2022 DUCKS UNLIMITED INTERNATIONAL SCIENCE REPORT

HIGHLIGHTS OF DUCKS UNLIMITED SCIENCE IN FY2022

DUCKS UNLIMITED

WHAT SCIENCE MEANS TO DU

Since its founding, Ducks Unlimited has embraced a scientific approach to conserving wetlands and associated uplands that support North America's waterfowl populations. More recently, DU's application of science has expanded to increase understanding of how habitat conservation affects ecosystem services (e.g., water quality, flood mitigation) that directly improve human health and livelihoods. This approach ensures DU's conservation actions continue to sustain waterfowl populations while increasing their relevance and benefits to broader segments of society.

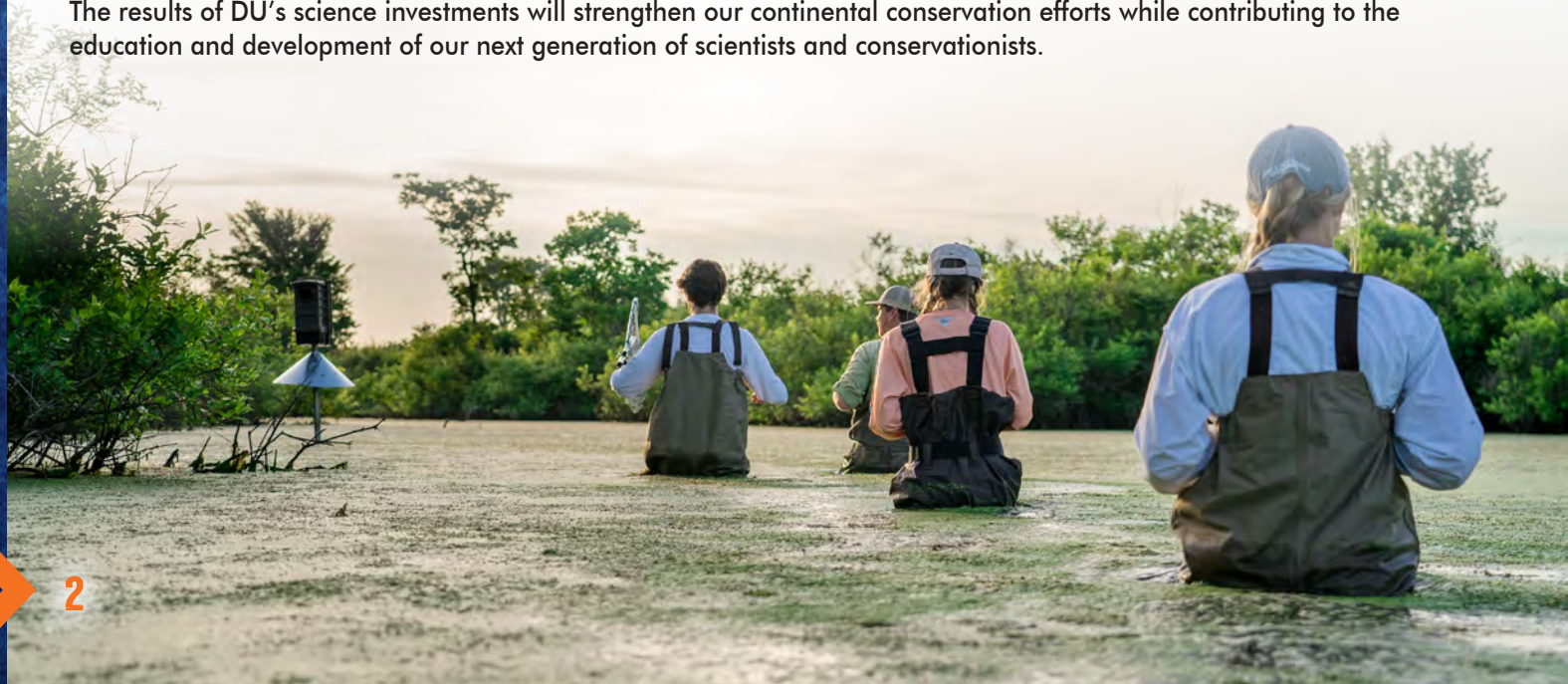
DU'S SCIENCE VISION STATEMENT

To strengthen Ducks Unlimited's vital science foundation through a robust internal science team and innovative partnerships that integrate data-based decision making to effectively and efficiently advance the conservation of waterfowl and their habitats in North America, as well as to recruit, retain, and engage a dedicated and diverse group of conservation professionals and supporters.

DU'S SCIENCE PRIORITIES AND APPROACH

Ducks Unlimited has a choice of where we invest our science resources and capacity. Activities that address our greatest uncertainties, in our most important geographies, and provide the greatest opportunities to achieve our conservation mission invariably receive highest priority. Across our 3 organizations, DU's science activities can be classified into 6 thematic areas: 1) conservation program planning, delivery and adaptation, 2) ecosystem services and human dimensions, 3) sustainable agriculture, 4) implications of climate change for conservation, 5) species of concern, and 6) development and refinement of the International Conservation Plan.

This annual International Science Report highlights the involvement and partnership of DU Inc., DU Canada, and DU de México in scientific efforts during FY2022, reflecting a combination of university-led research, projects conducted internally by DU staff, and other activities in which DU staff are otherwise involved. Just as conservation delivery relies on diverse partnerships and cross-border collaboration for maximum efficiency, so too do our scientific efforts. Paramount among our list of science partners are numerous federal and state agencies, university researchers, non-governmental organizations, foundations, NAWMP Joint Ventures, corporations, private landowners, and our volunteers and donors. The results of DU's science investments will strengthen our continental conservation efforts while contributing to the education and development of our next generation of scientists and conservationists.



DU - INTERNATIONAL

*COMPARING SPRING MIGRATION STRATEGIES OF NORTHERN PINTAILS FROM WINTERING AREAS ACROSS NORTH AMERICA

Georgina Eccles (PhD student) & Dr. Bart Ballard, Texas A&M Univ.–Kingsville

Understanding factors that influence pintail populations is critical for delivering effective conservation and management. Poor body condition in the Gulf Coast, poor reproductive success in the Prairies, and linkage through "cross-seasonal" mechanisms may be contributing factors. Employing GPS telemetry on 480 female pintails over 3 years, this study will yield information on differences in individual behavior, habitat use, migration strategy, and their relationship to annual survival and productivity. Support for this study provided by DU-SRO and DUC.

WATER QUALITY IMPROVEMENT CO-BENEFITS OF PRIORITY MALLARD HABITAT RESTORATION

Dr. Pascal Badiou & Dr. Lauren Bortolotti, DUC-IWWR; Dr. Nandita Basu & Dr. Emily Uri (Post-doctoral researcher), Univ. of Waterloo; Cathleen Sampselle & Dr. Ellen Herbert, DU-NHQ; Ed Verhamme & Doug Bradley, Limnotech

Harmful algal blooms fueled by phosphorus in Lake Erie have threatened wildlife habitat, economic livelihoods, and jeopardized clean and reliable drinking water supplies for communities. This study will collect data on the local and landscape factors influencing wetland phosphorus retention efficiency and parameterize a model of phosphorus retention and restoration cost across the U.S. and Canadian Great Lakes region. An ultimate goal is to generate a spatial model of potentially restorable wetlands and associated return on investment for the dual objectives of improving water quality and enhancing mallard habitat.

* DENOTES A STUDENT-LED PROJECT

DU INC. - NATIONAL

IDENTIFYING EFFECTS OF WEATHER AND LAND USE ON AUTUMN AND WINTER WATERFOWL DISTRIBUTION DYNAMICS IN THE 21ST CENTURY

Dr. Bram Verheijen (Post-doctoral researcher) & Dr. Lisa Webb, Univ. of Missouri; Dr. Heath Hagy, USFWS; Mike Mitchell & Dr. Dale James, DU-SR; Dr. Mike Brasher, DU-NHQ

Migration and winter distribution of waterfowl have implications for harvest opportunities, conservation planning, and stakeholder support for wetland and waterfowl conservation. Some evidence suggests the timing of migration and terminal distribution of several common waterfowl species may have shifted. This research will use band recovery, harvest, and aerial surveys to investigate whether waterfowl distribution during fall and winter in the Mississippi and Central flyways has changed over the past 40 years. This work will also examine how shfits may be influenced by weather (temperature, snow cover, precipitation), land use, or landscape changes throughout the flyways.

*ASSESSING THE CLIMATE CHANGE MITIGATION POTENTIAL OF WETLAND RESTORATION IN THE CONSERVATION RESERVE PROGRAM: MEASUREMENTS, MODELING, AND SCALING CHANGES IN SOIL CARBON AND GREENHOUSE GAS FLUXES

Dr. Sheel Bansal, U.S. Geological Survey; Dr. Shannon Osborne, USDA Agricultural Research Service; Dr. Chenhui Li, Univ. of Missouri; Dr. Jessica O'Connell & Megan Podolinsky (Ph.D. Student), Univ. of Texas Marine Science Institute; Dr. Siobhan Fennessy, Kenyon College; Dr. Thomas O'Halloran, Clemson Univ.; Dr. Kimberly Van Meter, Pennsylvania State Univ.; Dr. Emily Biggane, United Tribes Technical College; Dr. Ellen Herbert, Cathleen Sampselle, DU-NHQ; Kaylan Kemink & Kyle Kuechle, DU-GPRO

This project will explore how wetland restoration through the Conservation Reserve Program (CRP) in the Agricultural Midwest and Great Plains (~81% of wetland CRP) contributes to climate mitigation by measuring and modeling soil and vegetation carbon stocks and greenhouse gas fluxes in restored wetlands. This study will explore how climate, surrounding land-use, soils, and hydrology impact wetland carbon cycling. Additionally, the team will model other ecosystem functions of restored wetlands including surface water storage, nutrient retention, and waterfowl habitat value.

APPLICATION OF eBIRD DATA TO ENHANCE INTERREGIONAL PLANNING FOR MIGRATORY WATERFOWL DURING THE NONBREEDING PERIOD

Dr. Orin Robinson, Cornell Lab of Ornithology; Dr. Kevin Ringelman, Louisiana State Univ.; Dr. Auriel Fournier & Aaron Yetter, Illinois Natural History Survey; Dr. Mike Brasher, DU-NHQ

Mobile technology and citizen participation in scientific data collection are revolutionizing the type and quantity of information available for natural resource conservation and management. One such data collection and analytical platform relevant to waterfowl conservation is eBird, yet its utility for waterfowl conservation planning remains uncertain. This project will compare eBird data metrics to those obtained from independently collected waterfowl surveys to help identify under what circumstances eBird data are useful in waterfowl conservation and management.

* DENOTES A STUDENT-LED PROJECT

NATURAL INFRASTRUCTURE RESEARCH AND TRAINING

Dr. Brian Bledsoe, Univ. of Georgia; Dr. Ellen Herbert, DU-NHQ; Sara Burns, Jim Feaga, Tamara Jameson, Kali Rush, Mike Sertle, & Tom Pluemer, DU-GLAR; Will Cenac, Cassidy Lejeune, Dr. Aaron Pierce, & Dr. Todd Merendino, DU-SR; Thomas Parker DU-GPR

Natural infrastructure uses, restores, or emulates natural ecological processes to achieve engineering objectives and provide multiple conservation benefits. The UGA–DU partnership will educate a graduate workforce through practical research experience aimed at evaluating existing and planned conservation projects. The partnership will co-develop a research agenda that focuses on (1) enumerating the role wetland loss and conservation have played in regulating past floods and droughts and (2) exploring the biophysical and economic outcomes of future wetland conservation. DU and UGA will also co-develop a curriculum and internship program to further develop the engineering workforce.

DU INC. - SOUTHERN REGION

*MOTTLED DUCK BREEDING ECOLOGY IN SOUTHWESTERN LOUISIANA

Lizzi Bonczek (PhD student) & Dr. Kevin Ringelman, Louisiana St. Univ.

Western Gulf Coast mottled ducks have experienced long-term population declines, yet uncertainty remains about factors responsible for this decline. This study uses GPS telemetry to obtain comprehensive information on the breeding ecology of mottled ducks and its relationship to environmental and habitat variables in southwestern Louisiana.

*MALLARD BODY MASS VARIATION WITHIN AND AMONG WINTERS IN THE MISSISSIPPI ALLUVIAL VALLEY OF ARKANSAS

John Veon (MSc student), Dr. Brett DeGregorio, & Dr. David Krementz, Univ. of Arkansas-Fayetteville and USGS Arkansas Coop. Fish and Wildlife Research Unit; Luke Naylor, Arkansas Game and Fish Commission

In partnership with the waterfowl hunting community, this study will determine how body mass of mallards wintering in Arkansas varies across time, land management strategies, and other factors. Historical data will be used to examine patterns of mallard body condition over 5 decades, enabling assessment of how landscape, habitat, and climate trends may affect mallards in winter.

