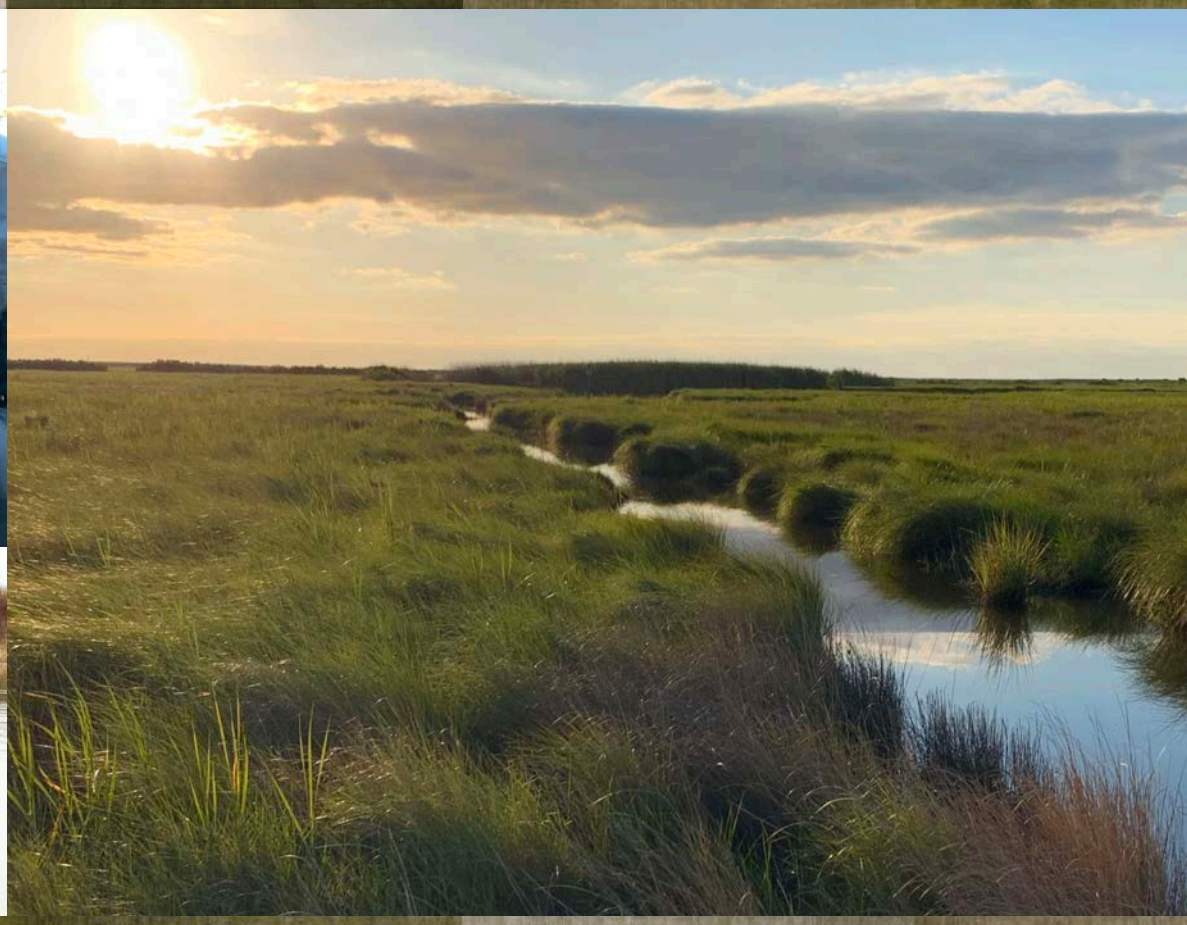
DUCKS UNLIMITED



Ducks Unlimited International Science Report

HIGHLIGHTS OF DUCKS UNLIMITED SCIENCE IN FY2021

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 conservation 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 advance 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 FY2021, 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.

IDENTIFYING THE WATER QUALITY IMPROVEMENT CO-BENEFITS OF PRIORITY MALLARD HABITAT RESTORATION

Dr. Nandita Basu & Dr. Emily Ury, Univ. of Waterloo; Dr. Ellen Herbert, DU-NHQ; Dr. Pascal Badiou & Dr. Lauren Bortolotti, DUC-IWWR

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.

DU INC. – NATIONAL

NATURAL INFRASTRUCTURE CAPACITY OF THE MAINSTEM MISSISSIPPI RIVER

Dr. Aditya Ranade, Two Degrees Adapt, Inc.; Mississippi River Cities and Towns Initiative; Multiple Private and NGO Partners; Dr. Ellen Herbert, DU-NHQ

DU is providing geospatial data and past project information for this study, designed to identify and motivate investments in wetland restoration for flood adaptation on the mainstem Mississippi River. This study will quantify economic losses through 2030 due to flooding along the Mississippi, evaluate the effectiveness of natural infrastructure adaptation measures in terms of avoided economic loss, and estimate return on investment for hypothetical floodplain restoration projects.

