RESEARCH AND EDUCATION
2023 STATUS UPDATE

# A Special Report from Delta Waterfowl

## 2023 Research Roster Highlights

Delta Waterfowl has always believed that waterfowl management decisions should be based on sound science. It's a philosophy Delta has followed since Dr. Albert Hochbaum began his work as the organization's first science director in 1938 at the Delta Marsh. Delta has continually focused research on ducks and duck hunting issues in North America. This strategy allows The Duck Hunters Organization to study important, long-term issues, as well as new concerns impacting ducks and duck hunters.

Delta's research informs our Duck Production, Habitat Conservation, and HunteR3 programs, as well as waterfowl management decisions throughout North America. Ultimately, all of our research supports Delta's mission to produce ducks and ensure the future of duck hunting.

This special report highlights our 2023 research program. Although the descriptions of each project are brief, more information is always available. As always, feel free to contact me to discuss any of Delta's research.

**Dr. Chris Nicolai**
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DELTA WATERFOWL'S LEGACY OF LEADING-EDGE SCIENCE DATES TO THE 1930S, WHEN ALDO LEOPOLD VISITED MANITOBA'S DELTA MARSH.

## Hot Spot Trapping to Improve Dabbler Production

### Evaluating dabbler nest success with a new trapping technique

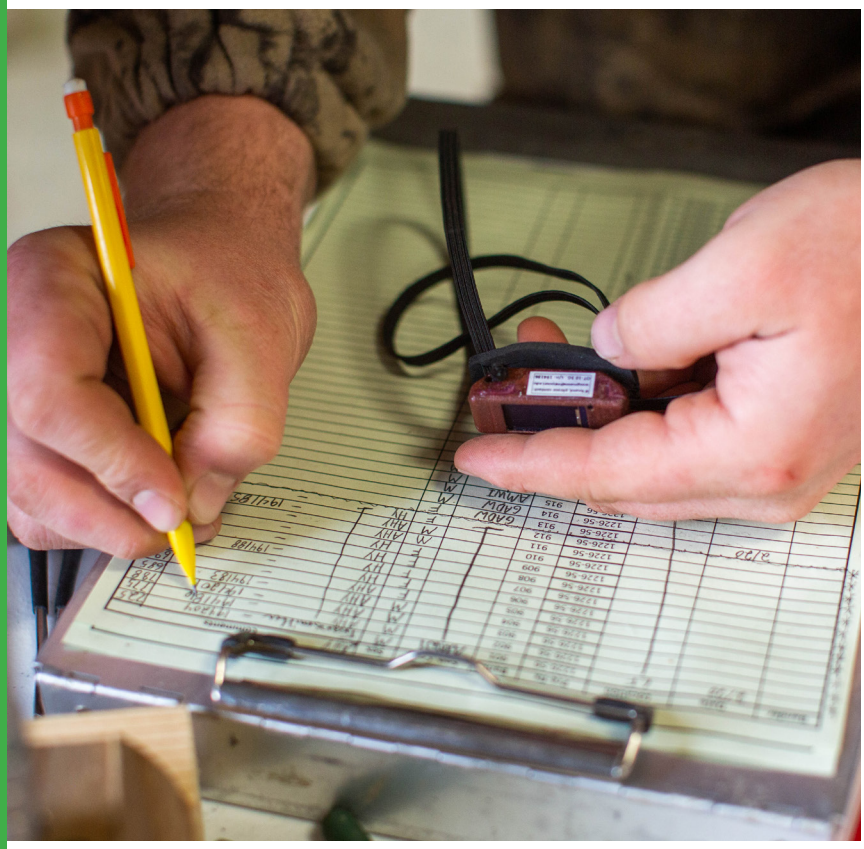
Hunter Veltkamp, M.S. Student, Dr. Todd Arnold, University of Minnesota, and Dr. Chris Nicolai, Delta Waterfowl

Delta is exploring whether focusing Predator Management on highly productive patches of grassland habitats could more efficiently boost production of dabblers such as mallards, pintails, and gadwalls. This project is vastly different from past nesting/predator removal projects in that we are interested in assessing how many ducks try to nest, rather than simply measuring nest success.

Predator trapping has typically focused on the full area of a township-sized block. Recent Delta projects have identified "hot spot" trapping as a potentially more effective approach to removing predators and a more efficient use of management dollars. Focusing trapping efforts on "hot spots" (i.e., grass-only sites) would allow waterfowl managers needed flexibility in both the size and location of Predator Management sites. This project will take place in North Dakota and help inform whether "hot spot" trapping can help increase duck production in the best quality habitats.

**DELTA WATERFOWL'S RESEARCH AND EDUCATION PROGRAM HAS RESULTED IN MORE THAN 950 PEER-REVIEWED STUDIES**

To estimate how many ducks are using the different treatment blocks, we are using a variety of methods to estimate how many nests are missed using a single pass chain drag. Efforts to use GPS to map ATV tracks and nests will allow the use of distance sampling methods. We are also dragging a sample of nesting cover a second time within 20 minutes to determine how many nests are missed on a single pass.



## Raccoon Satellite Telemetry

### Studying movements and habitat use of raccoons to improve effectiveness of Predator Management

Dr. Charlotte Milling, Post-Doctoral Researcher, Dr. Stanley Gehrt and Mr. Shane Mckenzie, Max Mcgraw Wildlife Foundation

In 2018, 2019, and 2021, we fitted 42 raccoons with GPS transmitting collars on Delta's canvasback study block in Manitoba. The transmitters collected incredible amounts of location data on each raccoon's daily movements. We discovered that raccoons spent a large percentage of time in wetland edges. Due to Covid-19, we were unable to track any raccoons in 2020. All of the field work has been completed and stable isotope samples are being processed in the lab. The goal is to better understand raccoon habits so we can set traps in their preferred locations, thereby more effectively reducing these top predators of diving-duck nests. We will also use stable isotopes to evaluate the role of duck eggs in the diet of raccoons. Ultimately, the goal is to learn more about raccoons, so we can manage these non-native predators and increase production of canvasbacks, redheads, ring-necked ducks, and other over-water nesting ducks.