*THE EFFICACY OF MARSH TERRACES FOR RESTORING AND ENHANCING GULF COASTAL WETLANDS

Madelyn McFarland (MSc student), Joseph French (MSc student), Raul Osario (PhD student), Drs. Brian Davis, Adam Skarke, & Ana Linhoss, Mississippi St. Univ.; Dr. Mike Brasher, DU-NHQ

Marsh terracing is a common restoration technique employed by DU along the Gulf Coast. This interdisciplinary study uses diverse data collection techniques to measure the benefits of marsh terracing, including emergent marsh expansion, shoreline erosion reduction, wave energy attenuation, submerged aquatic vegetation growth, and habitat quality for waterfowl and marsh birds. These data will inform future terrace designs to maximize gains for avian habitat and coastal sustainability.

* DENOTES A STUDENT-LED PROJECT

MISSISSIPPI ALLUVIAL VALLEY WINTER MALLARD BANDING PROGRAM-ARKANSAS

Dr. Doug Osborne, Univ. of Arkansas-Monticello

DU is supporting this winter banding project to help understand harvest distribution patterns, winter homing rates, and enable estimation of seasonal survival rates of mallards in the Mississippi Alluvial Valley. This work also provides outreach and education opportunities by involving local students and volunteers in banding efforts.

*ECOSYSTEM SERVICES ANALYSIS IN EDISTO BASIN, SOUTH CAROLINA

Lucas Clay (PhD Student), Dr. Tomas O'Halloran, & Dr. Marzieh Motallebi, Clemson Univ; Dr. Dale James, DU-SR; Dr. Ellen Herbert, DU-NHQ

DU is supporting a detailed assessment of the ecosystem services provided by land conservation in the Edisto Basin of South Carolina. The goal of this research is to quantify the contribution of protected lands to sequestering carbon and influencing water quality and water supply in the Edisto Basin. This work will also develop future scenarios of habitat loss to quantify the role of targeted land protection in mitigating these losses.

*EVALUATING MOTTLED DUCK NEST PREDATOR COMMUNITY IN SOUTHWESTERN LOUISIANA USING CAMERA TRAPS AND ARTIFICIAL NESTS

Alexandre Dopkin (MSc Student) & Dr. Kevin Ringelman, Louisiana State Univ.; Dr. Dale James, DU-SR

Mottled duck nest success averaged only 21% during a recent 2018–2020 study in southwestern Louisiana, largely due to nest predation. Researchers at Louisiana State University are using trail cameras and artificial nests across a diversity of habitats to identify the primary nest predators of mottled duck nests and provide information on nest predation risk as it varies by habitat type (e.g., pasture, cordgrass meadow, fallow rice, overwater marsh, marsh terrace, etc.). This study will provide a more holistic understanding of how predators are affecting mottled duck nest success in southwestern Louisiana.

*EVALUATING UNCREWED AERIAL VEHICLES TO MONITOR WATERFOWL RESPONSE TO WETLAND RESTORATION IN THE MISSISSIPPI ALLUVIAL VALLEY

Zack Loken (MSc student) & Dr. Kevin Ringelman, Louisiana State Univ.; Dr. Dale James, DU-SR; Dr. Anne Mini, Lower Mississippi Valley Joint Venture

This project will explore novel methods of monitoring duck use within forested and shallow water habitats on Wetland Reserve Easement sites in the Mississippi Alluvial Valley. Uncrewed aerial vehicles will be deployed to investigate their utility to monitor site use by waterfowl. Image analysis and machine learning will be used to establish protocols for estimating duck abundance and behavior at a project level scale.

* DENOTES A STUDENT-LED PROJECT

SOUTHEAST WINTERING GROUND CONTRIBUTIONS TO CONTINENTAL WATERFOWL POPULATIONS

Dr. Angela Hsiung (Post-doctoral researcher) & Dr. James Anderson, Clemson Univ.; Dr. Beth Ross & Dr. Heath Hagy, USFWS; Dr. Dale James, DU-SR

Understanding how non-breeding survival affects waterfowl population growth requires long-term data from multiple sources at a continental scale. This study will use integrated population modeling to test if non-breeding survival contributed to historical population growth rates and provide insights into the role of cross-seasonal effects between non-breeding and breeding season vital rates. This study also aims to describe how winter conditions affect non-breeding survival and population growth rates across a range of habitats, flyways, and species, which will help inform regional conservation priorities.

*SPATIOTEMPORAL PATTERNS OF SANCTUARY USE BY MALLARDS IN THE LMAV: WHITE RIVER NWR

Ethan Dittmer (MSc student), Dr. Doug Osborne, Univ. of Arkansas at Monticello, Dr. Dale James, DU-SR

Public waterfowl management areas often include sanctuaries closed to hunting and public access to provide waterfowl refugia and areas to obtain and conserve energetic resources. Relatively little research has investigated mallard use patterns of sanctuary in relation to public and private lands. Using satellite transmitters, this project aims to provide fine-scale information on movements and winter habitat selection of mallards associated with White River NWR and their spatiotemporal patterns of use of sanctuary, public hunting areas, and private lands. These data will provide valuable information for policy makers, conservation planners, and managers to make evidence-based decisions when designing wetland complexes with sanctuary.

A REGIONAL ASSESSMENT OF ECOSYSTEM SERVICES PROVISIONING IN RESTORED COASTAL WETLANDS

Dr. Anna R. Armitage, Texas A&M Univ. at Galveston; Dr. Jessica O'Connell, Univ. of Texas Marine Science Institute; Dr. Ellen Herbert, DU-NHQ; Dr. Dale James, DU-SR

Wetland restoration is a critical component of a multi-faceted coastal management strategy to compensate for impacts from disturbance, development, and climate change. An important restoration goal is to support local economies by reestablishing essential ecosystem services such as erosion protection, fishery support, and carbon sequestration. This project will evaluate the provision of ecosystem services in older restoration sites, through a fusion of field and remote sensing assessments. Research will be conducted to understand links between coastal wetland restoration design and the provision of ecosystem services.

Photos, P. Haefliger

DU INC. - GREAT LAKES & ATLANTIC REGION

*DEVELOPMENT OF BIOCONTROL FOR NON-NATIVE PHRAGMITES

Dr. Bernd Blossey & Post-doctoral researcher (TBD), Cornell Univ.

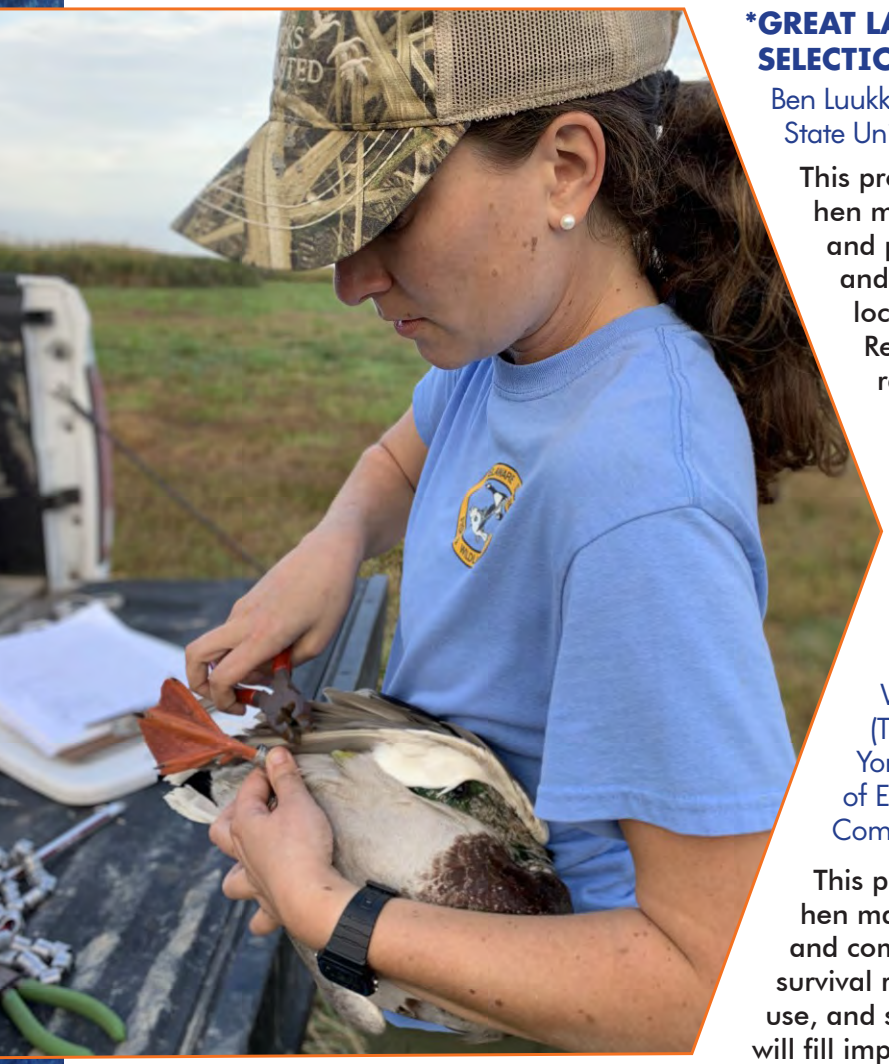
This project will assess recent releases of two moth (Archanara neurica and A. geminipuncta) species introduced in Canada to control non-native Phragmites to ensure host specificity and native Phragmites genotypes are safeguarded. In addition, supporting information will be collected regarding potential non-native Phragmites benefits using a social science questionnaire emailed to wetland managers across North America. This information will assist in securing a USDA/APHIS field release permit in the U.S.

* DENOTES A STUDENT-LED PROJECT

*ORIGINS OF PRE-SEASON BANDED MALLARDS IN THE NORTHERN ATLANTIC AND MISSISSIPPI FLYWAYS

Kayla Harvey (MSc student) & Dr. Michael Schummer, State Univ. of New York, ESF

This project will use stable isotope analyses on feathers and blood collected from pre-season banded mallards in the northern Atlantic and Mississippi flyways to determine the natal origin and genetic structure of mallards in the eastern U.S. These data will be used to inform harvest management and evaluate long-held assumptions about the birth (i.e., production) origin of mallards banded in the eastern U.S.



*GREAT LAKES MALLARD MOVEMENTS, HABITAT SELECTION, SURVIVAL, AND PRODUCTIVITY

Ben Luukkonen (PhD student) & Dr. Scott Winterstein, Michigan State Univ.

This project will deploy 475+ GPS/GSM transmitters on hen mallards in the Great Lakes states during breeding and post-breeding (August) to document movements and habitat use, estimate philopatry rates to breeding locales, estimate survival and productivity rates. Results from this study will inform subsequent recommendations for habitat and harvest management for Great Lakes mallards.

*MIGRATION ECOLOGY AND DEMOGRAPHICS OF EASTERN MALLARDS THROUGHOUT THE FULL ANNUAL CYCLE

Marie Racioppa (PhD student) & Dr. Mitch Weegman, Univ. of Saskatchewan; MSc student (TBD) & Dr. Jacob Straub, State Univ. of New York, Brockport; Josh Stiller, New York State Dept. of Environ. Cons.; Nate Huck, Pennsylvania Game Commission; Dr. John Coluccy, DU-GLAR

This project will deploy 1,099 GPS/GSM transmitters on hen mallards in the eastern U.S. and Canada to quantify and compare reproductive metrics, estimate seasonal survival rates, quantify and compare movements, habitat use, and selection throughout the annual cycle. This study will fill important gaps in our understanding of eastern mallard population ecology and provide additional insights into potential causes of population declines.

*IMPACTS OF PREY RESOURCES, WEATHER AND TIME OF DAY ON HABITAT USE FOR WINTERING LESSER SCAUP IN THE CHESAPEAKE BAY

Hannah Schley (MSc student) & Dr. Chris Williams, Univ. of Delaware

This study will use state of the art GPS/GSM transmitters implanted in female and male lesser scaup to evaluate wintering habitat use in relation to weather, time of day, and prey abundance and distribution in the Chesapeake Bay. In addition, the study will examine resource selection of lesser scaup to determine characteristics of preferred habitats that can be used to predict probability of use across the Chesapeake Bay. This study will provide information to help identify conservation efforts to benefit wintering populations of scaup.

* DENOTES A STUDENT-LED PROJECT

*EVALUATING WATERFOWL USE AND HABITAT QUALITY FOLLOWING WETLAND RESTORATION IN LAKE ONTARIO COASTAL WETLANDS AT BRADDOCK BAY WILDLIFE MANAGEMENT AREA

Christopher Mitchell (MSc student) & Dr. Rachel Schultz, State Univ. of New York, Brockport

Invasion of hybrid cattail and common reed (Phragmites) into Great Lakes coastal wetlands reduces habitat values by forming dense stands of monotypic vegetation. This project will measure waterfowl use and wetland characteristics to evaluate a wetland enhancement technique of dredging open water ponds within stands of invasive vegetation. This information is needed to ensure management activities are yielding gains for waterfowl.