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

The annual migration and winter distribution of waterfowl have implications for harvest opportunities, conservation planning, and stakeholder support for wetland and waterfowl conservation. A combination of anecdotal and empirical data suggests potential shifts in the timing of migration and terminal distribution of several common waterfowl species. This research will use multiple datasets, including band recovery, harvest, and aerial waterfowl surveys, to investigate whether patterns of waterfowl distribution during autumn and winter in the Mississippi and Central flyways have changed over the past 30–40 years. This work will also examine whether and how shifts in distribution may be influenced by weather (temperature, snow cover, precipitation), land use, and/or landscape scale habitat conditions throughout the flyways.

* DENOTES A STUDENT-LED PROJECT

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.

*MOTIVATIONS AND BARRIERS TO AGRICULTURAL CONSERVATION PRACTICES AND WATERFOWL MANAGEMENT IN THE SOUTHERN UNITED STATES

Taylor Linder (MS student), Dr. Kenneth Wallen, & Dr. Doug Osborne, Univ. of Arkansas-Monticello

This study, which was completed in 2021, assessed landowner motivations for enrolling in the Rice Stewardship Partnership operating in Arkansas, Louisiana, and Mississippi, and whether their conservation behaviors continue beyond the incentive period. This information will enable development of conservation programs that better align with landowner interests and yield benefits longer into the future.

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

John Veon (MS 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 (MS student), Joseph French (MS 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.

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.

* DENOTES A STUDENT-LED PROJECT

*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.

DU INC. – GREAT LAKES & ATLANTIC REGION

*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, & Dr. David Luukkonen, 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, and make subsequent recommendations regarding habitat and harvest management for Great Lakes mallards.

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

PhD student (TBD) & Dr. Mitch Weegman, Univ. of Saskatchewan; MS student (TBD) & Dr. Jacob Straub, State Univ. New York, Brockport

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

MS student (TBD) & 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 that can be used to identify conservation efforts likely to benefit wintering populations of scaup.

* DENOTES A STUDENT-LED PROJECT

*AMERICAN BLACK DUCK BROOD SURVIVAL, HABITAT USE, AND MOVEMENT IN COASTAL NORTH CAROLINA

Daniel Lawson (MS student) & Dr. Chris Williams, Univ. of Delaware

This study will estimate survival, habitat use, and movements of American black duck broods in coastal North Carolina. This information will provide insights into factors limiting population growth of black ducks in the eastern U.S. and aid refinement of habitat conservation priorities.

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

Christopher Mitchell (MS 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.

*RESPONSE OF WILD BEE DIVERSITY TO MANAGEMENT OF RESTORED WETLANDS IN AN AGRICULTURAL LANDSCAPE

Molly Jacobson (MS student) & Dr. Michael Schummer, State Univ. of New York, ESF

Documenting and understanding the ecological and economic contributions of wetlands beyond benefits to waterfowl is critical for building broader support for wetlands conservation. This study, completed in 2021, assessed native bee communities and plant associations among wetland management treatments in central New York.

**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.

* DENOTES A STUDENT-LED PROJECT

** DENOTES A DU FELLOWSHIP STUDENT-LED PROJECT

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, 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 we will be monitoring water quality of wetland inflows and outflows both before and after the restoration project.

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.

EFFECTS OF REDUCED WATER SUPPLIES FOR THE KLAMATH BASIN REFUGE COMPLEX

Dr. Mark Petrie, DU-WR; John Vradenburg & Dustin Taylor, USFWS

Refuges in the Klamath Basin once supported the largest concentration of fall staging waterfowl in the Lower 48 States. However, key refuges now receive far less water than they once did. This study examines the impact of reduced water supplies on waterfowl carrying capacity in the Klamath Basin and identifies how to optimally use available water to maximize waterfowl benefits.

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.

UPDATE OF THE WESTERN REGION'S WATERFOWL HABITAT PLANNING MODEL

Dr. Mark Petrie, DU-WR; Dr. Frank Feng, Univ. of Missouri; Dr. John Coluccy, DU-GLAR; Joel Sartwell, Missouri Dept. of Conservation; Orien Richards, USFWS

Over the past 15 years DU's Western Region has used the bioenergetic model TRUEMET to evaluate habitat conditions for migrating and wintering waterfowl and establish habitat objectives. In partnership with researchers at the University of Missouri, the Western Region is working to update and modernize this model.

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

Dr. Adam Janke & Dr. William Crumpton, Iowa State Univ.; Kaylan Kemink, DU-GPR; Dr. Ellen Herbert, DU-NHQ; Dr. John Coluccy, DU-GLAR; Graduate students (2) TBD

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.

IMPACT EVALUATION OF PRIVATELY PROTECTED AREAS: WATERFOWL IN THE PRAIRIE POTHOLE REGION

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

Extent-based (i.e., area) targets are popular as metrics of conservation success. While easily quantified, they are not consistently accurate and unbiased. Thus, there have been increased calls for evaluations of effectiveness in terms of biological effects. This project will estimate the biological effect, in terms of waterfowl pairs and broods, of the USFWS Small Wetlands Acquisition Program across a ten-year period in the PPR of North Dakota, South Dakota, and Montana.

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, University 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.

UNDERSTANDING THE PERCEIVED IMPACTS OF AN IMMERSIVE PRAIRIE EXPERIENCE

Kaylan Kemink, DU-GPR; Dr. Chris Felege, F4 Conservation Consulting, LLC; Sarah Cavanah; SE Missouri Univ.