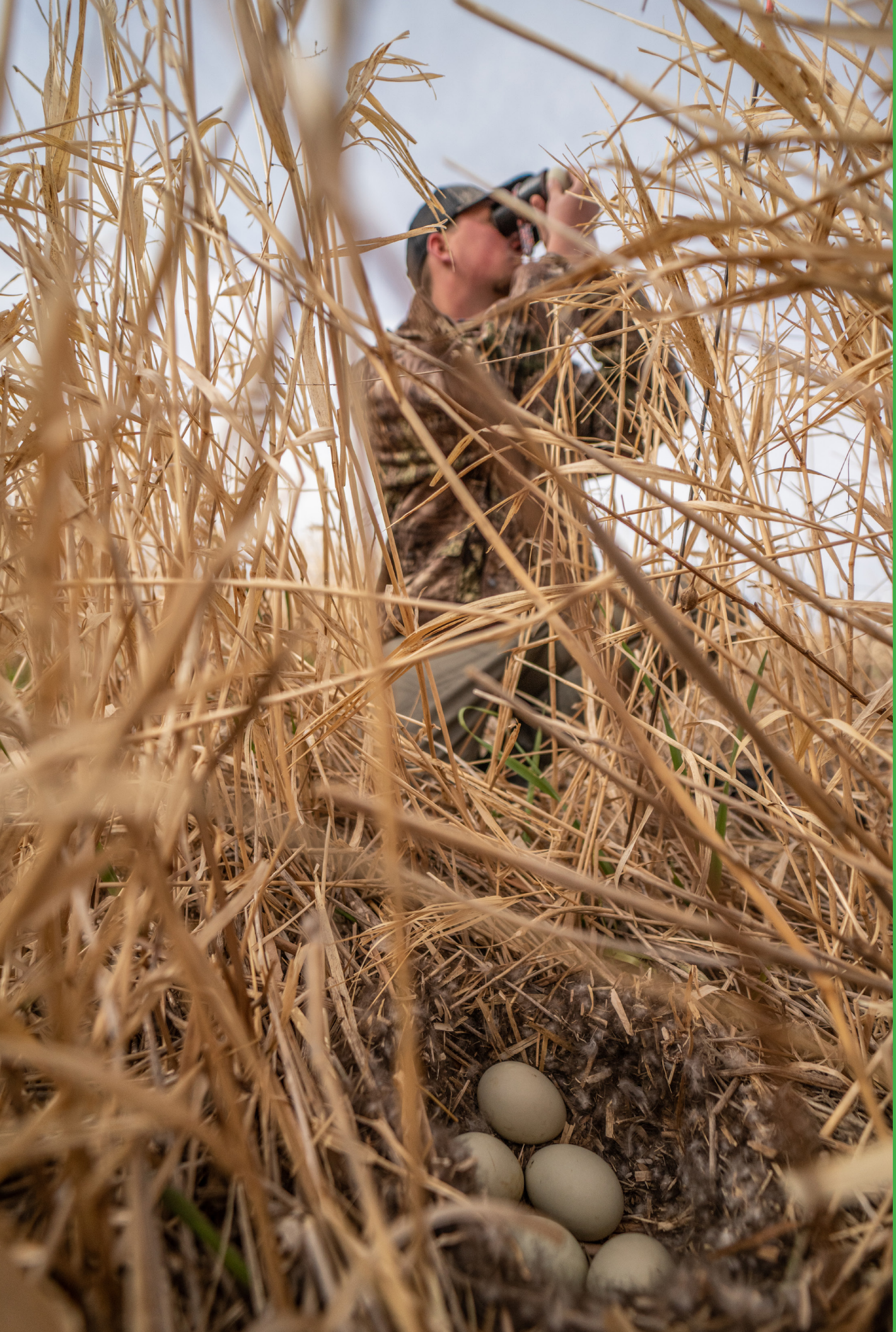
## Lower Mississippi Flyway Dabbler Tracking

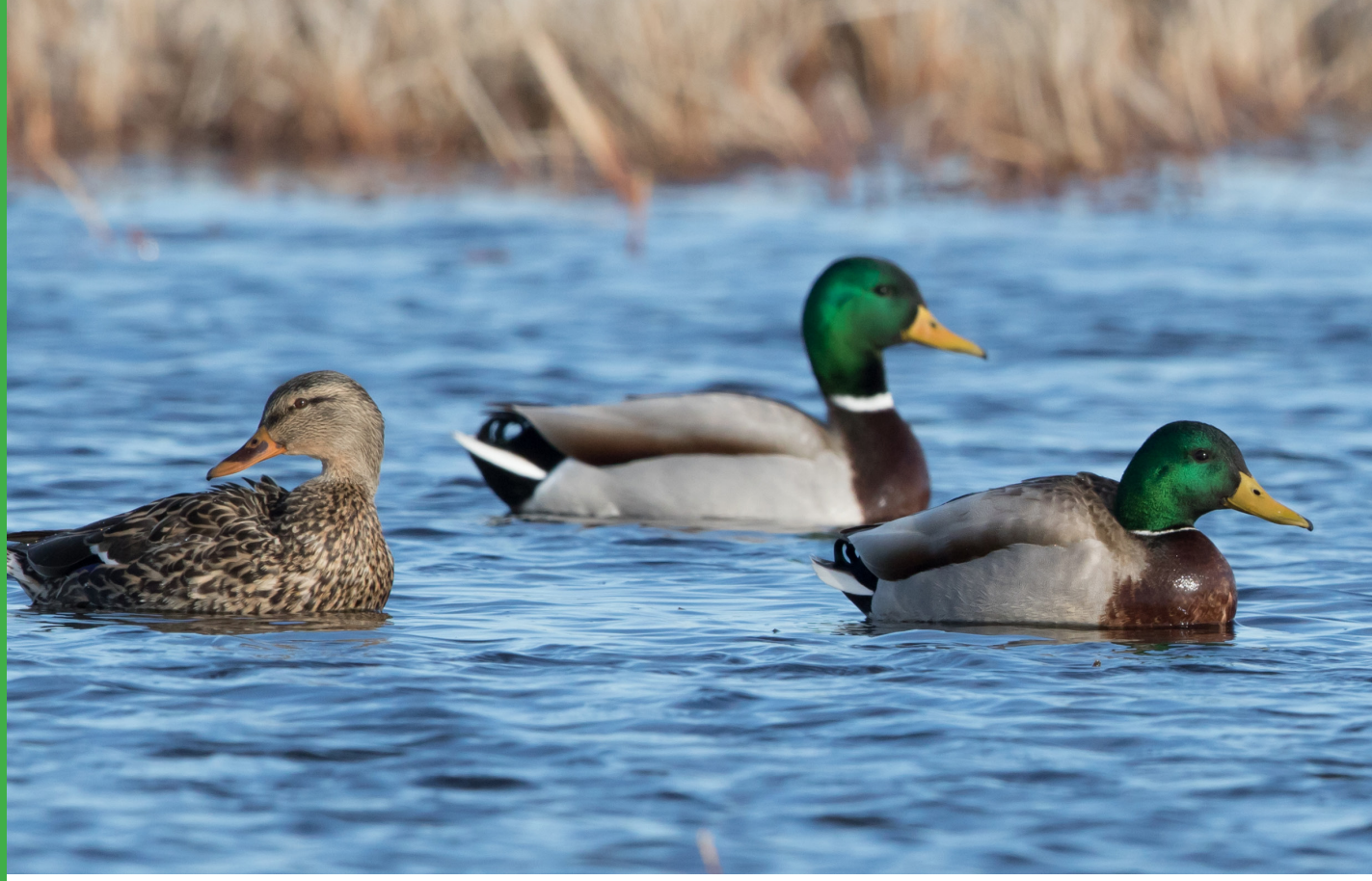
### Determining duck locations during hunting seasons and migration

Daniel Oden, M.S. Student, Starla Phelps, M.S. Student, Dr. Douglas Osborne, University of Arkansas Division of Agriculture, Dr. Chris Nicolai, Delta Waterfowl

Delta Waterfowl seeks to better understand the migration and wintering ground habits of dabbling ducks in the Mississippi Flyway to determine whether further management strategies are needed.