**LONG-TERM GENETIC EFFECTS OF GAME-FARM MALLARD RELEASES ON WILD MALLARDS IN NORTH AMERICA

Joshua Brown (PhD student) & Dr. Phil Lavretsky, Univ. of Texas El Paso

Current research indicates that ≥15% of eastern mallards have originated from released game-farm birds. To help understand factors contributing to the decline of eastern mallards, this study will assess the contribution of game-farm mallards to the genetic composition of mallards across North America and investigate the extent to which it may be causing maladaptation and decreased fitness in wild mallards.

EXPANSION OF AMERICAN BLACK DUCK DECISION SUPPORT TOOL AND SOUTH ATLANTIC BIOENERGETICS MODELING

Mike Mitchell & Dr. Dale James, DU-SR; Jess Skillman & Dr. John Coluccy, DU-GLAR

DU scientists will collaborate with partners from the Black Duck and Atlantic Coast Joint Ventures to expand the scope of the American Black Duck Decision Support Tool to portions of the midwestern U.S., south Atlantic, and eastern Canada. Once completed, the tool will help prioritize watersheds for habitat restoration and protection across most of the black duck's nonbreeding range.

REFINING TECHNIQUES FOR AUTOMATED NATIONAL WETLANDS INVENTORY MAPPING IN THE GREAT LAKES REGION: A DATA FUSION APPROACH

Alek Kreiger, Mat Halliday, Rob Paige, & Robb Macleod, DU-GLAR; Jarlath O'Neil-Dunne & Sean MacFadden, Univ. of Vermont

Wetlands are the most difficult land cover type to map due to the temporal changes and diversity of type (open water to forested). Yet, they are one of the most important cover types for waterfowl, fish, other wildlife. Wetland updates using manual methods are extremely expensive for large areas and not likely to happen on a regular basis. This study is investigating the development of an automated method to efficiently map wetlands and identify temporal changes in a consistent and repeatable manner.

MICHIGAN'S DOMESTIC ACTION PLAN – LAKE ERIE WATER QUALITY, WILDLIFE HABITAT AND PUBLIC RECREATION IMPROVEMENT PILOT PROJECT

Jason Hill, Rob Paige, Cathleen Sampselle, & Sara Burns, DU-GLAR; Michigan DNR, Michigan EGLE; Dr. Ellen Herbert, DU-NHQ; Ed Verhamme, Limnotech

Wetlands in the western basin of Lake Erie have the potential to contribute significantly to the reduction of nitrogen and phosphorus runoff into Lake Erie. DU is developing a site prioritization tool in Arc GIS to select optimal sites to restore drained agricultural lands to wetlands that intercept agricultural drainage. In collaboration with Limnotech this study will monitor water quality of wetland inflows and outflows both before and after the restoration project.

* DENOTES A STUDENT-LED PROJECT
** DENOTES A DU FELLOWSHIP

DU INC. - WESTERN REGION

THE IMPACT OF INCREASING GOOSE POPULATIONS ON DABBLING DUCK FOOD SUPPLIES IN THE CENTRAL VALLEY OF CALIFORNIA

Dr. Mark Petrie, DU-WR; Mike Casazza, USGS; Dr. Chris Nicolai, Delta Waterfowl; Cliff Feldheim, California Dept. of Water Resources

Wintering goose numbers in the Central Valley have increased from 1 million birds in the mid-2000s to nearly 2.5 million birds today. This study examines the current impact of geese on dabbling duck food supplies, especially rice, and the likelihood that goose numbers in the Central Valley will continue to grow.

THE ROLE OF PUBLICLY MANAGED HABITATS IN SUPPORTING WATERFOWL POPULATIONS IN WASHINGTON'S NORTH PUGET SOUND

Dr. Mark Petrie, DU-WR; Kyle Spragens, Washington Dept. of Fish & Wildlife

North Puget Sound supports the highest density of wintering waterfowl on the U.S. Pacific Coast, but birds are overwhelmingly dependent on agricultural foods in this region, even while the agricultural landscape is rapidly changing. This study is assessing these changes on landscape carrying capacity and the future role of public lands in offsetting effects on waterfowl.

CONSERVATION PLANNING FOR WATERFOWL AND PEOPLE IN THE CENTRAL VALLEY OF CALIFORNIA

Dr. Mark Petrie, DU-WR; Luke Matthews, California Rice Commission

Waterfowl hunters and rice farmers are critical supporters of waterfowl conservation in the Central Valley of California. This study examines how we can integrate objectives for both waterfowl populations and conservation supporters by identifying actions that can simultaneously meet the needs of waterfowl, waterfowl hunters, and rice producers in the Central Valley.

PACIFIC FLYWAY WATER ANALYSIS

Dr. Mark Petrie, DU-WR; Greg Yarris, Central Valley JV; Dave Smith, Intermountain West JV

The California Central Valley, Great Salt Lake, and Southern Oregon/Northeastern California (SONEC) collectively support 70% of all ducks in the Pacific Flyway. Each of these areas is facing long-term water shortages, and because they share birds throughout autumn-winter, the effects on waterfowl habitats and populations may be compounded. This study will examine the potential consequences of regional water shortages for Pacific Flyway waterfowl and identify conservation strategies to mitigate them.

GREENHOUSE GAS FLUX RESPONSE TO TIDAL REINTRODUCTION AT HILL SLOUGH

Dr. Dennis Baldocchi, UC Berkeley; Aaron Will, DU-WR

The Hill Slough Restoration Project will restore 603 acres of managed seasonal wetlands and 46 acres of upland habitat to tidal wetland by improving existing public infrastructure, breaching interior levees, and lowering and breaching exterior levees. DU is partnering with researchers at UC Berkeley to measure pre- and post-construction greenhouse gas emissions using an eddy-flux covariance tower. Data collected at the site will be used to verify calculated quantification of emissions. The project provides a unique opportunity to investigate carbon dynamics in a restored brackish wetland.

DU INC. - GREAT PLAINS REGION

*EXPLORING THE NEXUS BETWEEN WATER-QUALITY AND WATERBIRD HABITAT CONSERVATION IN THE IOWA PRAIRIE POTHOLE REGION

Evangeline Von Boeckman (MSc student), Dr. Adam Janke, & Dr. William Crumpton, Iowa State Univ.; Kaylan Kemink, DU-GPR; Dr. Ellen Herbert, DU-NHQ; Dr. John Coluccy, DU-GLAR

Wetlands in the Iowa Prairie Pothole Region provide significant potential to reduce nitrate loads associated with agricultural drainage, and wetlands designed to improve water quality may also provide significant wildlife benefits. This project will assess the wetland-bird habitat values of wetlands created or restored to receive drain tile water. Results will help establish restoration guidelines and build synergies between wetland restoration programs for wildlife and water quality.

UNDERSTANDING LANDOWNER MOTIVATIONS FOR PARTICIPATION IN CONSERVATION PROGRAMS AND PRACTICES

Kaylan Kemink, DU-GPR; Dr. Bob Pressey & Dr. Amy Diedrich, James Cook Univ.; Dr. Vanessa Adams, Univ. of Tasmania

Recent research has demonstrated an urgent need to study landowner motivations and values from a multilevel perspective. This project uses a structured equation model that integrates ideas from the value-belief-norm theorem, the theory of cultural cognition, and the theory of planned behavior to examine how individual, group, and cultural values affect landowners' participation in conservation programs and practices in the PPR of North Dakota, South Dakota, and Montana.

UND-DU UNDERGRADUATE INTERNSHIP

Univ. of North Dakota, The Nature Conservancy, USGS Northern Prairie Wildlife Research Center, & Enbridge Ecofootprint Grant Program

DU and partners collaborate each summer to develop research skill sets of undergraduate students. Participants develop their own projects and are assisted with identifying appropriate research protocols. Students receive academic credit and present their findings to peers at summer's end, with most ultimately presenting at scientific conferences. Some returning students have continued their research for several years and now have publications in development describing tests of long-standing nest searching and monitoring protocols and revealing new and innovative behavioral data.

AUTOMATING THE MEASUREMENT OF ANNUAL WETLAND PONDING IN THE PRAIRIE POTHOLE REGION

Dr. Jessica O'Connell, Univ. of Texas Marine Science Institute; Kaylan Kemink, DU-GPR

This project aims to develop a publicly available multi-sensor algorithm that will provide high resolution spatial and temporal wetland data for conservation planners. The methods used in this project will enable examination of shifts in the intra and inter annual dynamics of wetland complexes during the breeding season in the Prairie Pothole Region. Development of this method and its results will enable finer-scale examination of wetland dynamics and their differential effects on productivity of adult and juvenile (e.g., ducklings) obligate wetland birds.

* DENOTES A STUDENT-LED PROJECT

PERPETUAL CONSERVATION EASEMENTS IN THE PPR: GUIDING DECISION-MAKING THROUGH RETURN-ON-INVESTMENT ANALYSIS

Kaylan Kemink, Dr. Johann Walker, Aidan Healey, Randy Renner, & Boyan Liu, DU-GPR; Dr. Vanessa Adams, Univ. of Tasmania; Dr. Bob Pressey, James Cook Univ.; Sarah Olimb, World Wildlife Fund; Todd Frehrichs, USFWS

Conservation organizations are increasingly turning to return-on-investment analyses to improve allocation of limited resources. This project seeks to address some of the challenges currently faced by these analyses in dynamic systems. We focus on the Small Wetlands Acquisition Program in the U.S. PPR between 2008–2017 as a case study. Results will provide guidelines for conservation planners about trade-offs between conservation objectives and costs.

IMPROVING SOIL HEALTH ON AGRICULTURAL LANDS TO BENEFIT GRASSLAND BIRD HABITAT IN THE PRAIRIE POTHOLE REGION OF SOUTH DAKOTA

Brian Chatham & Bruce Toay, DU-GPR; National Fish and Wildlife Foundation

This project will provide soil health monitoring assistance through the life of DU cost-share agreements. DU will help producers better understand soil health and the benefits of incorporating soil health practices into their agricultural operations. DU will utilize the best available science to promote conservation practices that not only benefit wildlife, but also produce positive economic outcomes for producers in this landscape.

*PRODUCING BEEF AND BIRDS: IMPACTS OF HIGH INTENSITY SHORT DURATION GRAZING ON GRASSLAND SONGBIRDS

Taylor Linder (PhD student) & Dr. Susan Ellis-Felege, Univ. of North Dakota; Dr. Marissa Ahlering, The Nature Conservancy; Kaylan Kemink, DU-GPR

Cattle ranchers have alternatives in the grazing systems they employ on their land, which often vary in the intensity (i.e., stocking rate) and duration of grazing bouts. This project will evaluate the impacts of high intensity short duration (HISD) grazing practices on the productivity of grassland nesting birds (songbirds, shorebirds, waterfowl and grouse) and investigate motives and attitudes of ranchers towards grassland birds and on-farm conservation actions to help develop best practices.

EFFECTIVENESS OF THE COVER CROP AND LIVESTOCK INTEGRATION PROGRAM FOR IMPROVING WETLAND WATER QUALITY

Kyle Kuechle, Emily Schwartz, & Tanner Gue, DU-GPR; Greg Sandness, North Dakota Dept. of Environmental Quality

DU and conservation partners developed the Cover Crop and Livestock Integration Program (CCLIP) to help producers adopt sustainable agricultural practices that integrate seasonal cover crops and cattle ranching with traditional grain production to improve soil health and generate broader environmental benefits. This study will ascertain benefits of CCLIP to water quality by monitoring wetland nutrient concentrations and hydrology in seasonal and temporary wetlands embedded in CCLIP fields, conventional agriculture, and pastureland.

EFFECTIVENESS OF THE COVER CROP AND LIVESTOCK INTEGRATION PROGRAM FOR IMPROVING SOIL HEALTH AND SOIL CARBON ACCUMULATION

Kyle Kuechle, Emily Schwartz, Bruce Toay, Brian Chatham, & Tanner Gue, DU-GPR; Soil Health Institute; Dr. Ellen Herbert, DU-NHQ

Regenerative agricultural practices such as grazing management, no-till, cover cropping, and livestock integration can build soil health and sequester carbon. DU's science and agronomy teams are partnering with the Soil Health Institute to develop monitoring protocols to measure the accumulation of soil carbon and track other indicators of improved soil heath such as water infiltration and microbial activity.

* DENOTES A STUDENT-LED PROJECT

DU CANADA - NATIONAL

VULNERABILITIES OF CANADIAN WETLANDS IN A CHANGING CLIMATE

Dr. Mark Mallory, Acadia Univ.; Dr. John Brazner, Prov. of Nova Scotia; Dr. Cherie Westbrook, Univ. of Saskatchewan; Dr. Paul Keddy (consultant); Dr. Sara Knox, Univ. of British Columbia; Dr. Jan Ciborowski, Univ. of Calgary; Dr. Line Rochefort, Univ. of Laval; Dr. Pascal Badiou, DUC-IWWR; Dr. Maria Strack, Dr. Rebecca Rooney, Dr. Scott Davidson, & Dr. Courtney Robichaud, Univ. of Waterloo

This project is addressing two significant knowledge gaps: 1) what are the vulnerabilities of Canadian wetlands in a changing climate? and 2) how do current Canadian wetland policies address these emerging vulnerabilities (and what improvements could be made)? These questions are of high importance because the expected impacts of climate change on wetlands are varied, but severe, and will have significant implications for the habitats DUC restores, conserves, and manages.

