State University, and Ohio Division of Wildlife, October 2023.

2023 WPMC Publications

Published:

Kane, M., T. M. Gehring, B. T. Shirkey, K. L. Pangle, D. G. Uzarski, M. A. Picciuto, and J. W. Simpson. 2023. King Rail (*Rallus elegans*) presence in the Midwestern United States is predicted by local-scale factors and avian community. Ecology and Evolution 13(11):e10732

Brewer, D. E., T. M. Gehring, B. T. Shirkey, J. W. Simpson. 2023. King Rail (*Rallus elegans*) response to audio playback: implications for population estimation, monitoring methodology, and trapping approach. Journal of Field Ornithology 94(2).

Brewer, D. E., T. M. Gehring, M. M. Garcia, B. T. Shirkey, J. W. Simpson, A. M. V. Fournier. 2023. King rail (*Rallus elegans*) home range and microhabitat characteristics in western Lake Erie coastal marshes. Ecology and Evolution 13(4).

Schummer, M., J. W. Simpson, B. T. Shirkey, S. Kucia, P. Lavretsky, D. Tozer. 2023. Population genetics and geographic origins of mallards harvested in northwestern Ohio. PLoS ONE 18(3):e0282874

Brewer, D.E. Advancing secretive marsh bird conservation: Monitoring methodology, habitat association, and conspecific attraction. Ph.D. Dissertation, Central Michigan University. Mount Pleasant, MI, U.S.A.

In Review:

Vocalization behavior of resident and migrant Virginia rails (*Rallus limicola*) and soras (*Porzana carolina*) in northwestern Ohio, U.S.A. Waterbirds, *in review.* Shirkey, B. T., J. W. Simpson, J. M. Hansen, N. M. Hengst, R. J. Gates, and C. M. Tonra.

In Preparation:

Departure probabilities and spring migratory movement of Virginia Rails marked in northwestern Ohio. Hengst, N. M, N. D. Stott, B. T. Shirkey, R. J. Gates, and J. W. Simpson.

King Rail (*Rallus elegans*) Morphometric, Nesting, Mortality, and Movement Notes from a Northern Study Area. Brewer, D. E., T. M. Gehring, B. T. Shirkey, J. W. Simpson.