Using concepts from the field of experiential education, we are examining the effectiveness of the long-running program "Ducks University" within the organization. The research will determine if the program provides the perceived value to students 6–12 months beyond completion. Feedback from students will yield constructive criticism for improving the experience for future participants.

RADAR DATA AND ITS POTENTIAL CORRELATION WITH MIGRATION COUNT DATA

Mason Sieges & Paul Liu, DU-GPR

This study uses Next Generation Weather Radar data (NEXRAD) to identify waterfowl stopover sites and times in the Rainwater Basin. We are attempting to determine if radar data correlate with waterfowl count data from the same time periods. Strong correlation would hold promise for a more efficient method of gathering information about important waterfowl stopover areas.

* DENOTES A STUDENT-LED PROJECT

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. Hossein Sahour (Post-doctoral researcher) & 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.

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

Brad Schmidt & 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

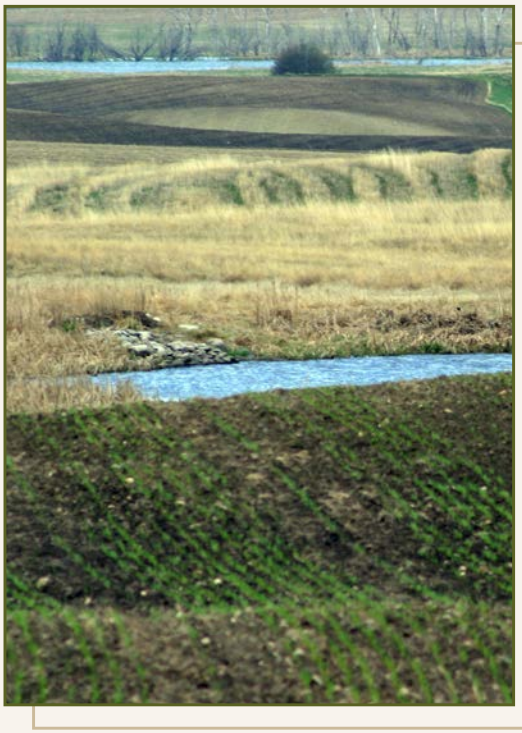
Regenerative agricultural practices such as grazing management, no-till, cover cropping, and livestock integration can build soil health and sequester carbon. DU's science and agronomy teams are partnering with the Soil Health Institute to develop monitoring protocols to measure the accumulation of soil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

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.



* DENOTES A STUDENT-LED PROJECT

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 American 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.

*MODELING WATERFOWL DISTRIBUTION AND ABUNDANCE IN CANADA

Antoine Adde (PhD student) & Steve Cumming, Univ. of Laval; Dr. Marcel Darveau, DUC-BOR; Dr. Erin Bayne, Univ. of Alberta; Eliot McIntyre, NRCan; Dr. Nicole Barker, ECCC

This project builds the first pan-Canada waterfowl distribution models that depict how duck population distributions change in time and space. This information will provide new insights into how much and where habitat must be conserved, especially for boreal regions.

KEY INFORMATION NEEDS FOR BIODIVERSITY CONSERVATION IN CANADA

Dr. Rachel Buxton, Carlton Univ.; Dr. Lauren Bortolotti, DUC-IWWR; numerous academic, government, & non-profit partners

To address the ongoing global biodiversity crisis, and to meet Canada's international commitments on biodiversity, conservation approaches must be underpinned by robust information. Researchers identified the key information needed to advance policy and management actions to conserve biodiversity in Canada, concluding that mechanisms to translate information into action are most urgently needed and recognizing multiple ways of knowing, especially Indigenous knowledge systems, will be critical to support the transformative change needed to conserve biodiversity at a national scale.

* DENOTES A STUDENT-LED PROJECT

DU CANADA – BRITISH COLUMBIA

PREDICTING HABITAT DISTRIBUTION FOR SEA DUCKS IN BRITISH COLUMBIA

Bruce Harrison & Courtney Hamilton, 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, 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.

RANKING THE ECOLOGICAL IMPORTANCE OF BC ESTUARIES FOR STRATEGIC CONSERVATION

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

Estuaries in British Columbia comprise less than 3% of the coastline but are among its most productive ecosystems and important to a wide variety of species, including an estimated 80% of all coastal wildlife. NGOs and governments in BC have partnered to coordinate efforts to secure and enhance estuarine habitats with high ecological value. This project provides an objective, province-wide assessment of estuary occurrence and ecological importance to waterfowl and waterbirds and was updated with improved mapping and ecological data in 2020.

DU CANADA – BOREAL

ROADS, PIPELINES, AND SEISMIC LINES... WHAT DO THEY MEAN FOR BOREAL DUCKS?

Dr. Stuart Slattery, Howie Singer, Llwellyn Armstrong, & Susan Witherly, 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 are unknown. In this study, we are assessing potential effects of roads, pipelines, and seismic lines on waterfowl settling and productivity in the Boreal Plains using aerial surveys. This information is critical to guiding DUC conservation in the boreal forest.

*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.