NATURAL CLIMATE SOLUTIONS IN CANADA—WETLANDS

Dr. Pascal Badiou, DUC-IWWR; Dr. Maria Strack & Dr. Scott Davidson, Univ. of Waterloo; Dr. Gail Chmura, McGill Univ.; Dr. Margot Hessing-Lewis, Hakai Institute

This project aims to assess and advance the potential of Canada's wetlands to help stabilize the global climate through natural climate solutions (NCS) while delivering co-benefits for people and biodiversity such as air and water filtration, soil health, wildlife habitat and climate resilience. NCS include protection of existing natural systems, restoration of those that have been lost or degraded, and improved management of working lands to minimize emissions. This project will promote the value of wetlands as NCSs to policymakers and industry and will support DUC policy and development initiatives.

RESNET: PROMOTING SUSTAINABLE AND RESILIENT ECOSYSTEMS THROUGHOUT CANADA

Dr. Elena Bennett, McGill Univ.; Adam Campbell, DUC-ATL; Dr. Vanessa Harriman, DUC-IWWR/BOR; Dr. Lauren Bortolotti, DUC-IWWR; numerous academic, government, non-profit, and industry partners

ResNet is a national research network to improve Canada's capacity to monitor, model, and manage working landscapes and the benefits they provide. DUC is involved in multiple sub-projects that combine scientific quantifications of these benefits with human dimensions of management issues. In Atlantic Canada, this project will improve our understanding of the trade-offs between the reinforcement of dykelands and restoration of tidal marshes in the Bay of Fundy. In the Prairies, this project will help us understand how to reduce conflict around wetland management through collaborative decision making.

KEY HABITAT SITES OF NORTH AMERICAN SEA DUCKS (ATLAS)

Sea Duck Joint Venture Partnership (Nic McLellan, DUC-ATL/IWWR)

Information on important areas for sea ducks in North America is lacking. This project is led by the Sea Duck Joint Venture and will compile the most important areas for sea ducks, on a continental scale, that will be a useful tool for conservation planning and habitat protection.

DU CANADA - BRITISH COLUMBIA

PREDICTING HABITAT DISTRIBUTION FOR SEA DUCKS IN BRITISH COLUMBIA

Bruce Harrison, Courtney Hamilton, & Paul Yeung, DUC-BC; Danielle Morrison, Nature Trust BC; Kathleen Moore, CWS; Llwellyn Armstrong & Dr. James Devries, DUC-IWWR

Pacific Birds Habitat JV (PBHJV) lacks the ability to inventory and assess waterfowl habitat along the entire 25,000-km BC coastline. This project is developing predictive models to identify key nearshore marine areas for important sea ducks. This product will aid in the assessment and targeting of conservation activity along the BC coast by PBHJV partners.

EVALUATING PERFORMANCE OF HABITAT PROJECTS IN BRITISH COLUMBIA

Zane Zondervan, Kyla Bas, Sarah Nathan, & Bruce Harrison, DUC-BC

DUC has constructed hundreds of habitat projects in BC since the late 1960s but had not conducted a comprehensive biological performance review since the 1990s. Since 2019 we have been evaluating project performance in terms of bird use and habitat structure across BC projects. Coastal projects include evaluation of the effects of new floodplain restoration techniques.

JOINT VENTURE DECISION SUPPORT SYSTEM FOR WETLAND, GRASSLAND AND RIPARIAN AREAS IN BRITISH COLUMBIA

Kathleen Moore, CWS; Danielle Morrison, NTBC; Courtney Hamilton & Bruce Harrison, DUC-BC

This project improves the ability of JV partners to standardize techniques used for prioritizing properties for securement and restoration throughout BC. The resulting tool estimates the “ecological value” of wetlands and grasslands while incorporating risks of disturbance/threats.

REVISITING A BIOENERGETIC MODEL TO UPDATE WATERFOWL HABITAT OBJECTIVES FOR THE FRASER RIVER DELTA.

Kathleen Moore, CWS; Bruce Harrison, Courtney Hamilton & Paul Yeung, DUC-BC; Dr. Mark Petrie, DU-WR; Drew Bondar, Delta Farmland and Wildlife Trust

The partners conducted a change analysis of agricultural crop composition between 1997–2020 in the Fraser Lowlands to track changes in the availability of wildlife-compatible crops (including vegetables, grasses, and grains) for wintering waterfowl carrying capacity models. Models are used to convert the food energy needs of waterfowl into conservation objectives for agricultural land in this critical Pacific Flyway wintering and staging area.

FACTORS INFLUENCING THE PERSISTENCE OF CREATED TIDAL MARSHES IN THE FRASER RIVER ESTUARY

Daniel Stewart, Asarum Ecological Consulting; Daniel Hennigar, Robyn Inham, & Eric Balke, DUC-BC

More than 100 tidal marshes have been constructed in the Fraser River Estuary over the last 40 years, but the factors behind project success have not been investigated. This project analyzed vegetation survey data from 78 marsh creation sites and 16 reference marshes to determine what factors influence (1) the persistence of created tidal marshes and (2) the resilience of created marsh plant communities. This project provides the most comprehensive analysis of tidal marsh creation efforts in the Fraser River Estuary to date and will support improved outcomes with future tidal marsh creation and restoration efforts.

DU CANADA - BOREAL

EFFECTS OF NATURAL AND ANTHROPOGENIC LINEAR FEATURES ON SETTLING AND PRODUCTIVITY OF DUCKS IN THE WESTERN BOREAL FOREST

Dr. Stuart Slattery, Howie Singer, Llwellyn Armstrong, Susan Witherly, & Dr. Matt Dyson, DUC-IWWR; Dr. Vanessa Harriman, DUC-IWWR/BOR

The Western Boreal Forest is changing rapidly due to industrial development. Implications of these changes for waterfowl nesting guilds (e.g., ground, overwater, cavity) are unknown. This study is assessing potential effects of roads, pipelines, and seismic lines on waterfowl settling and productivity at the guild level in the Boreal Plains using aerial surveys. This information will be used to guide and refine DUC conservation in the boreal forest.

SPECIES-HABITAT RELATIONSHIPS OF DUCKS IN THE WESTERN BOREAL FOREST

Dr. Matt Dyson, Dr. Stuart Slattery, Howie Singer, & Llwellyn Armstrong, DUC-IWWR; Dr. Vanessa Harriman, DUC-IWWR/BOR

Knowledge of species-specific responses to land use and landcover change informs our ability to deliver conservation programs and anticipate conservation needs. The Western Boreal Forest has rapidly changed in recent decades due to industrial development, and there remains uncertainty about the varying effects of these changes among different species of ducks. This study is assessing effects of roads, pipelines, and seismic lines on settling and productivity for American wigeon, blue-winged teal, green-winged teal, lesser scaup, mallard, northern shoveler, ring-necked duck, bufflehead, and common goldeneye across the Boreal Plains.

*DOES FOREST HARVESTING APPROXIMATE THE EFFECTS OF WILDFIRE FOR BOREAL-NESTING DUCKS?

Mark Bidwell (PhD student) & Dr. Bob Clark, Univ. of Saskatchewan; Dr. Vanessa Harriman, DUC-IWWR/BOR; Dr. Stuart Slattery, DUC-IWWR

Understanding the degree to which industrial disturbance approximates the effects of natural disturbance in the boreal forest is critical for focusing on the most important disturbances there. This study uses aerial surveys to investigate whether forest harvest emulates effects of fire on duck pair settling and productivity, hence whether conservation action is required.

WETLAND STATUS, CHANGE, AND SEASONAL INUNDATION DYNAMICS FOR ASSESSING THE VULNERABILITY OF WATERFOWL HABITAT WITHIN THE ARCTIC BOREAL VULNERABILITY EXPERIMENT REGION

Michael Merchant & Kevin Smith, DUC-BOR; Dr. Vanessa Harriman, DUC- IWWR/BOR; Dr. Stuart Slattery, Howie Singer, & Llwellyn Armstrong, DUC-IWWR; Michael Battaglia, Liza Jenkins, Dr. Laura Bourgeau-Chavez, & Dr. Nancy French, Michigan Tech Research Institute; Dr. Jennifer Baltzer, Wilfrid Laurier Univ.; Dr. Bruce Chapman, NASA; Dr. Chris Spence, ECCC

This collaboration under the auspices of NASA's Arctic Boreal Vulnerability Experiment (ABoVE) is assessing the utility of newly developed wetland mapping technology to predict changes in boreal waterfowl distributions through space and time. This information may ultimately improve our decision-making around spatial allocation of conservation resources.

THE NEXT GENERATION OF ALBERTA'S WETLAND INVENTORIES

Michael Merchant, Becky Edwards, James Varghese, & Al Richard, DUC-BOR

The Alberta Biodiversity Monitoring Institute (ABMI), DUC and Alberta Environment and Parks (hereafter ADA) are developing a wetland inventory conforming to the Government of Alberta's (GOA) mapping standards. With methods rooted in artificial intelligence and cloud computing, this project will be used to establish a technical workflow for detailed mapping of boreal wetlands cooperatively by ADA. These methods will be scaled across Alberta's boreal biome to update the wetland inventory, support various goals and objectives of the Alberta Wetland Policy, and provide information to support other government led planning information needs.

KASKA DENA TRADITIONAL TERRITORY WETLAND INVENTORY

Becky Edwards, Michael Merchant, & James Varghese, DUC-BOR

The primary focus of this project is to support Kaska Dena Council ongoing planning and management of the Kaska Indigenous Protected and Conserved Area (KIPCA) by generating wetland inventory products and sharing knowledge. Project partners will work with communities across the region to understand their needs and concerns and engage with the Guardians program to provide training opportunities to assist with knowledge generation and sharing (e.g., field work, use and application of the data).

WETLAND INVENTORY MAPPING TO SUPPORT TLICHO LAND USE PLANNING

James Varghese, Michael Merchant, Becky Edwards, Sonny Lenoir, & Jamie Kenyon, DUC-BOR

This project will provide a wetland inventory for the Tlicho region to address an outstanding knowledge gap that prevents a full understanding of biodiversity values of the region. A wetland inventory will support identification of important areas for species at risk with resulting land use planning initiatives incorporating this knowledge into decision making processes. This project will contribute to the maintenance of intact landscapes and recovery of species at risk by increasing the understanding of hydrological regimes, habitat types, and biodiversity values.

SLAVE/TALTSON DELTA WETLAND FISH HABITAT CONSERVATION PROGRAM

James Varghese, Michael Merchant, & Sonny Lenoir, DUC-BOR

Deninu Kų́ę First Nation, in collaboration with the Fort Resolution Metis Council, DUC, and the Canadian Parks and Wilderness Society are developing a fish habitat mapping and monitoring project to be carried out from fall 2020 through 2023. This Indigenous Habitat Participation Program project will be based in Ft. Resolution, NT and guided by a community-led committee. Main aspects of the project include: 1) Development and implementation of a field-based sampling program, 2) high resolution satellite-based mapping, and 3) data analyses to be conducted using both the field datasets and fish habitat maps.

PROTECTED AREAS GAP ANALYSIS—CONSERVATION AREAS, CARIBOU, & MULTI-SPECIES PLANNING

Lindsay McBlane & Alain Richard, DUC-BOR; Elston Dzus, Sandra Cardinal, Jacob Handel, & Tom Habib, Alberta-Pacific Forest Industries Inc.; Kevin Gillis, Mistik Management Ltd.; Kecia Kerr, Ryan Cheng, & Gord Vaadeland, Canadian Parks and Wilderness Society

This project uses GIS modeling to assess how well current protected areas network in northeast Alberta and northwest Saskatchewan represent features of conservation interest, including waterfowl abundance. The goal is to recommend an expanded, more representative network of conservation areas throughout the region, meet forestry certification goals, and contribute towards the Canadian Federal Government's protected areas goals. In so doing, DUC will use this multi-stakeholder project to leverage waterfowl and wetlands conservation.

IMPROVING WATERFOWL HABITAT CONSERVATION IN A MANAGED FOREST. A CASE STUDY ON THE BLACK SPRUCE FOREST MANAGEMENT AREA

Michael Merchant, Darrell Kovacz, Dr. Marcel Darveau, & Al Richard, DUC-BOR; Resolute Forest Products; Dave Thomson, Thomson Environmental; Al Harris, Northern Bioscience; Keith Hautala, Confederation College; Dr. Ashley Thomson, Lakehead Univ.

This collaborative project will improve tools used by forest managers by converting standard forestry maps to DUC's Enhanced Wetland Classification System, and then identifying key waterfowl habitats. The result will be more accurate inclusion of waterfowl needs in ongoing planning and operational decisions on a 13,700 km^2 (5,290 mi^2) forest management area.