Employing backpack transmitters powered by miniature solar panels, Delta installed radios on mallards, green-winged teal, and American wigeon





to record movements for the past two years. Ducks were caught during or after the 2019-2020 and 2020-21 hunting seasons in Arkansas, and in September 2021 in South Dakota.

Our goals are to understand when and where these ducks migrate, particularly in the fall, as well as how they respond to hunting pressure and weather events. Oden is focusing on describing preferred habitats each species chooses to use during the winter. Phelps is assessing fine-scale movements of these birds during their time spent in the Mississippi Alluvial Valley.

## Predator Trapping in Wetlands

**Extending trapping efforts into the wetlands to focus on over-water nesting ducks**

Mike Buxton, Delta Waterfowl

Based on recent Predator Management and nest monitoring studies, over-water nesting ducks are experiencing lower nest success than upland-nesting ducks, even on the same trapped block. Therefore, we are interested in setting traps in the same wetland habitats that over-water nesting ducks are utilizing.

Trapping will continue to examine the efficacy of trapping techniques within the perimeters of wetlands in southwest Manitoba. These efforts will include box traps on platforms in the water and traps on the edge of emergent vegetation where gaps exist in the cattail ring. We hope to learn more about nest predators that may spend the bulk of their time within wetlands, to help modify our trapping efforts to also benefit over-water nesting ducks.

## Strategic Placement of Hen Houses

**Using a suite of collected data to optimize Hen House placement and predict usage rates**

Matt Chouinard and Mike Buxton, Delta Waterfowl

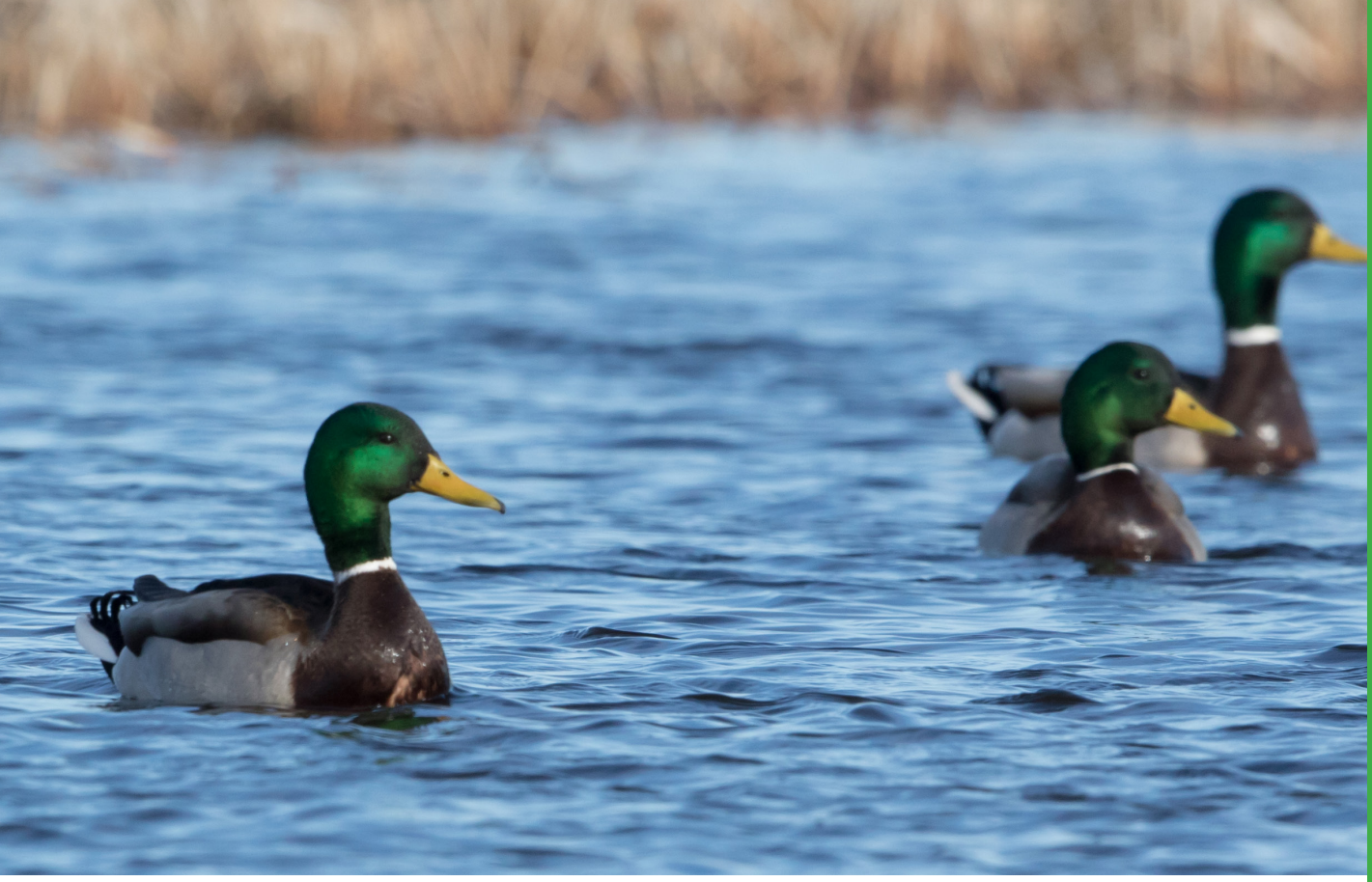
Delta has gathered several decades of data about the placement and usage rates of thousands of Hen Houses. A retrospective analysis will use these extensive long-term data to help inform the optimal placement of Hen Houses that maximize mallard hen occupancy and success. These already collected variables include age of the location and structure itself, density of surrounding Hen Houses, wetland conditions and size, breeding-duck pair densities, distance from road, and placement direction. The results will be used to maximize the efficacy of the successful Hen House program by installing future Hen Houses in the very best locations.

## Accuracy of Mid-winter Hen House Checks

**How representative are the mid-winter Hen House checks to determine prior use?**

Matt Choinard and Mike Buxton, Delta Waterfowl

Annual mid-winter maintenance of Hen Houses provides upkeep of the Hen House structures, and also allows data collection on the use of the structures. At annual maintenance checks, Hen House contents are examined several months after the breeding season to look for nest bowls and egg membranes. These data provide information on how many nests were attempted and hatched in the prior nesting season. In 2022, 200 Hen Houses in southwestern Manitoba were monitored throughout the breeding season to establish known nesting histories in these structures. This will provide the Hen House program an estimate of



the accuracy of the mid-winter checks. This data will also establish a use-rate correction factor to account for nest degradation after the breeding season.

