THURSDAY, 4 FEBRUARY 2016		
06:30 - 08:00	*Breakfast in Capital Ballroom*	
08:10 - 08:20	**Opening Remarks & Announcements**	
Capital Ballroom **08:20 - 09:40**	**I.1: Plenary**	
8:20	**I.1.2: Plenary Robert Clark** **Using Population Models to Test Ecological Hypotheses and Guide Conservation Decisions** (Robert Clark*)	
9:00	**I.1.2: Plenary Michael Schaub** **Inference About Population Processes by Combining Counts and Demographic Data Using Integrated Population Models** (Michael Schaub*)	
09:40 - 10:00	*Coffee break*	
Capital Ballroom **10:00 - 12:00**	**J.1: Integrated Population Models to Inform Waterfowl Ecology and Conservation** (Organizers: Todd Arnold, David Koons)	
10:00	**J.1.1: Weegman**	**Integrated Population Modelling Reveals a Perceived Source to be a Cryptic Sink** (Mitch D. Weegman*, Stuart Bearhop, Anthony David Fox, Geoff M. Hilton, Alyn J. Walsh, David J. Hodgson)
10:20	**J.1.2: Koons**	**Drivers of Lesser Scaup Population Dynamics at a Continental Scale** (David N. Koons*, Michael Schaub, Todd W. Arnold, Mitchell D. Weegman, Beth E. Ross, Jeffrey M. Warren, Christopher A. Nicolai, Robert G. Clark)
10:40	**J.1.3: Osnas**	**An Integrated Population Model for Northern Pintail to Guide Harvest and Habitat Management** (Erik E. Osnas*, G. Scott Boomer, Michael C. Runge, Robert G. Clark, James H. Devries)
11:00	**J.1.4: Arnold**	**An Integrated Population Model for American Black Ducks** (Todd W. Arnold*, David N. Koons, Michael Schaub)
11:20	**J.1.5: Riecke^**	**Integrated Population Models for Black Brant: Derived Parameters And Sampling Variance** (Thomas V. Riecke*, James S. Sedinger)
11:40	**J.1.6: Arnold, Koons**	**Integrated Population Models to Inform Waterfowl Ecology and Conservation: Pitfalls and Promises** (Todd W. Arnold*, Robert G. Clark, David N. Koons*, Erik E. Osnas, Thomas V. Riecke, Michael Schaub, Mitchell D. Weegman)
12:00 - 13:20	*Lunch break in Capital Ballroom*	

Capital ABC **13:20 - 15:20**	**K.1: Looking Ahead Toward Future Management of Shallow Lakes** (Organizers: Nicole Hansel-Welch, Mark Hanson)	
13:20	**K.1.1: Anteau**	**A Watershed Approach for Conservation of Prairie-Pothole Wetlands** (Michael J. Anteau*, Mark T. Wiltermuth, Lisa A. McCauley, Max Post van der Burg)
13:40	**K.1.2: Vitense^**	**Predicting Total Phosphorus and Assessing State Transition Risk in Shallow Lakes** (Kelsey Vitense*, Nicole Hansel-Welch, Mark A. Hanson, Brian R. Herwig, Kyle D. Zimmer, John Fieberg)
14:00	**K.1.3: Wiltermuth**	**Landscape-scale Evaluation of the "Alternative Stable State" Hypothesis within Large Northern Prairie Wetlands in Context of Waterbird Conservation** (Mark T. Wiltermuth*, Michael J. Anteau)
14:20	**K.1.4: Hanson**	**Rehabilitating Turbid Shallow Lakes: Harder than We Think?** (Mark A. Hanson*, Brian R. Herwig, Kyle D. Zimmer, Nicole Hansel-Welch, Kelsey Vitense, John Fieberg)
14:40	**K.1.5: Zimmer**	**Is Island Biogeography a Good Model for Managing Biodiversity in Shallow Lakes?** (Kyle D. Zimmer*, Luke E. Nolby, Mark A. Hanson, Brian R. Herwig, William O. Hobbs, Joy M. Ramstack Hobbs, Kevin M. Theissen)
15:00	**K.1.6: Hansel-Welch**	**Management or Restoration - What Are We Doing With Shallow Lakes in Minnesota?** (Nicole Hansel-Welch, Tammy Baden, Todd Call, Jenny DuBay, Ann Geisen, Steve Kittelson, Melissa Thompson)
Capital D **13:20 - 15:20**	**K.2: Mexico's Rich Waterfowl History, Contemporary Wetland Challenges, and Maintaining Anatid Biodiversity** (Organizers: Eduardo Carrera-González*, Alberto Lafón-Terrazas, Leigh H. Fredrickson)	
13:20	**K.2.1: Carrera-González**	**Introductory Remarks: International Cooperation Across North America a Key to Continental Waterbird Conservation** (Eduardo Carrera-González*, Alberto Lafón-Terrazas, Leigh H Fredrickson)
13:40	**K.2.2: Valverde**	**A Historical Perspective on the Conservation of Waterfowl in Mexico** (Jorge Enrique Mendoza Valverde*)
14:00	**K.2.3: Lafón-Terrazas**	**The Current State of Policy and Legislation Related to Environmental Resources in Mexico** (Alberto Lafón-Terrazas*)
14:20	**K.2.4: Carrera-González**	**Distribution and Status of Mexico´s Wetland Resources** (Eduardo Carrera-Gonzále*)
14:40	**K.2.5: Lafón-Terrazas**	**Initial Efforts for Waterfowl Monitoring in Mexico** (Alberto Lafón-Terrazas*, Mauro Iván Reyna-Medrano)