DU CANADA - PRAIRIES

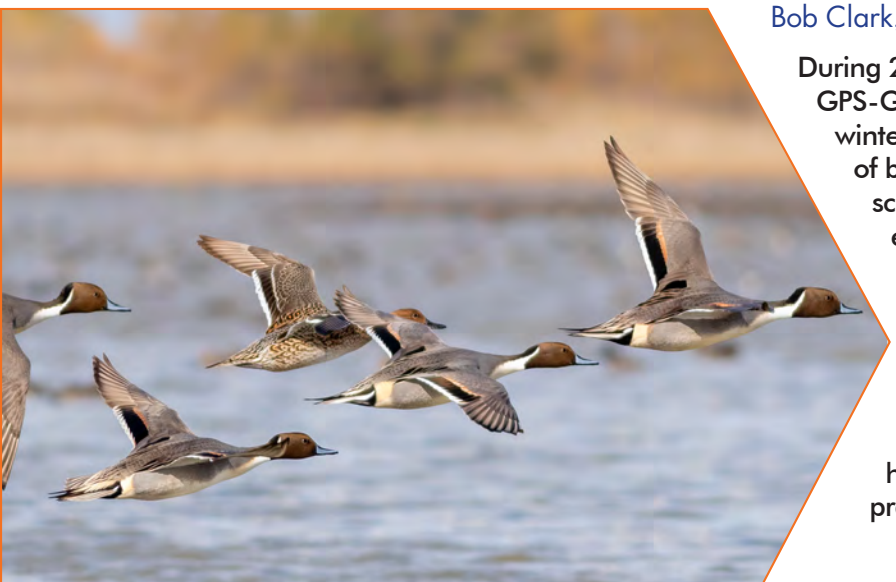
CLASSIFYING PRAIRIE WETLAND PERMANENCE USING REMOTE SENSING

Lyle Boychuk, DUC-SK; Dr. Lauren Bortolotti, Dr. James Paterson, & Llwellyn Armstrong, DUC-IWWR

Prairie wetlands range from being inundated with water for only a few days a year to being permanently flooded, with this permanence affecting wetland suitability as duck habitat and vulnerability to drainage. This project uses remote sensing methods to classify wetland vegetation communities and terrain metrics and will lead to a classification model to predict wetland permanence class based on wetland size, terrain metrics, and vegetation community composition. Predictions will be incorporated into a tool to identify temporary and ephemeral wetlands that can be enrolled in conservation programs.

FROM WINTERING TO BREEDING—UNDERSTANDING THE IMPORTANCE OF MIGRATORY AND BREEDING HABITAT SELECTION FOR NORTHERN PINTAILS ACROSS NORTH AMERICA

Dr. James Devries & Howie Singer, DUC-IWWR; Dr. Bob Clark, ECCC; Dr. Bart Ballard, Texas A&M Univ.



During 2019, this pilot project evaluated the utility of GPS-GSM tags attached to pintail females during winter for identifying subsequent characteristics of breeding sites at both landscape and nest scales. If GPS-GSM tags provide unbiased estimates of habitat selection, this research will provide valuable information on pintail breeding effort and success, nest site habitat selection, landscape-level habitat selection, and cross- seasonal effects on pintail breeding effort. This information will aid in the delivery of habitat conservation efforts for pintails in prairie Canada.

RELATIONSHIP BETWEEN LIFE HISTORY TRAITS, HABITAT SELECTION, AND DEMOGRAPHY IN A DYNAMIC WATERFOWL COMMUNITY

Dr. Frances Buderman, Pennsylvania St. Univ.; Dr. David Koons, Colorado St. Univ.; Dr. James Devries, DUC-IWWR

The study uses data from the annual breeding waterfowl survey, at the survey segment and strata level, in conjunction with spatially and temporally varying climate and land use datasets to explore patterns in habitat selection and demographic response for nine species of prairie breeding ducks. This study identifies species-specific habitat selection and demographic relationships with landcover and climate variables that will be useful in anticipating the future response of species to land use and climate change.

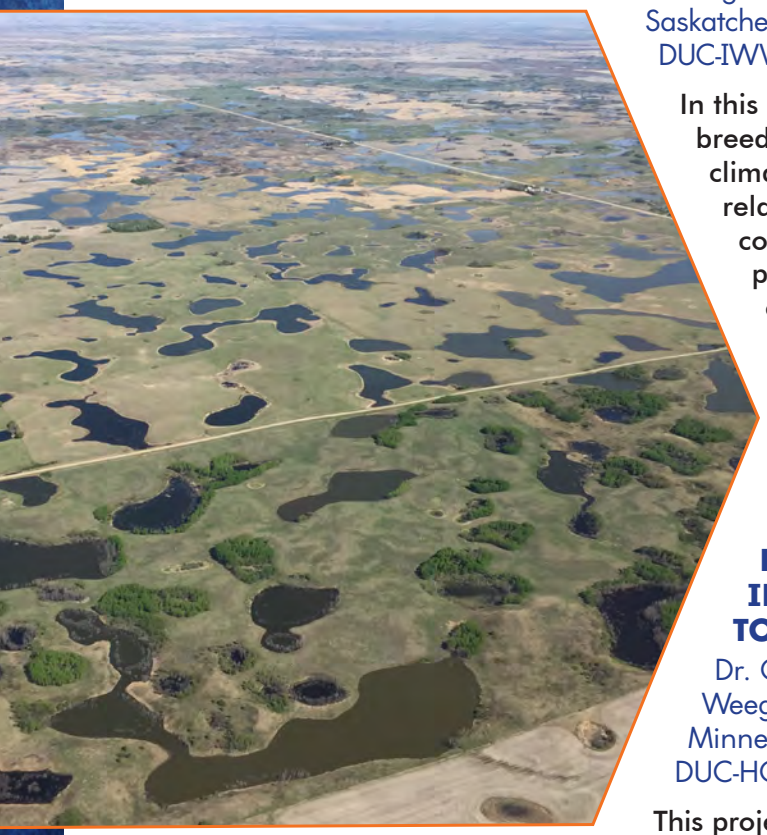
PRAIRIE CONSERVATION PLANNING "COST TOOL" DEVELOPMENT

Dr. James Devries, Llwellyn Armstrong, & Susan Witherly, DUC-IWWR; Dr. David Howerter, DUC-HO; Paul Thoroughgood, DUC-SK; Cynthia Edwards, DUC; various other DUC staff

Developed from many years of field research, the "Cost Tool" incorporates information on waterfowl nest habitat selection and success with costs of habitat conservation to provide a decision support tool predicting return on investment (cost per hatched nest) for all 16mi^2 grids in prairie Canada. This planning product provides a powerful tool for mapping the relative return on investment of various conservation actions across prairie Canada and is being used by DUC to guide conservation investment decisions.

USING INTEGRATED POPULATION MODELS TO PRIORITIZE REGION-SPECIFIC CONSERVATION STRATEGIES UNDER GLOBAL CHANGE

Dr. Qing Zhao (Post-doctoral researcher) & Dr. Mitch Weegman, Univ. of Saskatchewan; Dr. Todd Arnold, Univ. of Minnesota; Dr. James Devries, DUC-IWWR; Dr. Dave Howerter, DUC-HO; Dr. Bob Clark, ECCC



In this study, we analyzed 25 years (1990–2014) of pintail breeding population survey, band-recovery, pond count, climate, and land use data to estimate regional-scale relationships between demography and environmental conditions. Using an integrated population model, we predicted regional population responses under future changes in climate, wetland drainage, and agricultural intensification. Our study highlights the importance of considering region-specific conservation strategies to accommodate variation in future global changes and demographic responses.

QUANTIFYING THE DEMOGRAPHY OF NORTH AMERICAN DABBLING DUCKS USING INTEGRATED ANALYSES AND SCENARIO-PLAYING TO GUIDE CONSERVATION PLANNING

Dr. Qing Zhao (Post-doctoral researcher) & Dr. Mitch Weegman, Univ. of Saskatchewan; Dr. Todd Arnold, Univ. of Minnesota; Dr. James Devries, DUC-IWWR; Dr. Dave Howerter, DUC-HO; Dr. Bob Clark, ECCC

This project uses 55 years of breeding waterfowl survey data in the PPR (1961–2016) to develop Bayesian hierarchical models of land use and climate change effects on productivity (i.e., age ratios at banding) for seven common dabbling duck species. These models will be used to predict the responses of the dabbling duck community to future climate and land use change scenarios, thereby providing conservation practitioners with a more holistic view of conservation measures that differentially or uniformly benefit waterfowl.

UNDERSTANDING WETLAND CARBON, NITROGEN, AND PHOSPHORUS SEQUESTRATION POTENTIAL IN AGRICULTURAL LANDSCAPES

Dr. Irena Creed, Univ. of Saskatchewan; Dr. Tim Moore & Dr. Christian von Sperber, McGill Univ.; Dr. Pascal Badiou, DUC-IWWR; Dr. David Lobb, Univ. of Manitoba

Understanding the benefits of waterfowl habitat to society is important for expanding support for conservation. This project focused on how wetlands in agricultural landscapes capture carbon, nitrogen, and phosphorus and improve quality of downstream waters. Monitoring and research efforts focus on vulnerable agricultural landscapes in Alberta, Manitoba, and Ontario.

PRAIRIE ECOSYSTEM SERVICES PROJECT: QUANTIFYING THE CONTRIBUTION OF WETLANDS IN LIVESTOCK PRODUCTION LANDSCAPES TO CLIMATE CHANGE MITIGATION

Dr. Pascal Badiou & Dr. Lauren Bortolotti, DUC-IWWR; Dr. Sara Knox, Univ. of British Columbia; Dr. Aaron Glenn, AAFC; Dr. Kim Ominski, Univ. of Manitoba; and others from AAFC and Univ. of Manitoba

This project will focus on wetlands embedded in grazing lands and cropped fields to understand how land use affects wetland greenhouse gas emissions and carbon sequestration. Information from this project will determine the degree to which wetlands in agricultural landscapes contribute to natural climate solutions and how to manage these systems to maximize benefits.

SEMI-NATURAL LANDSCAPE FEATURES AS BENEFICIAL INSECT RESERVOIRS: ARTHROPOD PREDATOR COMMUNITY COMPOSITION IN PRAIRIE POTHOLE LANDSCAPES

Dr. Paul Galpern, Univ. of Calgary; Dr. James Devries, DUC-IWWR

This project is quantifying the value of wetlands in croplands to pollinating and beneficial insects that may provide value to farmers through improved crop pollination and pest control. Researchers are measuring the abundance and diversity of insects at varying distances from the wetland into the adjacent cropland in prairie agroecosystems of southern Alberta. Understanding the value of wetlands in providing these important ecosystem services to producers provides valuable information supporting the retention of wetland habitat in prairie agroecosystems.

QUANTIFYING TERRESTRIAL ARTHROPOD BIODIVERSITY ALONG A CHRONOSEQUENCE OF WETLAND RESTORATION

Dr. Paul Galpern, Univ. of Calgary; Dr. James Devries, DUC-IWWR

While prairie wetlands are known as biodiversity hotspots for birds, amphibians, and mammals, less is known about the arthropod diversity these habitats support, especially for restored wetlands. In this study, researchers are sampling the community composition of bees, beetles, flies, spiders and harvestmen under wetland retention and restoration scenarios. Information gathered on arthropod biodiversity will be used in DUC communication and policy efforts aimed at protecting and retaining wetlands in prairie agroecosystems.

*DIVERSITY AND ABUNDANCE OF BEES IN CANADIAN PRAIRIE AGROECOSYSTEMS: UNDERSTANDING THE ROLE OF REMNANT AND RESTORED HABITAT IN SUPPORTING NATIVE BEE POPULATIONS

Samantha Morrice (MSc student), Univ. of Saskatchewan; Dr. James Devries, DUC-IWWR; Dr. Sean Prager, Univ. of Saskatchewan

This project is examining the diversity and abundance of native bees associated with wetlands and field edges in croplands and grasslands in the parkland agroecosystem of central Saskatchewan. Quantifying the abundance and diversity of these species provides valuable information on the potential of remnant semi-natural habitats to provide pollination services in prairie agroecosystems. Quantifying ecosystem services provided by wetlands and other habitats supports DUC communication and policy efforts to conserve these important habitats.

ASSESSING AND MAPPING THE BIODIVERSITY POTENTIAL OF PRAIRIE LANDSCAPES

Dr. James Devries, Dr. James Paterson, Dr. Lauren Bortolotti, & Paige Kowal, DUC-IWWR

This project will use prairie-wide observations for mammals, birds, amphibians, and reptiles to develop probability of occurrence layers for each species as a function of biogeoclimatic variables at multiple scales. These layers will be used to map biodiversity potential across prairie Canada as a function of land use and habitat characteristics at fine spatial scales. This effort will enhance DUC conservation planning by highlighting areas of potential high biodiversity and allowing prediction of the impact of conservation activity, land use, and habitat change (e.g., wetland and grassland loss) on biodiversity potential.