### Duck Harvest and Survival

**How does hunting harvest impact duck populations?**

Thomas Riecke, Assistant Professor, University of Montana

Researchers are undertaking one of the big unresolved questions in waterfowl management: What influence does hunting harvest have on waterfowl survival rates and population trends? By using new scientific approaches, the team can more accurately answer this question for a number of important species, including mallards, pintails, and blue-winged teal. They will take a unique approach and look at population cohorts (male/female and juvenile/adult) to more fully understand how differing survival rates might help inform the relationship between harvest and population sizes. In addition, they will revisit our understanding of how density dependence (that is, how many breeding pairs of ducks that a given year's wetlands can accommodate) works in duck populations. They are finding that both harvest and environmental conditions on the breeding grounds have important impacts on survival, and that long-used models may not improve our understanding of the impacts of hunter harvest on duck populations.

### Spatiotemporal Variation in Duck Demographic Rates

**How environmental change influences duck population dynamics**

Madeleine Lohman, PhD Student, and Dr. Perry Williams, University of Nevada-Reno

Waterfowl monitoring has created one of the few extensive multi-species, longitudinal, individual-based data sets in the world. Using these data, Lohman will investigate spatiotemporal variation in demographic rates of dabbling ducks in the prairie pothole region to help shed new light on the basic biology and conservation needs of widely distributed wildlife populations. This work will focus on spatiotemporal variation in demographic rates, including survival, harvest mortality, and fecundity, and comparing this variation across multiple dabbling duck species. In doing so, it will also examine the responses of these species to changing environmental conditions.

**DELTA HAS TRAINED MORE THAN 600 MASTER'S AND DOCTORAL STUDENTS, INCLUDING SOME OF TODAY'S FOREMOST WATERFOWL BIOLOGISTS**

### Canvasback/Redhead Integrated Population Models

**Determining needs for the management of key diver species**

Dr. Dan Gibson, Post-Doctoral Researcher, and Dr. David Koons, Colorado State University

Although redheads and canvasbacks use the same breeding habitat in the prairie pothole region (primarily Manitoba and Saskatchewan), the two species historically overwintered in two distinct areas of the United States: Chesapeake Bay (canvasbacks) and Laguna Madre, Texas (redheads). Given that less is known about the linkages between winter habitat and waterfowl populations, it remains unclear the extent to which long-term shifts in overwinter habitat conditions

have influenced waterfowl population dynamics and hunting opportunities.

The goal of this work is to develop models that link seasonal variation in both breeding and overwinter habitat conditions with full annual cycle demographic data for canvasbacks and redheads. This data will help determine what factors drive each species' population growth throughout their continental ranges. We have found that variation in winter habitat conditions and harvest pressure influenced seasonal survivals for both canvasbacks and redheads. However, population growth for both species was overwhelmingly driven by patterns in duck production, which in turn was regulated by fluctuations in habitat conditions (e.g., breeding pond densities and conversion of habitat to cropland) throughout the prairies. These results will provide conservation partners with a better understanding of the demographic mechanisms most closely associated with canvasback and redhead population trajectories, which will benefit management efforts and help drive future research efforts on the species.

## Analyzing Canvasback Production in Relation to Predators, Parasitism, and Local Landscapes.

Michael Johnson, PhD Student, and Dr. David Koons, Colorado State University

Multiple field seasons in Manitoba proved to Johnson that the recipe to improve canvasback production is not as straightforward as once thought. The fate of over-water nests depends on the extent of numerous competing pressures that dynamically vary year to year. Canvasback nesting data will be used to assess the impacts of predation and parasitism, simultaneously, on production for two time periods (1983-1990 and 2016-2021) in a local breeding population of canvasback. Additionally, Johnson will link the influence of these mechanisms to local habitat variables so that targeted efforts to benefit canvasback production incorporate these considerations into wetland conservation programs.

## Mercury Loading in Nevada Wood Ducks

### Demographics of a wood duck population in a mercury super fund site

Morgan Byrne, M.S. Student, Dr. Perry Williams, Dr. Mae Gustin, University of Nevada Reno, and Dr. Chris Nicolai, Delta Waterfowl

Delta's Dr. Chris Nicolai has maintained an 18-year project monitoring an isolated population of wood ducks in western Nevada. During the life of this project, feather samples have been collected from all banded birds and repeated feather sampling occurred for all nesting hens. Byrne collected liver, breast tissue, and two types of feather samples from 100 hunter-killed wood ducks. Importantly, she found mercury levels as high as 40,000 ppb and found a correlation between tissue and feather samples. She has already developed a model using whole wood ducks to scale mercury levels in feathers and breast tissue. She will compare mother and offspring levels of mercury to determine whether offspring directly or indirectly inherit mercury loadings.

The levels of mercury found in this population of wood ducks is among the highest levels ever recorded in a bird species, exceeding levels for survival and reproduction. We will use this data to gain understanding of the trade-offs these ducks are making to maintain a stable population.

## Identification of Redhead and Canvasback Eggs

### Using genetics to improve visual identification

Mike Johnson, PhD Student, and Dr. David Koons, Colorado State University

Redhead and canvasback eggs are typically quite different in appearance, but characterizing some individual eggs by these species can be problematic. This is important when we consider that redheads frequently lay their eggs in canvasback nests, resulting in a mixed-species nest of eggs. Biologists have used a number of characteristics, like egg color and texture, in the past to assign eggs to either species. However, this method has never been tested for accuracy. Johnson will collect a number of unhatched eggs and use these visual methods to assign them to either species. He will then use genetics to confirm how accurate this method is.

## Using Saliva to Identify Nest Predators

### Can we use residual saliva on depredated eggs to determine the nest predator?

Chris Nicolai, Delta Waterfowl, Dr. Phil Lavretsky, University of Texas, El Paso.