**WATERFOWL NEST SUCCESS IN THE WESTERN BOREAL FOREST: DOES INDUSTRIAL DEVELOPMENT ALTER PREDATION?

Dr. Matt Dyson & Dr. Brad Fedy, Univ. of Waterloo; Dr. Stuart Slattery, DUC-IWWR

Understanding how important industrial activities affect waterfowl in the boreal forest is critical for developing the right conservation actions. This project will help us learn how industrial disturbance influences where waterfowl choose to nest and tests the assumption that linear features reduced nest success by fragmenting the landscape.

*LANDSCAPE EFFECTS ON BREEDING HABITAT SELECTION AND INCUBATION BEHAVIOUR IN BOREAL NESTING DUCKS

Ryan Johnstone (MSc Student), Dr. Matt Dyson, & Dr. Brad Fedy, Univ. of Waterloo; Dr. Stuart Slattery, DUC-IWWR

Nest site selection and incubation behavior can influence nest success, and little is known how industrial landscape changes in the boreal forest interact with these life history characteristics. This study used female mallards marked with GSM transmitters and iButton temperature recorders in nests to examine these relationships. This information will help better identify how development influences behavior of breeding female ducks.

ALBERTA HIGH RESOLUTION WETLAND INVENTORY METHODOLOGY DEVELOPMENT FOR BOREAL AND PRAIRIE LANDSCAPES

Michael Merchant, DUC-BOR; Lyle Boychuk, DUC-SK; Dr. Craig Mahoney, GOA; Emily Jones, Univ. of Lethbridge; Dr. Chris Hopkinson, Univ. of Lethbridge

The goal of this project was to improve our wetland mapping capabilities in boreal and prairie regions while meeting the minimum mapping standards (e.g. accuracy, minimum mapping unit, and class) soon to be released by the Government of Alberta (GoA). The work assessed several novel, high-resolution remote sensing datasets, many of which DUC has not had access to in the past. In particular, this project assessed the mapping capabilities of airborne LiDAR data which was distributed to DUC by the GoA. The results of this project were promising and have helped position DUC as a leader in provincial wetland mapping.

* DENOTES A STUDENT-LED PROJECT

** DENOTES A DU FELLOWSHIP STUDENT-LED PROJECT

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, 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.

HIGH LATITUDE WETLAND DETECTION USING MULTI-DATE AND MULTI-SENSOR EARTH OBSERVATION DATA: A CASE STUDY IN THE NORTHWEST TERRITORIES

Michael Merchant, Rebecca Warren & Rebecca Edwards, DUC-BOR; Claudia Haas, GNWT

The extent and type of wetlands in Canada's northern regions remain poorly understood, particularly because a comprehensive wetland inventory does not exist. This project helps fill this gap, whereby DUC analysts developed habitat maps of the Dınàgà Wek'èhodì region in the Northwest Territories. This project is a continuation of DUC's efforts to develop a wall-to-wall inventory of the territory and has also helped advance DUC's operational wetland mapping capabilities in the north, via the assessment of machine-learning algorithms and novel remotely sensed datasets (e.g. ArcticDEM).

ENHANCED WETLAND MAPPING OF WHOOPING CRANE HABITAT IN THE NORTHWEST TERRITORIES

Rebecca Edwards, Alain Richard, & Michael Merchant, DUC-BOR

Enhanced wetland mapping of the Whooping Crane Habitat Extension (WCHE) project was undertaken by DUC, contractually by Parks Canada and in collaboration with Environment and Climate Change Canada (ECCC). The project involved a multi-sensor satellite-based classification of 1,258,450 hectares (~3.1 million acres) of wetlands and associated uplands. This detailed classification will be used by ECCC to identify and delineate critical habitat for whooping cranes outside Wood Buffalo National Park.

WETLAND MAPPING IN THE DAWSON REGION FOR SUPPORT OF LAND USE PLANNING

Rebecca Warren, Jamie Kenyon, Michael Merchant, & Rebecca Edwards, DUC-BOR

This project involved a remote sensing-based wetland classification of the Dawson planning region of west-central Yukon undertaken cooperatively by Tr'ondek Hwech'in, DUC, and the Yukon government. This three-year project acquired wetland information to guide management decisions related to land use planning and implementation of wetland policy in the region. Wetlands were identified and classified into five major classes following the Canadian Wetland Classification System (bog, fen, swamp, marsh, and open water).

CLASSIFYING OPEN WATER FEATURES USING OPTICAL SATELLITE IMAGERY AND AN OBJECT-ORIENTED CONVOLUTIONAL NEURAL NETWORK

Michael Merchant, DUC-BOR

This study assessed the open water classification capabilities of Sentinel-2 optical satellite imagery and an object-oriented convolutional neural network. Recently, there has been immense growth in artificial intelligence and its applications to remote sensing, especially with deep learning algorithms. This study helps build DUC's technical capabilities to harness deep learning methods by providing a workflow and accompanied statistical assessment. It is anticipated that DUC will increasingly utilize these technologies in our landscape classification and monitoring efforts.

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 & 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 other ecosystem services. This project uses remote sensing methods to classify wetland vegetation communities and is developing a statistical model to predict wetland permanence based on wetland size and vegetation community composition.

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

Dr. James Devries, 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 Missouri; 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 Missouri; 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.

* DENOTES A STUDENT-LED PROJECT

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.

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, 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.