QUANTIFYING PRAIRIE WETLAND ECOSYSTEM SERVICES—THE WETLAND DECISION SUPPORT SYSTEM

Dr. Lauren Bortolotti, Llwellyn Armstrong, Paige Kowal, Dr. Pascal Badiou, Bryan Page, Dr. James Paterson, Dr. James Devries, & Dr. Amy Shipley, DUC-IWWR

Wetlands provide many valuable ecosystem services, and quantification and communication of these values can garner support for DU's mission. This study is developing spatially explicit models of prairie wetland ecosystem services including water storage, nutrient retention, carbon storage, and biodiversity. The resulting product, Wetland DSS, will have numerous applications, including communicating wetland values to the public and improving our understanding of how to maximize ecosystem services from waterfowl conservation delivery.

PRAIRIE WATER: ENHANCING RESILIENCE FOR PRAIRIE COMMUNITIES

Dr. Chris Spence, ECCC; Jared Wolfe & Dr. Emily Cavaliere, Univ. of Saskatchewan; Dr. Bob Clark, ECCC; Dr. Lauren Bortolotti & Dr. James Devries, DUC-IWWR; Dr. Vanessa Harriman, DUC-IWWR/BOR; and others from ECCC and Birds Canada

Understanding the combined effects of wetland drainage and climate change is key to planning the amount and type of conservation delivery needed to sustain waterfowl populations into the future. This project uses the Cold Regions Hydrologic Model to quantify how these forces will affect waterfowl abundance and broader bird biodiversity.

* DENOTES A STUDENT-LED PROJECT

DOES PROXIMITY TO ROADS AFFECT PAIR DENSITY OF CANVASBACKS AND REDHEADS?

Dr. Michael Anderson & Llwellyn Armstrong, DUC-IWWR

Many waterfowl surveys in the PPR were established along grid roads, generally spaced a mile apart, where indicated pairs were typically counted 0.25 mi to either side of the roadway. A necessary assumption when extrapolating such estimates to larger landscapes is that roads do not bias results and produce inaccurate estimates of population size. This project is using data collected near Minnedosa, MB in 1983–1990, to evaluate whether numbers of canvasback and redhead pairs and broods counted along grid roads are representative of entire landscapes.

DELTA MARSH, RESTORING THE TRADITION—WATERFOWL RESPONSE

Dr. Lauren Bortolotti, Dr. Dale Wrubleski, Bob Emery, Paige Kowal, Llwellyn Armstrong, & Howie Singer, DUC-IWWR; Dr. Vanessa Harriman, DUC-IWWR/ BOR; Dr. Michael Anteau, USGS; Frank Baldwin, ECCC; Cameron Meuckon, Government of Manitoba

This study uses a multi-pronged approach to assess the response of waterfowl to the restoration of Delta Marsh. It leverages historical waterfowl and submersed aquatic vegetation surveys and new data on waterfowl abundance, vegetation response, waterfowl distribution within the marsh, and nutrient acquisition by diving ducks to provide a holistic evaluation of the success of the restoration and value of the marsh as habitat for migratory waterfowl.

DELTA MARSH, RESTORING THE TRADITION—FISHERIES RESPONSE

Dr. Dale Wrubleski, Bob Emery, Paige Kowal, & Llwellyn Armstrong, DUC-IWWR; Doug Watkinson, Dr. Amanda Caskenette, DFO

A ten-year research and monitoring program was undertaken to determine how temporary exclusion screens could be used to exclude invasive common carp while minimizing impacts to the native fish assemblage at Delta Marsh. A combination of sampling methods was used to study changes in the fish assemblage pre- and post-exclusion, and inside and outside the carp exclusion zone in the marsh. This information is essential for assessing how the exclusion of carp to restore Delta Marsh is affecting other fish species.

DELTA MARSH, RESTORING THE TRADITION—FISHERIES METHODS

Dr. Amanda Caskenette, Dr. Eva Enders, Ricky Di Rocco, & Doug Watkinson, DFO; Dr. Dale Wrubleski, Bob Emery, Paige Kowal, DUC-IWWR

Fisheries monitoring for the Delta Marsh restoration project provided an opportunity to work with Canadian federal government staff to develop or improve fish sampling methods for large wetlands. This project is the first to develop fish length-width relationships that will be useful for selecting screen size for fish passage or exclusion projects where only length data is available. This study also determined methods for correcting gillnet selectivity bias in a habitat in which gillnets are not commonly used. This project is also likely the first to use trail cameras to monitor fish movement under different environmental conditions at common carp exclusion structures.

DELTA MARSH, RESTORING THE TRADITION—WATER CLARITY AND SUBMERSED AQUATIC VEGETATION

Paige Kowal, Dr. Pascal Badiou, Bob Emery, Dr. Dale Wrubleski, Llwellyn Armstrong, & Bryan Page, DUC-IWWR; Dr. Gordon Goldsborough, Univ. of Manitoba

This study is assessing the habitat response to the exclusion of invasive common carp from Delta Marsh. It compares water clarity data and submersed aquatic vegetation data between time periods before and after carp exclusion, which has been collected as part of a research and monitoring program. This information will enable assessments of how the exclusion of carp from Delta Marsh is affecting multiple indices of waterfowl habitat quality.

*STABLE ISOTOPE MASS BALANCE MIXING MODELS TO QUANTIFY INDIVIDUAL DELTA MARSH WATER BALANCE COMPONENT CONTRIBUTIONS

Marija Glavonjic (MSc student), Dr. Tricia Stadnyk, & Dr. Shawn Clark, Univ. of Manitoba

The objective of this study is to better understand the origins of water in Delta Marsh (e.g., agricultural run-off, direct precipitation, ground water, Lake Manitoba, etc.). Stable water isotopes will be used with data on weather, water levels, and potential outputs (water flux) from a new hydrologic model. This information will verify recently developed hydrologic models for the marsh and the role of the surrounding watershed on water inputs. This information will then be combined with nutrient data to model nutrient loading to the marsh.

APPLYING A GENE-SUITE APPROACH TO EXAMINE THE PHYSIOLOGICAL STATUS OF WILD-CAUGHT WALLEYE

Dr. Jennifer Jeffrey (Post-doctoral researcher), Hunter Carlson, Jason Treberg, & Dr. Ken Jeffries, Univ. of Manitoba; Dr. Eva Enders, DFO; Dr. Dale Wrubleski, DUC-IWWR

A non-lethal technique was used to determine the physiological condition of large walleye held in Delta Marsh during the summer months by the common carp exclusion screens developed by DUC and partners to restore duck habitat. Gill tissue samples were analyzed for the expression of genes linked to heat stress and anaerobic metabolism. The longer fish were held in the marsh, the more apparent was the expression of these genes. Based on this information, the temporary exclusion screens are being lifted earlier in the summer to reduce stress to fish held in the marsh.

* DENOTES A STUDENT-LED PROJECT

ESTIMATING THE IMPACT OF CONSERVATION AND LANDSCAPE CHANGE ON WATERFOWL PRODUCTIVITY – THE WATERFOWL PRODUCTIVITY MODEL

Dr. James Devries, Llwellyn Armstrong, & Bob Emery, DUC-IWWR; Dr. David Howerter, DUC-HO; various other DUC staff

This effort combines information from three long-term nesting studies in a predictive model—the Waterfowl Productivity Model—to estimate waterfowl productivity at landscape scales given population density, habitat availability, nest habitat selection, and nest survival. The model is derived from data on over 23,000 duck nests found on 188 study sites across prairie Canada during 1993–2011. This model allows prediction of how conservation actions and background landscape change will impact the number of hatched nests.

*IMPACTS OF CLIMATE CHANGE IN PRAIRIE CANADA – WATERFOWL PRODUCTIVITY

Dr. Lauren Bortolotti, Dr. James Devries, & Llwellyn Armstrong, DUC-IWWR; Zhe Zhang (PhD student) & Dr. Yanping Li, Univ. of Saskatchewan; Dr. Benjamin Rashford, Univ. of Wyoming

Future improvements in conservation planning for waterfowl will require enhanced understanding of the effects of climate change on prairie wetlands, agricultural land use, and population demographics. In the second part of a multi-stage project, this study will incorporate direct impacts of climate change on wetlands and indirect (economically driven) effects on land use into models of prairie waterfowl productivity.

*COOLING EFFECTS OF PRAIRIE WETLANDS

Zhe Zhang (PhD student) & Dr. Yanping Li, Univ. of Saskatchewan; Dr. Lauren Bortolotti, DUC-IWWR

Wetlands have been documented to effect local atmospheric cooling, but it is unclear if that cooling is detectable and important at regional scales. By modelling wetland-atmosphere interactions in the Prairie Pothole Region, this study revealed that wetlands, when abundant, can reduce summer temperatures by up to 3 degrees Celsius and reduce the number of hot days during heatwaves. This study documented an important climate regulation ecosystem service that has implications for on-farm benefits, including potentially protecting crops from heat stress.

EFFECTS OF LANDSCAPE COMPOSITION AND CLIMATE ON DUCK NEST SUCCESS IN THE CANADIAN PRAIRIES

Dr. Lauren Bortolotti, Bob Emery, & Llwellyn Armstrong, DUC-IWWR; Dr. David Howerter, DUC-HO

This study gathered data from over 5,000 upland-nesting duck nests over 9 years, spanning gradients of landscape composition, climate, and waterfowl density in the Canadian Prairies. Results will improve our understanding of factors limiting prairie ducks and the long-term capability of prairie landscapes to support waterfowl to refine conservation planning.

*INFLUENCE OF WETLAND PESTICIDE POLLUTION ON WATERFOWL DISTRIBUTION, ABUNDANCE AND PRODUCTIVITY IN THE PRAIRIE POTHOLE REGION

Tyler Bryan (MSc student) & Dr. Christy Morrissey, Univ. of Saskatchewan; Dr. James Devries, DUC-IWWR

This project examines the hypothesis that waterfowl presence, abundance and composition will decrease in relation to increasing rate of pesticide pollution because of impacts on aquatic invertebrate communities. Understanding the relationship between incidence of pesticide pollution and changes in the waterfowl community using prairie potholes will help DUC engage the agricultural industry and landowners in adopting environmentally sustainable agricultural practices.

* DENOTES A STUDENT-LED PROJECT

EVALUATING DITCH PLUG WETLAND RESTORATIONS IN THE PRAIRIE POTHOLE REGION

Dr. James Paterson, Dr. Matt Dyson, Howie Singer, & Dr. Stuart Slattery, DUC-IWWR

This study is evaluating the success of ditch plug wetland restorations in supporting ducks and other wildlife by sampling restored wetlands of various ages and comparing waterfowl and other biodiversity to undrained wetlands in similar landscapes. Results from this study will improve wetland restoration decisions (e.g., value of restoring wetlands in different landscapes) and build support for the value of restored wetlands supporting ducks and other biodiversity.

COMPARATIVE REPRODUCTIVE PARAMETERS OF SYMPATRIC LESSER SCAUP AND RING-NECKED DUCKS IN PARKLAND, MANITOBA

Gordon Hammell (retired); Howie Singer, & Llwellyn Armstrong, DUC-IWWR

Waterfowl managers are concerned that lesser scaup populations remain below conservation goals. Contrasting population growth trajectories for sympatric, phylogenetically similar lesser scaup and ring-necked duck prompted investigations that might help explain these trends and provide insight for population management of both species. Results from these analyses suggest that greater productivity of ring-necked ducks is a likely proximate cause for the differing population growth trajectories between the species.

USE OF SHOOT DIMENSIONS AND MICROSCOPIC ANALYSIS OF LEAVES TO DISTINGUISH *TYPHA LATIFOLIA, TYPHA ANGUSTIFOLIA*, AND THEIR INVASIVE HYBRID *TYPHA X GLAUCA*

Jennifer Wasko & Dr. Gordon Goldsborough, Univ. of Manitoba; Dr. Terence McGonigle, Brandon Univ.; Dr. Dale Wrubleski, Dr. Pascal Badiou, & Llwellyn Armstrong, DUC-IWWR

The hybrid cattail is morphologically intermediate between its parental species. This study explored a method to distinguish these taxa based on morphology throughout emergent life stages. Four traits of gross morphology and four from microscopic examination of leaf cross sections were evaluated. Results indicated that mean leaf-apex angle for a shoot can be used to distinguish the parental Typha species and the hybrid. The remaining seven traits can be used as additional support for determinations.

DU CANADA - CENTRAL CANADA

ASSESSING WETLAND RESTORATION OPPORTUNITIES IN SOUTHERN ONTARIO USING GIS AND MULTI-CRITERIA DECISION MAKING: PRINGLE CREEK WATERSHED CASE STUDY

Mallory Carpenter & Kyle Borrowman, DUC-ON; Emily Alvarez, Tavis Buckland, Yichun Du, Jack Forsyth, & Arthur Tong, Ryerson Univ.