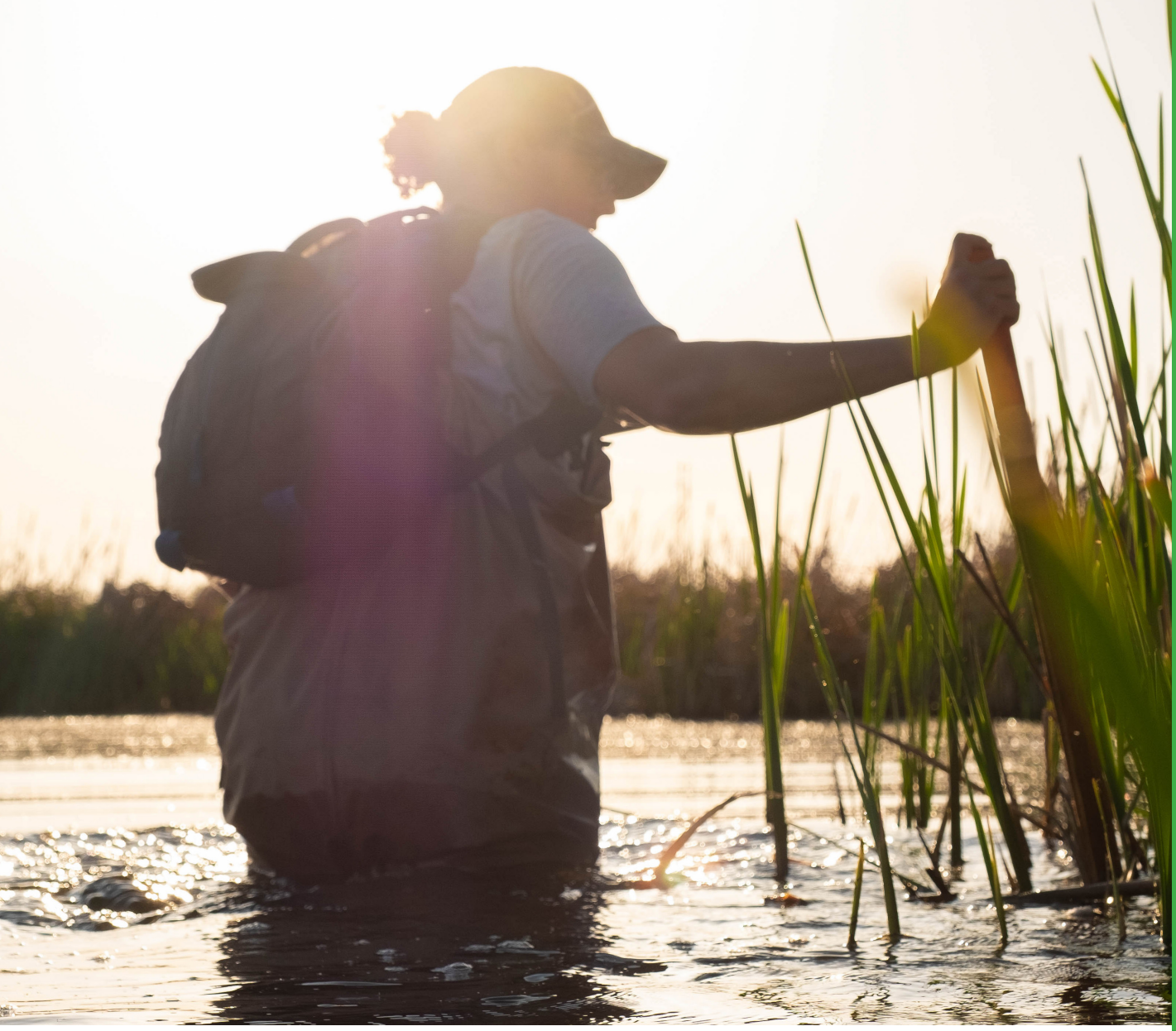
Determining the nest predator of waterfowl nests has always been subjective. Delta has used trail cameras in the past with limited success. New techniques have been developed that can collect saliva samples from predated eggshells. However, it is unknown if the moist conditions found at over-water nests will yield sufficient saliva samples. Delta will swab a number of egg fragments and have them tested for viable DNA that can identify the species of the nest predator. This will help inform the proportion of nests destroyed by a suite of nest predators.

## Drone Brood Surveys

### Developing an operational survey to measure complete duck production

Grant Rhodes, Delta Waterfowl Technician, and Dr. Chris Nicolai, Delta Waterfowl

Delta has been using a combination of pair surveys, nest monitoring, and brood surveys to measure productivity. However, none of these approaches are known to be perfect, as nests can be missed, broods can be missed, etc., and we have likely been incorrectly measuring overall duck production on managed sites. We want to begin to find a simpler and more accurate method to measure the ultimate measure of our management actions—duckling production. In 2022, we will begin new methods using drones.



## Graduate Student Retention Survey

### Gaining an understanding of limitations for trained waterfowl graduate students to stay in the profession

Dr. Chris Nicolai and Joel Brice, Delta Waterfowl, Dr. Mike Brasher and Diane Eggeman, Ducks Unlimited, and Shaun Oldenburger, Texas Parks and Wildlife Department

In concert with the North American Waterfowl Management Plan NAWPEP committee, we designed a series of surveys to gain understanding of factors that limit retention of trained waterfowl graduate students. Over 40 questions were prepared and we will survey the hundreds of waterfowl graduate students that began graduate school as identified by professors, theses/dissertations, and presentations at professional meetings. The large number of questions are broad and include a suite of personal and professional topics that may inform limiting factors.

## Mallards and Black Ducks on Long Island

### Habitat Use of American Black Ducks and Mallards on Eastern Long Island: Assessing the Utility of Corn Fields to Wintering Waterfowl

Riley Stedman, M.S. Student, and Dr. Mike Schummer, State University of New York

Stedman is investigating habitat selection by black ducks and mallards on eastern Long Island during winter with the aim of understanding the relative contribution of cornfields relative to salt and freshwater marshes. In 2022, she conducted her first field season and is currently in the process of deploying an additional 50 GPS/GSM units. In short, Stedman is investigating non-conventional methods of supporting waterfowl along the Atlantic Coast. Although conventional thinking suggests that simply restoring wetland habitat along the Atlantic Coast would provide the greatest benefit to waterfowl, the area is rife with red-tape, high land costs, and irreversible wetland losses. Alternatively, agricultural fields, specifically corn, may play a role in sustaining waterfowl at important times of the year in an area genuinely impoverished of food for ducks and geese.

## Identification of Game Farm Mallards

**Determining the implications of game-farm mallard release for eastern U.S. mallard populations using morphology and feather patterns**

Hunter Collins, M.S. Student, and Dr Mike Schummer, State University of New York

During pre-season banding, genetically pure wild, game-farm, and various wild/domestic mallard hybrids are all available for banding. Substantial movement of mallards during pre-season banding adds additional complications, making it impossible to use geographic location as proxy for mallard genotype (Harvey 2022). Introgression of artificially selected, game-farm genes has been proposed as a reason for the recent near 50 percent decline of eastern mallards, but currently lack of capacity to designate genotype at time of banding precludes greater understanding of potential differences in survival and reproduction among genotypes. Collins will develop rapid and logistically feasible methods to differentiate mallards collected during pre-season banding. This will enable ust ot untangle these metrics.

## Evaluating Three Styles of Radio Attachments

**An assessment of radio attachment methods to understand transmitter impacts on mallards**

Future Graduate Student, University of Saskatoon, Dr. Karen Machin, Dr. Mitch Weegman, University of Saskatoon, Blake Bartzen, Canadian Wildlife Service, Paul Link, Louisiana Department of Wildlife And Fisheries, Dr. Matt Dyson, Ducks Unlimited Canada, and Dr. Chris Nicolai, Delta Waterfowl

Radios have been used for decades to understand the movements, harvest rates, survival, and a number of other demographic rates for ducks. An underlying assumption is that the attachment of radios does not bias these demographic rates. Several studies have shown subtle or detrimental effects of different attachment methods. Delta will attach 75 radios in each of two years in Saskatchewan on female mallards in late summer. We will attach 25 radios using each of the three following attachment methods: backpacks, implants, and prong and suture. We will also compare these data to standard leg-banded ducks in an overall contemporary assessment of attachment style.