*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 where water in Delta Marsh comes from (e.g. agricultural run-off, direct precipitation, ground water, Lake Manitoba, etc.). Stable water isotopes will be used with weather data, water level data 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.

*IMPACTS OF CLIMATE CHANGE IN PRAIRIE CANADA – WETLAND DENSITY

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

To improve conservation planning, it is necessary to understand the effects of climate change on prairie wetland abundance and distribution, agricultural land use, and associated impacts on waterfowl. In the first part of a multi-stage project, this study will develop methods to simulate changes to prairie wetlands under climate change using a sophisticated climate model.

*IMPACTS OF CLIMATE CHANGE IN PRAIRIE CANADA – WATERFOWL PRODUCTIVITY

Dr. Lauren Bortolotti & Dr. James Devries, 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.

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.

EVALUATING DITCH PLUG WETLAND RESTORATIONS IN THE PRAIRIE POTHOLE REGION

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

We are piloting a project to evaluate the success of ditch plug wetland restorations in supporting ducks and other wildlife. This project will sample restored wetlands of various ages and compare wildlife biodiversity to undrained wetlands in similar landscapes. Our results will help 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.

DU CANADA – CENTRAL CANADA

*CONSERVATION AND MANAGEMENT OF WATERFOWL AND OTHER AQUATIC BREEDING HABITATS UNDER CLIMATE CHANGE IN EASTERN CANADA

Antoine Adde (PhD student), Clara Casabona i Amat (MSc student), Alexandra Gélinas (MSc student), Dr. Roberto Quezada Garcia (Post-doctoral researcher), Dr. Steve Cumming, Dr. Nancy Gélinas, & Dr. Marc Mazerolle, Univ. of Laval; Dr. Marcel Darveau, DUC-BOR; Dr. Diana Stralberg, BAM-Univ. of Alberta; Travis Logan, Ouranos; Christine Lepage, ECCC

This multifaceted project investigates potential effects of climate change on breeding waterfowl and cranes in eastern Canada: (1) likely locations of climate refuges for eastern waterfowl, (2) adaptation of forest management to ensure persistence of black ducks, (3) colonisation patterns of the sandhill crane, a species rapidly expanding to Quebec and damaging crops, and (4) developing a socio-economic approach to evaluate climate adaptation scenarios for waterfowl management.

SUSTAINABLE MANAGEMENT OF LAKE SAINT-PIERRE: MULTI-DISCIPLINARY CENTRE OF EXPERTISE

Gilbert Cabana, Raphaël Proulx, Julie Ruiz, & Stéphane Campeau, UQTR; Valérie Gravel & Philippe Séguin, Univ. of McGill; Monique Poulin, Lota Tamini, & Anne Vanasse, Univ. Laval; Bernard Filion, DUC-QC

The Quebec government established a multidisciplinary center of expertise in sustainable management of the Lake Saint-Pierre floodplain in 2018. The mandate of this Centre is to propose a science-based intervention strategy favoring establishment of sustainable agriculture that is adapted to and respectful of the ecosystem of Lake Saint-Pierre. This effort will advance waterfowl conservation by reducing habitat impacts of traditional agriculture and supporting restoration of priority environments.

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.

SETTING CONSERVATION AND RESTORATION PRIORITIES IN AGRICULTURAL LANDSCAPES: HOW TO OPTIMIZE ECOSYSTEM SERVICES AND MINIMIZE TRADE-OFFS BETWEEN BENEFICIARIES

Dr. Monique Poulin, Univ. of Laval; Dr. Pascale Biron, Concordia Univ.; Bernard Filion, DUC-QC

Agricultural landscapes provide many benefits to society (e.g., food, income, and ecosystem services), which at times seem mutually exclusive. This project will map potential watercourse restoration via freedom space in riverine systems (i.e. allowing rivers to meander again) and use maps in scenario modeling to examine trade-offs between environmental and agricultural objectives. This information will help DU facilitate landscape planning that ensures sustainability of both agricultural industries and ecosystem services. The ultimate goal is to develop win-win conservation approaches for landowners by including water management (quantity and quality), biodiversity, and long-term climate adaptation.

*EFFECTS OF POND TYPE AND HUMAN DISTURBANCES ON BREEDING OCCUPANCY AND NESTING SUCCESS OF WATERFOWL IN THE ABITIBI CLAY BELT

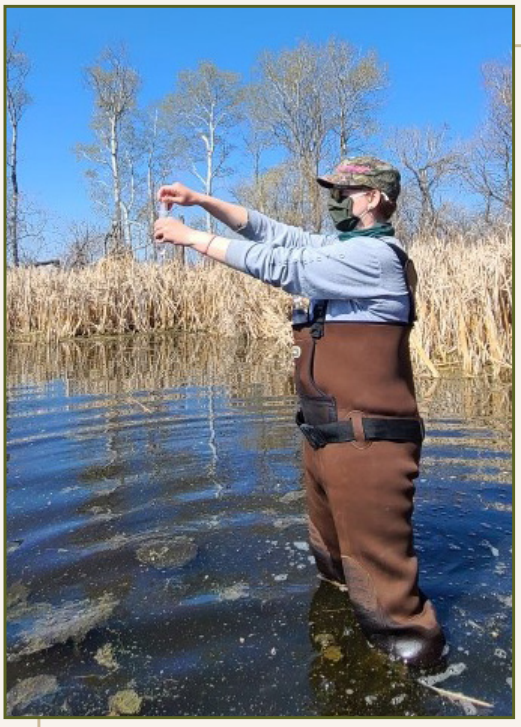
Émilie Desjardins (MSc student), Mariano Feldman (PhD student), Dr. Louis Imbeau, Dr. Nicole Fenton, & Dr. Philippe Marchand, Univ. of Québec, Abitibi-Témiscamingue; Dr. Marcel Darveau, DUC-BOR; Dr. Marc Mazerolle, Univ. of Laval