DUC Ontario collaborated with the Master of Spatial Analysis Program at Ryerson University to develop a suitability index tool to quantitatively identify sites for wetland restoration using GIS and multicriteria decision making. This tool was developed and piloted for the Pringle Creek watershed in Whitby, Ontario and is currently being expanded to other urban municipalities.

QUANTIFYING THE VALUE AND RISK OF RESTORING WETLAND HABITATS IN AGRICULTURAL LANDSCAPES

Dr. Sarah French (Post-doctoral researcher) & Dr. Rebecca Rooney, Univ. of Waterloo; Dr. Dale Wrubleski & Dr. James Devries, DUC-IWWR; David McLachlin, DUC-ON

This project is assessing how the invertebrates, wildlife and water quality of restored wetlands are influenced by surrounding land use and cover. Special attention is focused on land use effects on pesticide loading. This information will help DUC understand impacts of land use adjacent to our projects, especially those receiving surface water runoff from agricultural lands.

DEVELOPING SPECIES-HABITAT CONSERVATION MODELS FOR PRIORITY WATERFOWL IN EASTERN CANADA

Dr. Mark Mallory, Acadia Univ.; Dr. Mark Gloutney, DUC

Conservation planning under NAWMP is increasingly driven by biological planning models that connect duck demography or abundance to habitat conditions. This project will use data collected over 5 decades in eastern Canada to link breeding waterfowl abundance to a suite of habitat characteristics and develop regional, species-habitat models to predict distribution of priority waterfowl. These models will be used to advance spatial targeting of conservation delivery in the Eastern Habitat Joint Venture.

IMPLEMENTING BIOLOGICAL CONTROL OF INTRODUCED PHRAGMITES AUSTRALIS IN ONTARIO

Dr. Michael McTavish (Post-doctoral researcher), Smith Forest Health Lab and AAFC; Dr. Rob Bouchier, AAFC; Dr. Sandy Smith, Univ. of Toronto; Erling Armson, DUC-ON

Introduced common reed (Phragmites australis) is considered one of the most invasive plants in North America, displacing native species and threatening wetland biodiversity. Mechanical and chemical management have proved costly and ineffective for larger populations. As an alternative, nearly 20 years of research has identified the stem-boring noctuid moths as suitable biocontrol agents, and a petition for their release in Canada has recently been approved. This project is part of a larger initiative that will determine the impact of the stem-boring noctuid moths on introduced and native Phragmites and survival of the moths at all life stages.

DETERMINING THE NUTRIENT RETENTION CAPACITY OF NEWLY RESTORED WETLANDS IN SOUTHWESTERN ONTARIO

Bryan Page, Dr. Pascal Badiou, & Shane Gabor, DUC-IWWR; Owen Steele, DUC-ON

Restored wetlands have been identified as natural infrastructure with the potential to reduce phosphorus loads entering streams and rivers across the working landscape of southwestern Ontario, ultimately reducing phosphorus loading to Lake Erie. This project studied restored edge-of-field wetlands to determine their ability to remove nutrients from agricultural runoff. Results indicate that restored wetlands can effectively reduce nutrients entering Lake Erie. This information will help DUC promote restoration of small wetlands in Ontario.

Photo, Francis St. Pierre

THE INDIVIDUAL AND SYNERGISTIC EFFECTS OF WETLAND LOSS AND ROAD DENSITY ON LOCAL EXTINCTION RATES OF AMPHIBIANS

Dr. James Paterson, DUC-IWWR; Tanya Pulfer, Ontario Nature and CWS; Emma Horrigan, Smera Sukumar, & Brittney Vezina, Ontario Nature; Dr. Ryan Zimmerling, CWS; Dr. Christina Davy, Carleton Univ.

This project uses community science data to estimate how wetland loss and road density interact to affect local extinction and colonization rates of amphibians in Ontario. This information will identify which species are most sensitive to habitat change and the locations of populations most at risk of local extinction. This will improve spatial targeting for conserving wetland biodiversity and highlight the importance of waterfowl habitat for other wildlife.

DU CANADA - ATLANTIC

IDENTIFYING DEMOGRAPHIC BOTTLENECKS AND HABITAT USE TO SUPPORT THE RECOVERY AND MANAGEMENT OF AMERICAN COMMON EIDER: A RANGE-WIDE, FULL LIFE-CYCLE TELEMETRY PROJECT

Scott Gilliland, Dr. Greg Robertson, Dr. Al Hanson, & Christine LePage; CWS/ECCC, Nic McLellan, DUC-ATL/IWWR, Kelsey Sullivan, State of Maine; Lucas Savoy, Biol. Res. Inst.; Dr. Jean-François Giroux, Univ. du Québec à Montréal; Dr. Oliver Love, Univ. of Windsor; Dr. Mark Mallory, Acadia Univ.

This multi-year project will deploy satellite tags on hen American common eiders across their breeding range. The project aims to develop a methodology to assess breeding status, assess breeding propensity, and identify periods in the annual cycle when female mortality occurs. It will also provide information on movement and habitat use at various spatial scales and help identify conservation opportunities for this sub-species.

ESTIMATING POPULATION GROWTH AND RECRUITMENT RATES ACROSS THE RANGE OF AMERICAN COMMON EIDERS

Dr. Jean-François Giroux & Martin Patenaude-Monette, Univ. du Québec à Montréal; Randy Milton & Glen Parsons, Prov. of NS; Scott Gilliland & Dr. Eric Reed, CWS; Brad Allen, St. of Maine; Dan McAuley, USGS; Nic McLellan, Dr. Mark Gloutney & Dr. Katherine Mehl DUC-ATL/IWWR

This project used banding data from female American common eiders throughout their range to estimate population growth and recruitment rates. This project helps identify regions where there are declines and where conservation efforts for common eider should be focused.

MARINE ECOSYSTEM CHANGES IN ATLANTIC CANADA: DRIVERS OF ALTERED ABUNDANCE AND HABITAT USE BY WATERFOWL AND MARINE BIRDS?

Dr. Sarah Gutowsky (Post-doctoral researcher) & Dr. Mark Mallory, Acadia Univ.; Dr. Greg Robertson & Scott Gilliland ECCC; Nic McLellan, DUC-ATL/IWWR

This project will model distributions and abundances of American common eiders and other waterfowl species to identify changes and associated drivers through time. This will involve the collection and exploration of various waterfowl and environmental data. This work will also help identify important areas for waterfowl and predict how they may change through time, thus providing insights for marine and coastal conservation planning.

ASSESSING AND IMPROVING ALEWIFE FISH PASSAGE AT DUC FISHWAYS IN ATLANTIC CANADA

Dr. Mike Stokesbury & Dr. Aaron Spares, Acadia Univ.; Dr. Mike van den Heuval & Dr. Sean Landsman, Univ. of Prince Edward Island; Nic McLellan, DUC-ATL/IWWR; Jonathan Platts, DUC-ATL

This long-term project uses PIT tagging technology to assess and improve passage efficiency of migratory fish species, including alewife, rainbow smelt and brook trout at DUC wetlands with fishways in coastal habitat of Atlantic Canada. This improved connectivity should increase the health and productivity of both freshwater and marine environments.

RUNNING ON EMPTY? FRESHWATER FEEDING BY SPAWNING ANADROMOUS ALEWIFE ALOSA PSEUDOHARENGUS

Sarah Stewart (BSc Honors student), Dr. Aaron Spares & Dr. Mike Stokesbury, Acadia Univ.; Dr. José Varela, Univ. De Cádiz; Nic McLellan, DUC ATL/IWWR

DUC manages many fish ladders that provide migratory passage to alewife and many wetlands and lakes that provide spawning and nursery habitat. This project assesses the diet of migrating and spawning alewife, a species thought to have fasted during this period of their life cycles. This project improves the ecological understanding of this species and highlights another value these freshwater habitats provide.

*ASSESSING AND IMPROVING AMERICAN EEL PASSAGE AT DUC WATER CONTROL STRUCTURES

Brandon Nilsen (MSc student) & Dr. Mike Stokesbury, Acadia Univ.; Nic McLellan, DUC-ATL/IWWR

DUC manages water control structures in coastal areas where young American eels, a species of growing conservation concern, migrate to freshwater habitats to mature. This project is assessing and improving American eel passage at DUC water control structures with the installation of different enhancement structures (e.g., ramps).

UNDERSTANDING AND MEASURING BLUE CARBON STORAGE IN SALT MARSHES OF THE MARITIME PROVINCES

Dr. Jeff Ollerhead & Dr. Holly Abbandonato, Mount Allison Univ.; Nic McLellan, DUC-ATL/IWWR

This project aims to better understand how to measure and quantify carbon storage in both natural and restored salt marshes. In addition, it will help identify knowledge gaps for our region to address and facilitate the verification of carbon storage for offsetting. This project will improve our knowledge of this important function that salt marshes provide.

*AQUATIC INVERTEBRATES AS INDICATORS FOR ECOSYSTEM SENESCENCE OF WETLAND IMPOUNDMENTS IN THE UPPER BAY OF FUNDY

Jacob Demers, CIC/DUC-Quebec, Dr. Josh Kurek, & Dr. Dave Leiske, Mount Allison Univ.; Dr. Al Hanson, CWS; Nic McLellan, DUC-ATL/IWWR

This project explores the aquatic invertebrate communities of DUC wetland impoundments in relation to age and water chemistry parameters. This work will improve understanding and management-related decisions to maintaining long-term productivity of wetlands.

* DENOTES A STUDENT-LED PROJECT

*NESTING HABITAT USE AND AVAILABILITY FOR CAVITY-NESTING DUCKS IN THE LOWER SAINT JOHN RIVER FLOODPLAIN, NEW BRUNSWICK

Heidi Harding (MSc student) Jared Sonnleitner (MSc student) & Dr. Joe Nocera, Univ. of New Brunswick; Nic McLellan, DUC-ATL/IWWR

Evidence suggests that common goldeneye have experienced regional population declines in New Brunswick, possibly related to a decline in natural cavity availability. This project investigates whether natural cavity availability has changed over time along the lower St. John River, the regional effect of a long-term nest box program, reproductive parameters for cavity nesters, and whether site characteristics can inform cavity or nest box usage. This information will help inform nest box programs and conservation for cavity nesting waterfowl.

*WETLAND BIRD RESPONSE TO HISTORIC AND CURRENT ANTHROPOGENIC HABITAT DRIVERS AND CONSERVATION IMPLICATIONS IN ATLANTIC CANADA

Kiirsti Owen (PhD student) & Dr. Joe Nocera, Univ. of New Brunswick; Dr. Mark Mallory, Acadia Univ.; Nic McLellan, DUC-ATL/IWWR

This broad research project will assess waterfowl and wetland bird use of coastal, dykeland habitats along the Bay of Fundy, including DUC wetland projects, throughout the annual cycle. This project will also build on previous wetland senescence research and assess bird use with respect to wetland age, habitat, and management techniques.

*SUB-HABITAT USE BY FISH IN, AND PHYSICAL CHARACTERISTICS OF, RESTORED AND ESTABLISHED SALT MARSHES IN MEGA- AND MICROTIDAL REGIMES

Kiana Endresz (PhD Student), John Linihan (MSc Student), & Dr. Myriam Barbeau, Univ. Of New Brunswick; Dr. Jeff Ollerhead, Mount Allison Univ.; Nic McLellan, DUC-ATL/IWWR

This project is researching how fish utilize salt marsh habitats in the Maritime Provinces and how this varies depending on the location and tidal regime. In addition, it will focus on how the physical characteristics of salt marsh relate to fish usage. This project improves our understanding of salt marsh values and how we design salt marsh restoration projects in the future to maximize biodiversity outcomes.

DU DE MÉXICO

COASTAL EROSION DYNAMICS IN THE TELCHAC-CELESTUN SECTION OF THE YUCATAN: DIAGNOSIS AND POSSIBLE MITIGATION MEASURES

Dr. Paulo Salles de Almeida & Dr. Alec Torres-Freyermuth, Engineering Institute of the National Univ. of Mexico; Secretary of Sustainable Development of the state of Yucatan; Eduardo Carrera & Gabriela de la Fuente, DUMAC-NHQ

Coastline erosion along Mexico's Yucatan peninsula threatens the ecological integrity of mangrove swamps and other wetlands that provide important habitat for waterfowl wintering in Mexico. This study will estimate coastline erosion and accretion rates from Telchac to Celestun, determine the effect of port infrastructure on sediment transport processes and coastline erosion, and identify possible mitigation activities to increase the resilience of coastal wetlands in this region.

* DENOTES A STUDENT-LED PROJECT

SEAGRASS STUDY IN THE LAGUNA MADRE DE TAMAULIPAS

Dr. Leonardo Arellano & Dr. Arturo Mora, Tamaulipas St. Univ.