## Saskatchewan Nest and Brood Success

**Development of a rapid duckling production tool for upland-nesting ducks in Saskatchewan**

Grant Rhodes, M.S. Student, Dr. Kevin Ringelman, Louisiana State University, Hannah Sabatier, M.S. Student, Dr. Ben Sedinger, University of Wisconsin-Stevens Point, and Dr. Chris Nicolai, Delta Waterfowl

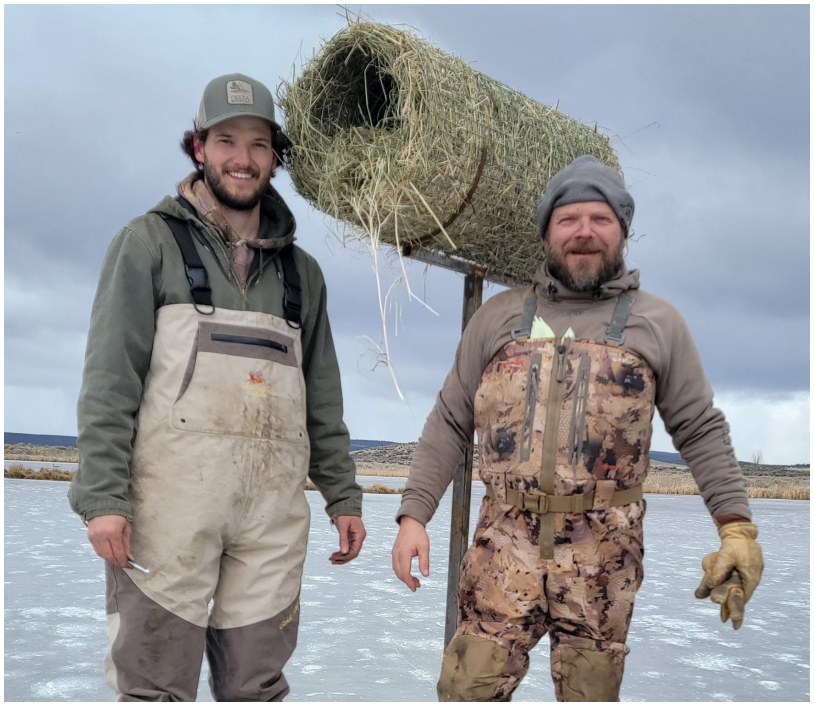
Delta is expanding its Predator Management research into Saskatchewan. We are developing projects to assess how effective these efforts are in this additional jurisdiction. This project will expand beyond monitoring nest success to simultaneously measure brood survival and the total number of ducklings produced across three trapped and three non-trapped study blocks. The use of drones, VHF radios, and nasal saddles attached to incubating hens, plus a drone-based VHF receiver, will allow for the exploration of using new technology to measure demographic rates that have traditionally been very difficult to measure. The hope is to use new technology to provide new methods in the future to monitor brood production following management actions.

## California Hen Houses

**Testing the success of Hen Houses in the Intermountain West**

Evan Yunker, M.S. Student, Dr. Bruce Dugger, Oregon State University, and Dr. Chris Nicolai, Delta Waterfowl

Hen Houses have shown great success in other parts of North America, yet a thorough assessment of their success has not been studied in the Intermountain West's wetlands. Yunker will install 200 Hen Houses in three regions of California on federal, state, and private wetlands. He will monitor their use in 2023 and 2024. Additionally, he will collect data on potential reasons why their success may vary from prairie-installed Hen Houses.



# SCHOLARSHIPS

## DAVE ANKNEY AND SANDI JOHNSON WATERFOWL AND WETLANDS GRADUATE RESEARCH SCHOLARSHIP

### 2023

**Caroline Blommel, M.S. Student, and Dr. Dave Koons, Colorado State University**

Blommel is analyzing long-term mark-recapture and harvest data (1990-2021) to estimate the joint impact of harvest and seasonal climate change on the demographic rates of black brant that breed on the Yukon Kuskokwim Delta. Blommel will develop custom multi-event models in a Bayesian framework to estimate annual cause-specific mortality and breeding propensity of brant, as well as the effect seasonal climate change-driven processes have had on these vital rates. Multi-event models allow for some uncertainty in the assignment of breeding status to estimate annual breeding propensity more accurately, while also allowing for the discernment of harvest and non-harvest mortality. Blommel's research will provide valuable insight into how the brant population will be jointly impacted by climate change and harvest, and could help inform anticipatory management decisions to compensate for the demographic impact of climate change.

**Jeffrey Edwards, M.S. Student, University of Missouri, Dr. Lisa Webb, University of Missouri, and Dr. Drew Fowler, Louisiana State University**

Most blue-winged teal research has been focused on the breeding grounds, leaving substantial information gaps related to the non-breeding period of the annual cycle, including distribution, habitat use, and linking survival to environmental factors and individual decision making. Using movement data from approximately 350 blue-winged teal, Edwards will use an integrated step selection to link wetland inundation and habitat selection to blue-winged teal survival throughout the non-breeding season. He will also examine what factors may be influencing blue-winged teal migration using discrete choice modeling to test the hypothesis that blue-winged teal migrations are driven primarily by the daylight cycle.

### 2021

**Mike Johnson, PhD Student, and Dr. Dave Koons, Colorado State University** — See Various Delta Research Projects, Above.

**Jordan Thompson, M.S. Student, and Dr. Ben Sedinger, University of Wisconsin-Stevens Point**

Thompson has spent the past few summers studying emperor geese in southwest Alaska on the waterfowl rich Yukon Kuskokwim Delta. Sport and subsistence harvests of emperor geese in Alaska were closed in the mid 1980s following greater than 50 percent population declines between the mid-1960s and mid-1980s. However, after a gradual population increase spanning 30 years, subsistence harvest and a limited sport harvest season were reopened in 2017. Maintaining the recently opened harvest season requires that the emperor goose population remains above the harvestable threshold set forth by managers. Thompson will assess nest survival models and analyze them in a Bayesian framework to test for drivers of annual and individual variation, compare characteristics of used nest sites and associated randomly determined sites, and she will construct a multistate capture-mark-recapture model to predict the probability of an emperor goose returning to within 200 meters of its nest site in the previous year.