We are assessing the use of natural and mining tailing ponds by waterfowl in the southern and northern boreal landscapes of the Abitibi Clay Belt. Results will help evaluate core assumptions of DUC's Eastern Boreal program and improve Black Duck Joint Venture population models.

*NETWORK ANALYSIS OF UMBRELLA AND INDICATOR SPECIES: ASSESSING THE INTEGRITY OF NORTHERN ECOSYSTEMS

Alexandre Terrigeol (PhD student) & Dr. Daniel Fortin, Univ. of Laval; Dr. Marcel Darveau, DUC-BOR; Dr. Christian Hébert, NRCan

This project is assessing consequences of human development and global change on bird communities in the taiga of Ontario and Québec and will identify indicator species of ecosystem integrity that could be used in future conservation and monitoring efforts.



*INTEGRATING SUSTAINABLE FOREST MANAGEMENT OBJECTIVES TO CONSERVE WETLAND/RIPARIAN HABITATS IN QUÉBEC

Diego Farina (BSc student), Gabrielle Filteau (MSc student), Chanèle Poirier (MSc student), Jonathan Ricard (MSc student), & Jérôme Cimon-Morin, Univ. of Laval; Dr. Marcel Darveau, DUC-BOR; Louis Imbeau, Univ. of Québec, Abitibi-Témiscamingue; Geneviève Labrecque & Marie-Ève Sigouin, Rayonier A.M. Canada S.E.N.C.

This project aims to improve wetland and riparian management in Quebec by improving wetland mapping, riparian zone delineation, road network design to minimize wetland crossings, and the contribution of large forest retention patches for conserving riparian zones. This information will influence voluntary forest certification schemes and new provincial regulations, benefitting waterfowl habitats at the landscape scale.

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, Trent Univ. and Ontario MNRF

We are using 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 to local extinctions. This will improve spatial targeting for conserving wetland biodiversity and highlight the importance of waterfowl habitat for other wildlife.

DU CANADA – ATLANTIC

ANNUAL MOVEMENT PATTERNS OF AMERICAN COMMON EIDERS (SOMATERIA MOLLISSIMA DRESSERI)

Dr. Mark Mallory & Molly Tomlik, Acadia Univ.; Dr. Rob Ronconi, ECCC; Brad Allen, State of Maine; Chris Dwyer, USFWS; Stéphane Lair, CCWHC; Dr. Conor Mallory, Gov. of Nunavut; Nic McLellan, DUC-ATL/IWWR; Randy Milton & Glen Parsons, Prov. of Nova Scotia; Lucas Savoy, BRI

This project combines satellite telemetry data for 46 American common eiders from three regions in the southern part of their breeding range and investigates annual movement patterns. As a sub-species with growing population concerns, this work allows a better understanding of threats faced by identifying key locations and migratory corridors.

ESTIMATING POPULATION GROWTH AND RECRUITMENT RATES OF AMERICAN COMMON EIDER

Dr. Jean-François Giroux & Martin Patenaude-Monette, Univ. du Québec à Montréal; Randy Milton, Prov. of NS; Scott Gilliland, CWS; Nic McLellan, DUC-ATL/IWWR

This project uses 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 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.

*APPLICATION OF PALEOLIMNOLOGICAL TOOLS FOR ASSESSING THE TRANSFER OF MARINE-DERIVED NUTRIENTS TO FRESH WATER SYSTEMS, NOVA SCOTIA, CANADA: FOCUS ON ALOSA PSEUDOHARENGUS WITHIN THE GASPEREAU LAKE WATERSHED

Lauren Muzak Ruff (MSc student), Dr. Ian Spooner, & Mark Mallory, Acadia Univ.; Nic McLellan, DUC-ATL/IWWR

This project explores the use of paleolimnology to detect historic changes in marine-derived nutrients transferred into freshwater ecosystems that contain potential barriers (hydroelectric dams) to fish passage. The transfer of marine nutrients is important in coastal ecosystems and this project will help elucidate the importance of fish passage to wetland project management.

* DENOTES A STUDENT-LED PROJECT

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.

*DETECTING AND QUANTIFYING MARINE-DERIVED NUTRIENTS TRANSFERRED BY ALEWIFE

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

This project uses stable isotope analyses to detect marine-derived nutrients in freshwater ecosystems during alewife migration. It also quantifies nutrient inputs by individual alewife, enabling estimation of total nutrient input during a spawning migration. This project also allows us to relate improved fish passage to wetland productivity.

*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).