In 1996, DUMAC and the Tamaulipas State University conducted the first seagrass biomass study at Laguna Madre Tamaulipas. In 2019, the study was replicated to determine contemporary shoalgrass biomass, a critical food resource for redheads, and compare to earlier findings from the 1970s. This information will help determine trends in seagrasses and guide development of policies at state and federal levels to conserve this important habitat for migratory and resident waterfowl species.

WETLANDS INVENTORY AND CLASSIFICATION IN MEXICO

Eduardo Carrera, Gabriela de la Fuente, Norma Rangel, & Diana Sánchez, DUMAC-NHQ

The lack of a wetlands inventory in Mexico and associated data related to wetland characteristics and extent motivated DUMAC to initiate in 1991 the Mexico National Wetlands Inventory and Classification. Since then, DUMAC has been working regionally to complete what represents the first wetlands inventory to include all Nearctic and Neotropical wetland types in Mexico. Completed in 2020, this information will be available through a web-based map server for all institutions and agencies to support their wetlands conservation initiatives in Mexico.

COASTAL DIGITAL CHANGE DETECTION ANALYSIS IN SINALOA AND SONORA

Gabriela de la Fuente, Eduardo Carrera, Carlos Salinas, & Norma Rangel, DUMAC-NHQ

Coastal wetlands along the upper Pacific coast (UPC) of Mexico support 38% of migratory waterfowl wintering in Mexico. Prior to 1987, the most important threats for these coastal wetlands were agricultural expansion and runoff of agrochemicals and fertilizers, causing uncontrolled growth of cattail at important intertidal areas for waterfowl and shorebirds. After 1987, intensive shrimp farming began in Sinaloa and Sonora and became the primary cause of the loss and degradation of mangrove forests in this region. This study, initiated in 2016, measured the amount and distribution of mangrove forest loss due to shrimp farm growth. This information will serve as a visual tool to show local and federal authorities the damages of the shrimp farm industry to mangrove forests within the coastal wetlands ecosystems of the UPC, and will inform public policy to guide the management, restoration, and conservation of these important habitats.

WATERFOWL SURVEYS OF MEXICO: A MULTI-ORGANIZATIONAL COLLABORATION

Metropolitan Univ.; Biopicture A.C.; Birds.mx; National Commission of Natural Protected Areas; Biodiversity Conservation of Central Mexico, A.C.; Municipality of Almoloya de Juarez; Mexico St. Univ.; Chihuahua State Government; Chihuahua Municipality Government; ITZAMNA, A.C.; Aguascalientes Environmental Movement, A.C.; Wildlife Management Unit at Chiconahuapan Lagoon and Los Golodrinos, ASOCIES, A.C.; PROFAUNA; Secretary of Urban Development and Environment of Yucatan; Secretary of Environment and Territorial Planning of the State of Guanajuato; Secretary of Environment and Natural Resources of the States of Mexico, Durango and Zacatecas; Black Forest A.C.; Secretary of Environment and Territorial Development of Durango, Society for Research and Use of Wildlife; Forest and Wildlife Services; Morelos St. Univ.; Sinaloa St. Univ.; Zacatecas St. Univ.; Queretaro St. Univ., Michoacán St. Univ.; U.S. Fish and Wildlife Service; and DUMAC.

Effective conservation and management of migratory waterfowl populations requires an understanding of their ecology and distribution throughout the annual range. In recognition of this, the U.S. Fish and Wildlife Service began collaborating with Mexican biologists in 1937 to conduct aerial surveys of the distribution of wintering waterfowl across major wetland complexes in Mexico. Resource constraints and logistical considerations became increasingly challenging in the early 2000s, ultimately leading to discontinuation of the survey after 2006. DUMAC is using a diverse coalition of partners to renew the Mexico mid-winter waterfowl surveys, thus providing a critical data stream for understanding contemporary trends in waterfowl populations and guiding conservation efforts in Mexico. DUMAC has been working with current and retired USFWS biologists for the aerial surveys and train pilots and observers following the protocols used in the original mid-winter waterfowl surveys. The renewed survey was flown annually during January 2018–2020, providing a foundation from which to resume Mexico mid-winter waterfowl surveys.

SHOREBIRD SURVEYS OF MEXICO: A MULTI-ORGANIZATIONAL COLLABORATION

Alberto Lafon, PROFAUNA; José Juan Flores, ASTERESI, AC; Héctor Garza, Tamaulupas St. Univ.; Ignacio González, Alina Olalla & Adrian Varela, Nuevo Leon St. Univ.; Hugo Corzo, Veracruz St. Univ.; Cesar Tejeda, UNICACH; Juan Manuel Koller & Stefan Louis Arriaga, Tabasco St. Univ.; Jorge Correa, ECOSUR; Juan Chablé, Yucatan St. Univ.; Javier Sosa, CEGES; Jesús Vargas, Campeche St. Univ.; Moisés Rosas, José Hernández, Edwin Chay, Rene Kantun, Cristobal Cáceres & César Romero, National Commission of Natural Protected Areas; Alejandro Meléndez, Metropolitan Univ.; Ruben Pineda, Queretaro St. Univ.; Tiberio Monterrubio, Michoacan St. Univ.; Fernando Urbina, Morelos St. Univ.; Lucia B. Ramírez, Chiapas St. Univ.; Miguel Angel Díaz & Manuel Macias, Secretariat of Environment and Natural Resources; Jonathan Hiley, York Univ.; Mario Marín, Erika Maldonado & Antonio Martínez, Sinaloa State Government; Humberto Almanza & Salvador Hernández, Univ. of Guadalajara; Mireya Carrillo & Mateo Ruíz, ECOSUR; Eduardo Carrera, Gabriela de la Fuente, David Colón, DUMAC-NHQ; Jorge Cerón and David Canul, DUMAC-SERO; Aurea Estrada, DUMAC- CRO

After the conclusion in 2006 of the National Strategy for the Conservation and Management of Shorebirds, which followed similar documents developed for Canada and the USA, it became clear that the limited data on shorebirds in Mexico hindered effective prioritization and conservation of the most important wetlands for this group of birds. In response, DUMAC collaborated with professionals from partner organizations and universities to design and conduct a national shorebird survey for Mexico between 2010 and 2017. The survey was divided into 3 regions: Gulf Coast, Pacific Coast, and Northern and Central Highlands. The data gathered was used to help update the National Strategy and identify the most important areas for shorebirds in Mexico. This information will support management decisions and help focus additional resources and conservation efforts on priority habitats shared with migratory waterfowl.

DU FELLOWSHIP SUPPORT

EDWARD D. AND SALLY M. FUTCH GRADUATE FELLOWSHIP

**DEVELOPMENT OF FULL ANNUAL CYCLE FRAMEWORK USING STATE-OF-THE-ART GPS ACCELERATION TRACKING DEVICES ON WATERFOWL: THE CASE OF THE GREENLAND WHITE-FRONTED GOOSE

Alec Schindler (PhD student) & Dr. Mitch Weegman, Univ. of Saskatchewan

Activities throughout the annual cycle convey trade-offs in individual fitness and lifetime reproductive success. For example, long-lived species may reduce reproductive effort in some years to increase the potential for future production. This study will use GPS-tracking devices to quantify decision-making of Greenland white-fronted geese and use these data in a full annual cycle model to assess their individual and population level effects on survival, reproduction, and population growth. This research will inform conservation of a declining species and provide a scientific framework applicable to other species.

WATERFOWL RESEARCH FOUNDATION FELLOWSHIP

**AGENT-BASED MODELING TO EVALUATE CARRYING CAPACITY OF WINTER AND MIGRATIONAL HABITATS

Rob Blenk (PhD student) & Dr. John Eadie, Univ. of California, Davis

Agent-based modeling (ABM) is an increasingly appealing approach for assessing habitat conservation needs for waterfowl during the non-breeding period due to its ability to incorporate spatial dynamics, evaluate multiple metrics of body condition and survival, and undertake scenario planning and evaluation. This study will refine the application of an ABM to California's Suisun Marsh by incorporating results from a series of waterfowl foraging behaviour experiments. The resulting model will be used to predict and evaluate the effects of alternative wetland restoration activities on the area's ability to sustain target populations of wintering waterfowl.

BONNYCASTLE FELLOWSHIP FOR WATERFOWL AND WETLAND RESEARCH

**IDENTIFYING MIGRATION ROUTES, TIMING OF MIGRATIONS, AND IMPORTANT BREEDING, STAGING AND WINTERING AREAS FOR BLUE-WINGED TEAL

Brett Leach (MS student) & Dr. Lisa Webb, Univ. of Missouri

Compared to other dabbling ducks, the non-breeding ecology of blue-winged teal is poorly understood, largely due to its primary wintering distribution in Central and South America. This study is using GPS telemetry to identify spring breeding locations, migration stopover sites, and wintering areas for this species, while also quantifying habitat use, timing and patterns of migration, and other understudied aspects of its annual cycle.

** DENOTES A DU FELLOWSHIP

DUC-MBNA CANADA BANK CONSERVATION FELLOWSHIP

** POLYCYCLIC AROMATIC COMPOUND CONTAMINATION AND HEALTH IMPLICATIONS IN COMMON EIDER DUCKS AT A DIESEL SPILL SITE AND A REFERENCE SITE IN NUNATSIAVUT, CANADA

Reyd Smith (PhD student) & Dr. Jennifer Provencher, Carleton Univ.

Small-scale oil spills and chronic leaks can impact wildlife through sub-lethal exposure. For example, oil exposure may alter gene expression, with downstream effects on reproductive success. This study will examine the exposure patterns and toxicogenomic effects of polycyclic aromatic compounds (PACs) on female common eiders and will work with local Inuit knowledge holders to improve understanding of local bird biology through other knowledge systems and achieve shared conservation objectives.

BONNYCASTLE FELLOWSHIP IN WETLAND AND WATERFOWL BIOLOGY

** SPATIOTEMPORAL VARIATION IN MALLARD DEMOGRAPHIC RATES

Madeleine Lohman (PhD student) & Dr. Perry Williams, Univ. of Nevada, Reno

Population dynamics and distributions of waterfowl shift over time and space. Elucidating the mechanisms behind these changes will enable us to better predict the effects of environmental change. This study involves the development and implementation of mathematical models to assess the effects of precipitation and land use on survival, harvest mortality, and fecundity for mallards in the Prairie Pothole Region from 1961–2015. These models will help inform how and where to direct management efforts in light of changing climate and land use.

MICHAEL F.B. NESBITT FAMILY RESEARCH FELLOWSHIP

** QUANTIFYING THE INFLUENCE OF ENVIRONMENTAL CONDITIONS AND AMERICAN BLACK DUCK BEHAVIOUR AND MOVEMENTS THROUGHOUT THE FULL ANNUAL CYCLE ON SUBSEQUENT PRODUCTIVITY

Ilsa Griebel (PhD student) & Dr. Mitch Weegman, Univ. of Saskatchewan

American black duck populations decreased between the 1950s and 1980s and have not recovered to historic levels. Financial and logistical challenges of accessing the boreal region, where black ducks breed, has hindered assessment of whether black duck population growth is limited by factors during the breeding season. This study will use GPS-acceleration tracking devices to collect data on black duck movement and behaviour to identify factors which influence their productivity. This project will provide information critical for identifying landscapes most important for the management and conservation of black duck populations.

SPENCER T. AND ANN W. OLIN FOUNDATION WETLANDS AND WATERFOWL RESEARCH FELLOWSHIP

** MALLARD DISTRIBUTIONS, HABITAT SELECTION, AND MOVEMENT BEHAVIOR RELATIVE TO SPATIOTEMPORAL CHANGES IN LANDSCAPE ENERGETICS AND HUNTING PRESSURE

Nick Masto (PhD student) & Dr. Bradley Cohen, Tennessee Tech Univ.

Food energy, habitat availability, and hunting pressure are thought to drive duck distributions during winter, though datasets have not been available to evaluate this in an integrated framework. This study will use hundreds of GPS-tagged mallards plus frequent estimates of landscape conditions and energetics to evaluate the relative contributions of landscape energetics, hunting pressure, and shifts in wetland availability on wintering waterfowl movements and distributions. This research will help refine regional conservation planning tools and facilitate wetland restoration efforts for habitat features most limiting to waterfowl during the non-breeding period.

DR. BRUCE D.J. BATT FELLOWSHIP IN WATERFOWL CONSERVATION

** IMPROVING ESTABLISHMENT AND INVASION RESISTANCE IN THE RESTORATION OF AQUATIC AVIAN HABITAT

Kate Sinnott (MSc student) & Dr. Karin Kettenring, Utah State Univ.

There has been a global decline in aquatic plant density and diversity that could be partially ameliorated by restoration, but research on best practices for aquatic plant restoration is sparse. This study will investigate planting methods that result in higher establishment of aquatic plantings, test planting methods with a focus on scalability of aquatic plant revegetation, and elucidate how species richness influences invasion resistance. Study results will be used to improve the success of aquatic plant revegetation projects by identifying techniques that are effective and scalable.

** DENOTES A DU FELLOWSHIP

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DUCKS UNLIMITED

Ducks Unlimited conserves, restores and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people.