## JOHN DALE SCHOLARSHIP

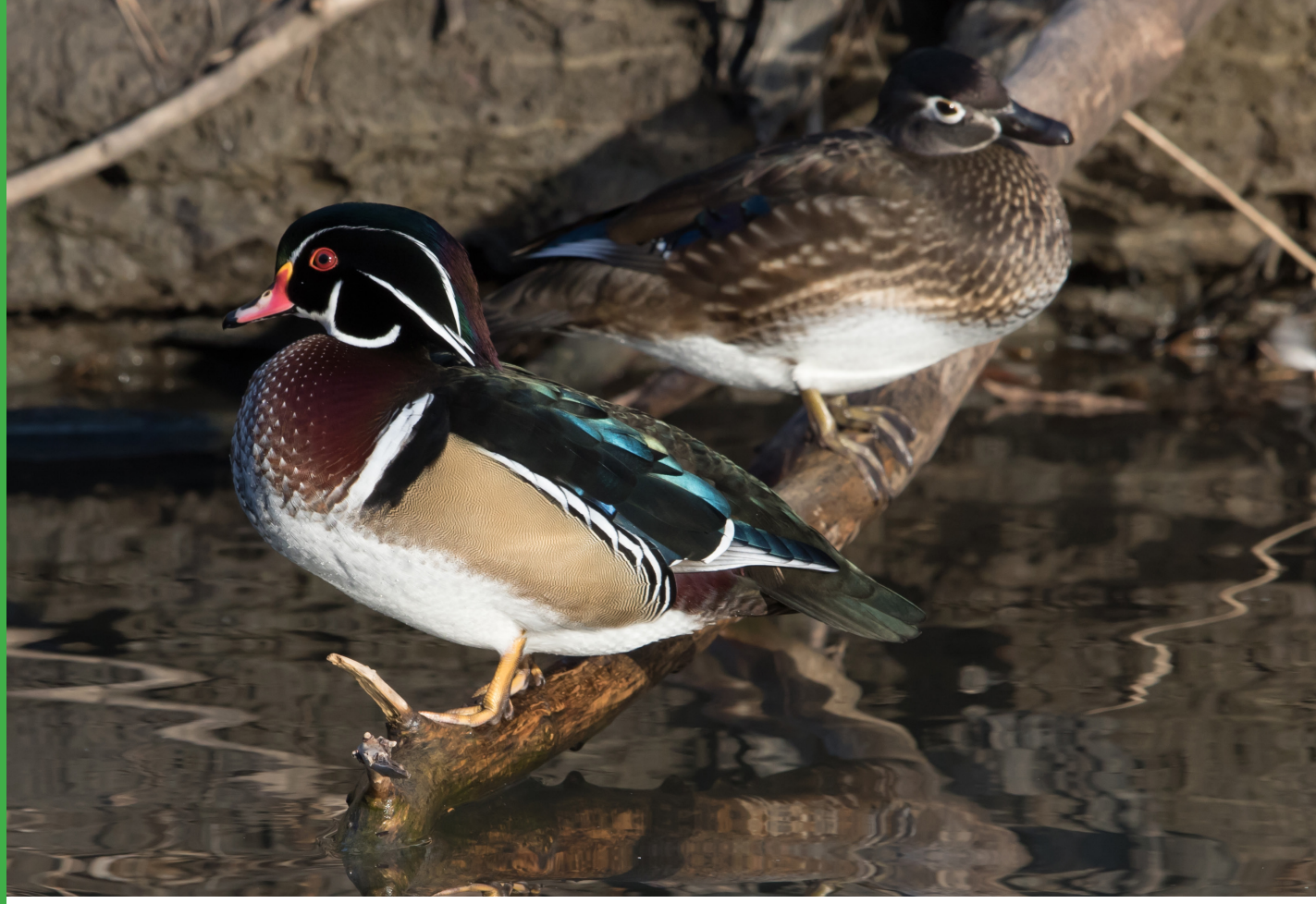
**Jeffrey Edwards, M.S. Student, University of Missouri** — See above, under Ankney/Johnson Scholarship.

**Blake Struthers, M.S. Student, and Dr. Chris Williams, University of Delaware**

Struthers will work on comparing nesting chronology, nest-box selection, and recruitment for nesting wood ducks in Maryland and Delaware. He will focus on micro-habitat factors that female wood ducks use to evaluate and select nest boxes and how this relates to recruitment. Other components of the project include investigating the size and symmetry of female wood ducks' white eye patches to determine if the wood duck densities associated with habitat types are potentially affecting stress and nest success. Lastly, Struthers will attach GPS transmitters on female wood ducks and radio-marked ducklings to monitor movement trends, habitat selection, and survival rates.

**Hunter Veltkamp, M.S. Student, University of Minnesota** – See above, under Delta research projects.

**Future Graduate Student, University of Saskatchewan** — See above under, Delta research projects.



# THESES AND DISSERTATIONS
(SINCE 2021)

Byrne, M. 2023. Demographic response to mercury levels in wood ducks. Thesis, University of Nevada Reno.

Coffield, H. 2021. Effect of contract attribute levels on willingness to participate in a Working Wetland Program. Thesis, North Dakota State University.

Davis, M. 2022. Comparison and Evaluation of Simple Chain and Cable-chain Upland Nest Searching Techniques on Predator Trapped and Non-trapped Sites. Thesis, Brandon University.

Harvey, K. 2022. Geographic origins and genetics of pre-hunting season banded mallards in the northern Atlantic and Mississippi flyways. Thesis, University of New York.

Kucia, S. 2021. Investigation of eastern mallard breeding metrics. Thesis, State University of New York.

Neufeld, L. 2021. Comparing migration ecology among geographically distinct populations of Canada Geese (Branta canadensis) and Cackling Geese (Branta hutchinsii). Thesis, University of Manitoba.

Phelps, S. 2023. Movements of American Wigeon and American green-winged teal marked in eastern Arkansas. Thesis, University of Arkansas at Monticello.

Rohrer, T. 2021. Effects of predator management and parasitism on over-water nesting diving duck production in southwestern Manitoba. Thesis, South Dakota State University.

Standler, R. 2023. The use of drones and thermal camera imaging technology for avian nest searching. Thesis, University of Manitoba.

Terry, C. 2021. Duck brood density in relation to invertebrate abundance in agriculture wetlands in the mid-continent prairies. Thesis, Louisiana State University.

# PUBLICATIONS
## (SINCE 2021 — DELTA STAFF IN BOLD)


**Bushaw, J.**, C. Terry, K. M. Ringelman, M. K. Johnson, K. Kemink, and **F. C. Rohwer**. 2021. Application of Unmanned Aerial Vehicles and Thermal Imaging Cameras to Conduct Duck Brood Surveys. Wildlife Society Bulletin 45:274-281.

Cook, N., K. Shoemaker, and **C. A. Nicolai**. 2021. Inferring movements and staging locations for canvasback (Aythya valisineria) using light-level geolocators. Journal of Fish and Wildlife Management. 12:308-321.

Koons, D. N., T. V. Riecke, G. S. Boomer, B. S. Sedinger, J. S. Sedinger, P. J. Williams, and T. W. Arnold. 2022. A niche for null models in adaptive resource management. Ecology and Evolution 12:e8541.

Kucia, S. R., M. L. Schummer, J. W. Kusack, K. A. Hobson, and **C. A. Nicolai**. 2023. Natal Origins of Mallards Harvested in the Atlantic Flyway of North America: Implications for Conservation and Management. Avian Conservation and Ecology 18: article 10.