A MANAGED REALIGNMENT IN THE UPPER BAY OF FUNDY: COMMUNITY DYNAMICS DURING SALT MARSH RESTORATION OVER 8 YEARS IN A MEGATIDAL, ICE-INFLUENCED ENVIRONMENT

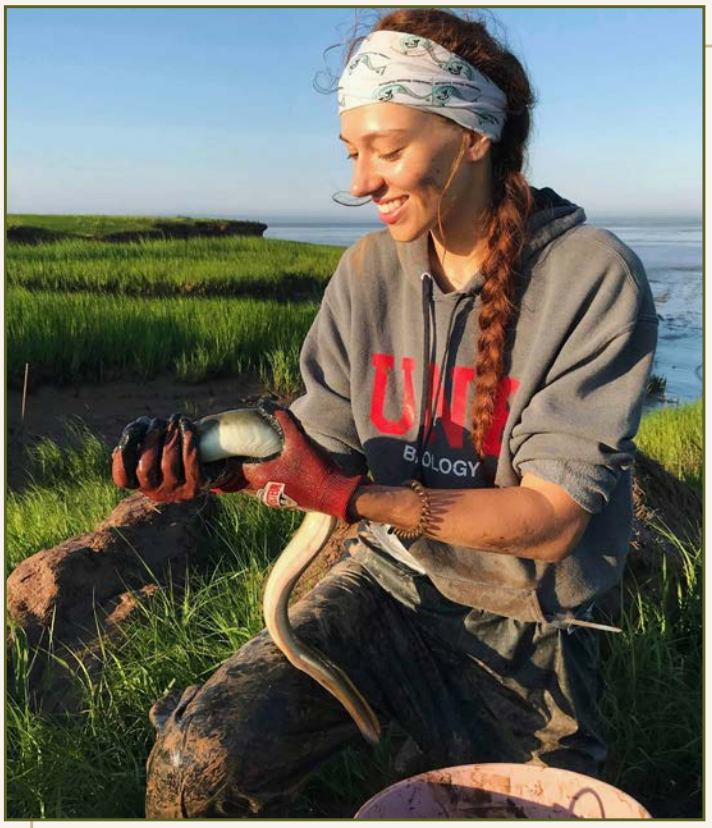
Spencer Virgin, Allen Beck, Laura K. Boone, Allison K. Dykstra, & Dr. Myriam Barbeau, Univ. of New Brunswick; Dr. Jeff Ollerhead, Mount Allison Univ.; Nic McLellan, DUC-ATL/IWWR

This project investigates the ecological and physical processes of salt marsh restoration in a unique environment. The successful restoration of salt marsh provides an important buffer from the tide to a dyke system protecting human infrastructure at risk of sea level rise. Additionally, because of historic loss of salt marsh in the Bay of Fundy, the importance of this habitat for waterfowl, and the other ecological benefits it provides, salt marsh restoration is a conservation priority for DUC.

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

Jacob Demers (MSc student), 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) & Dr. Joe Nocera, Univ. of New Brunswick; Nic McLellan, DUC-ATL/IWWR

There is evidence that common goldeneye have experienced regional population declines in New Brunswick, and some have attributed this 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 impact of a long-term nest box program, and whether site characteristics can inform cavity or nest box usage by waterfowl species. 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.

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.

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.

* DENOTES A STUDENT-LED PROJECT

COASTAL DIGITAL CHANGE DETECTION ANALYSIS IN SINALOA AND SONORA

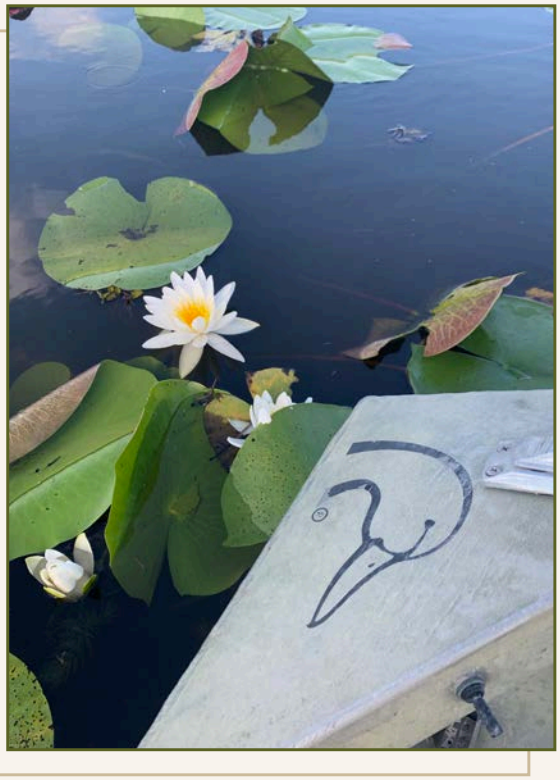
Gabriela de la Fuente, Eduardo Carrera, Carlos Salinas, & Norma Rangel, DUMAC-NHQ

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 was agricultural expansion and resulting runoff of agrochemicals and fertilizers, causing the 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. These wetlands provide the most important habitat for migratory waterfowl in this region, while supporting a great diversity of other waterbirds, wildlife, and fisheries. These findings will help 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 Goverment; 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), Univ. of Missouri; & 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.

** DENOTES A DU FELLOWSHIP STUDENT-LED PROJECT

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.