Masto, N. M., R. M. Kaminski, P. D. Gerard, B. E. Ross, M. R. Kneece, K. Barrett, and G. Wilkerson. 2021. Aerial strip-transect surveys: indexing autumn–winter waterbird abundance and distribution in South Carolina. Journal of Southeastern Fish and Wildlife Agencies 87:89-100.

Mezebish, T. D., R. B. Chandler, G. H. Olsen, M. Goodman, **F. C. Rohwer**, N. J. Meng, M. D. McConnell. 2021. Wetland Selection by Female Ring-Necked Ducks (Aythya collaris) in the Southern Atlantic Flyway. Wetlands. 41:84

Mezebish, T. D., G. H. Olsen, M. Goodman, **F. C. Rohwer**, and M. D. McConnell. 2022. Spring Migration and Breeding Distribution of Female Ring-Necked Ducks Wintering in the Southern Atlantic Flyway. Avian Conservation & Ecology 17:2:5

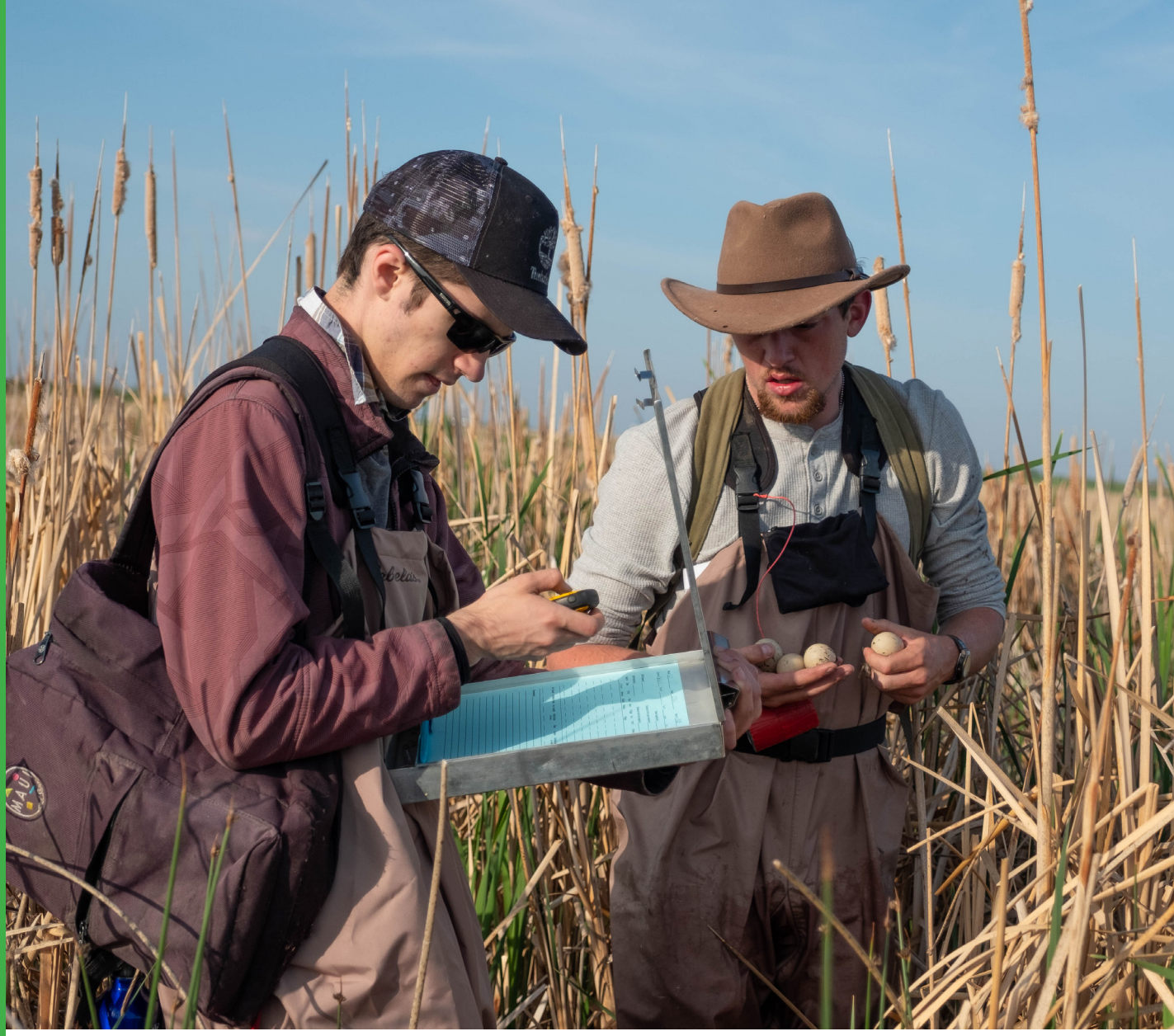
Mitchell, B.J., C.V. Terry, K.M. Ringelman, K.M. Kemink, M.J. Anteau, and A.K. Janke. 2022. Wetland occupancy by duck broods in agricultural landscapes of the United States prairie pothole region. Journal of Wildlife Management 87:E22347.

Overton, C. T., A. A. Lorenz, E. P. James, R. Ahmadov, J. M. Eadie, F. Mcduie, M. J. Petrie, **C. A. Nicolai**, M. L. Weaver, D. A. Skalos, S. M. Skalos, A. L. Mott, D. A. Mackell, A. Kennedy, E. L. Matchett, and M. L. Casazza. 2021. Megafires and thick smoke portend big problems for migratory birds. Ecology 103:1-5.

Palumbo, M.D., **S.A. Petrie**, M. Schummer, B.D. Rubin and J.F. Benson. 2022. Influence of Resource Selection on Nonbreeding Season Mortality of Mallards. Journal of Wildlife Management. 86:E22292.

Sedinger, J. S., D. N. Koons, M. S. Lindberg, T. V. Riecke, A. G. Leach, B. W. Meixell, and **C. A. Nicolai**. 2022. Do hunters target auxiliary markers? An example using black brant. Journal of Wildlife Management 86:E22172.

Thompson. J. M., T. V. Riecke, B. L. Daniels, K. A. Spragens, M. Gabrielson, B. S. Sedinger, and **C.A. Nicolai**. 2022. Survival and cause-specific mortality of American green-winged teal banded on the Yukon-Kuskokwim Delta, Alaska. Journal of Wildlife Management 86:E22223.



## Research Leaders

Throughout the organization's storied history, Delta Waterfowl has amassed an impressive body of research that includes supporting more than 300 graduate students and publishing 600 peer-reviewed scientific papers.

Delta's research has profoundly influenced how waterfowl, wetlands, and annual harvest are managed. It has also provided biologists, technicians, and young scientists with the opportunity to gain hands-on experience and guidance to become leaders in waterfowl and wetland conservation. We are proud that many of Delta's former students are working for government and non-government agencies, as well as universities.

Delta Waterfowl's important waterfowl and wetland research is made possible by you—our generous donors, members, and volunteers. We deeply appreciate your support. Thank you!

DELTA WATERFOWL

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