DUC-MBNA Canada Bank® Conservation Fellowship

**HABITAT SELECTION BY BREEDING SCOTERS IN THE BOREAL FOREST OF THE NORTHWEST TERRITORIES

Moriah Tanguay (MSc student) & Dr. Kirsty Gurney, Univ. of Saskatchewan

North American breeding populations of scoters, which breed predominantly in the rapidly changing boreal forest, remain below historical levels, yet habitat needs for these sea ducks remain poorly documented. To help predict impacts of ongoing environmental change in northern areas and prioritize key habitats for conservation of these species, this research will identify wetland and landscape characteristics that predict breeding scoter abundance and examine the relative importance of foraging and nesting habitat for wetland selection by scoters.

Bonnycastle Fellowship in Wetland and Waterfowl Biology

**SPATIOTEMPORAL VARIATION IN MALLARD DEMOGRAPHIC RATES

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

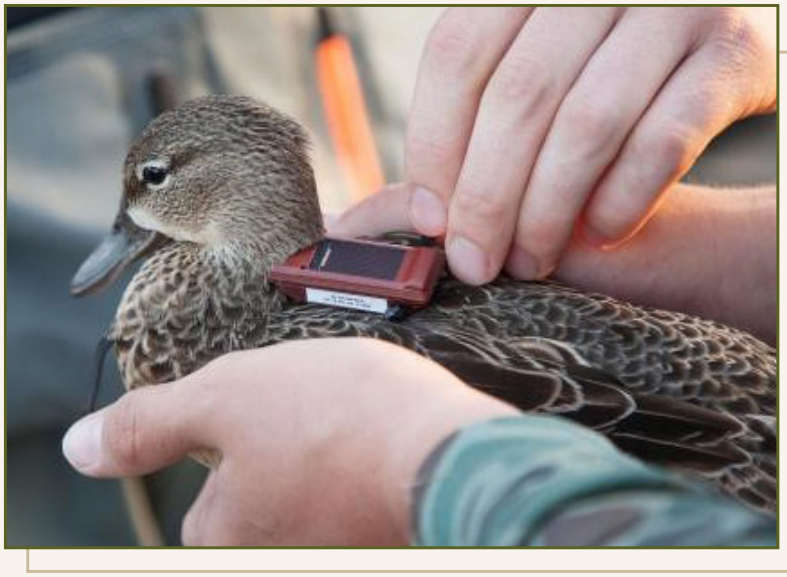
Population dynamics and distributions of waterfowl shift over time and space. Elucidating the mechanisms behind these changes will enable us to better predict the effects of environmental change. This study involves the development and implementation of mathematical models to assess the effects of precipitation 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.

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 STUDENT-LED PROJECT

Michael F.B. Nesbitt Family Research Fellowship

**A MULTI-SPECIES ANALYSIS OF LANDSCAPE EFFECTS ON INDIVIDUAL DECISION-MAKING AND FITNESS IN WETLAND- DEPENDENT MIGRATORY SHOREBIRDS

Sarah Clements (PhD student) & Dr. Mitch Weegman, Univ. of Missouri

Migratory species are affected by habitat and climate over broad geographic ranges, and it can be difficult to monitor individuals and populations over a full annual cycle. This project is using GPS-acceleration tracking devices to make inferences about habitat use and productivity of shorebirds without needing to resight or recapture the marked individuals. Tracking three wetland-dependent shorebird species (American avocet, black-bellied plover, Hudsonian godwit), ranging from short- to long-distance migrants, this project will provide information on habitats used by this group of migratory birds and how its quality may influence survival and productivity.

Spencer T. and Ann W. Olin Foundation Wetlands and Waterfowl Research Fellowship

**SEED-BASED WETLAND RESTORATION FOLLOWING PHRAGMITES REMOVAL: HARNESSING SEED TRAITS AND SYSTEMS MODELING TO REESTABLISH LOST AVIAN HABITAT

Emily Tarsa (PhD student) & Dr. Karin Kettenring, Utah St. Univ.

One of the greatest threats to wetland conservation and waterfowl habitats across North America is the invasion of Phragmites australis. Recent research highlighted effective control strategies for Phragmites, but natural recolonization of native plants needed to support waterfowl habitat has been limited. This research is focusing on how to effectively revegetate wetlands following Phragmites removal by identifying functional traits that drive seed and seedling life stage transitions for native species.

Dr. Bruce D.J. Batt Fellowship in Waterfowl Conservation

**PRODUCTIVITY OF BREEDING WATERFOWL ON WORKING LANDS IN A FLOOD-IRRIGATED SYSTEM

Casey Setash (PhD student) & Dr. David Koons, Colorado St. Univ.

In the Intermountain West, effective water management is essential for both agricultural production and waterfowl habitat, and is more pressing than ever due to drought, climate change, and growing human demands for water. This project is evaluating waterfowl production (nest survival, nest density, duck abundance) before and after irrigation infrastructure improvements in the North Platte Basin of Colorado. Results from this study will be used to inform best management practices benefitting both agricultural producers and waterfowl managers.

** DENOTES A DU FELLOWSHIP STUDENT-LED PROJECT

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

Ducks Unlimited Science and Planning Contacts

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