15:00	**K.2.6: Carrera-González**	**Distribution and Composition of the Mexican Waterfowl Harvest** (Eduardo Carrera-González*, Alberto Lafón-Terrazas, Leigh H. Fredrickson)
Senate **13:20 - 15:20**	**K.3: Population Dynamics** (Chair: Matt Dyson)	
13:20	**K.3.1: Malachowski^**	**Seasonal and Annual Survival Rates and Cause-specific Mortality of the Endangered Hawaiian Duck** (Christopher P. Malachowski*, Bruce D. Dugger)
13:40	**K.3.2: Warren**	**Within-season and Carry-over Effects of Reproductive Effort on Survival in Female Lesser Scaup** (Jeffrey M. Warren*, David N. Koons)
14:00	**K.3.3: Messmer^**	**Associations of Western Boreal Forest Duck Populations to Indices of Spring Phenology** (David J. Messmer*^, Robert G. Clark, Stuart Slattery, Mark Drever, Chris Derksen)
14:20	**K.3.4: Sheppard^**	**Vital Rates of New Zealand Mallards** (Jennifer L. Sheppard*^, Todd Arnold, Courtney L. Amundson, David Klee, Todd Dennis)
14:40	**K.3.5: Leach^**	**Probability of Mate Change and Its Effects on Demographic Rates of Black Brant** (Alan G. Leach*^, James. S. Sedinger, Thomas V. Riecke, David H. Ward, W. Sean Boyd)
15:00	**K.3.6: Riecke^**	**Response of Long-lived Waterfowl to Latitudinal Fitness Variation** (Thomas V. Riecke*^, Alan G. Leach, Jim S. Sedinger, David H. Ward, and W. Sean Boyd)
Caucus **13:20 - 15:20**	**K.4: Harvest** (Chair: Matt Chouinard)	
13:20	**K.4.1: Boomer**	**Analyzing the Relationship between Midcontinent Mallard Harvest and Survival Probabilities** (G. Scott Boomer*, Guthrie S.Zimmerman, Nathan L. Zimpfer, James D. Nichols)
13:40	**K.4.2: Sedinger, B.^**	**Exploring Compensation in Duck Mortality: Do Harvest Regulations Really Matter?** (Benjamin S. Sedinger*, Christopher A. Nicolai, Kelley M. Stewart)
14:00	**K.4.3: Vaske**	**Improving the Accuracy of Self-reported Waterfowl Harvest Estimates** (Jerry J. Vaske*, Jay Beaman, Craig Miller)
14:20	**K.4.4: Deane1^**	**Harvest and Non-harvest Mortality Relationships for Lesser Scaup Breeding in Southwestern Montana** (Cody E. Deane, Jay J. Rotella, Jeffrey M. Warren, David N. Koons, Robert R. Garrott)
14:40	**K.4.5: Soulliere**	**Trends in North American Diving Duck Hunting Community with Focus on Scaup** (Gregory J. Soulliere*, Jane E. Austin, Benjamin M. Kahler)

15:00	**K.4.6: Open**	
15:20 - 15:40	*Coffee break*	
Capital ABC **15:40 - 17:40**	**L.1: Looking Ahead Toward Future Management of Shallow Lakes** (Organizers: Nicole Hansel-Welch, Mark Hanson)	
15:40	**L.1.1: Hagy**	**Evolution of Backwater Lakes along the Illinois River with Waterfowl as a Sentinel of Change** (Heath M. Hagy*, Aaron P. Yetter, Michelle M. Horath, Joshua Stafford)
16:00	**L.1.2: Evelsizer**	**Ten Years of Shallow Lake Renovations; Applying What's Been Learned to Future Management** (Vincent D. Evelsizer*)
16:20	**L.1.3: Wrubleski**	**Restoring a Large Freshwater Coastal Wetland on the Prairies; Delta Marsh, Manitoba** (Dale A. Wrubleski*)
16:40	**L.1.4: Hutchins**	**Time-lapse Photography: Documenting Wetland Restoration and Shallow Lake Management in Minnesota** (Emily J. Hutchins*, John E. Maile)
17:00	**L.1.5: Anthony^**	**Seed-Bank and Invertebrate Potential of Moist-Soil Wetlands in the Southwest** (Ryan S. Anthony*, Ryan O'Shaugnessy, Ryan S. Luna, and Daniel P. Collin)
17:20	**L.1.6: Hanson**	**Discussion** (Mark Hansen, Nicole Hansel-Welch)
Capital D **15:40 - 17:40**	**L.2: Mexico's Rich Waterfowl History, Contemporary Wetland Challenges, and Maintaining Anatid Biodiversity** (Organizers: Eduardo Carrera-González, Alberto Lafón-Terrazas, Leigh H. Fredrickson)	
15:40	**L.2.1: Lafón-Terrazas**	**Distribution and Productivity of the Mexican Ducks and Related Species** (Alberto Lafón-Terrazas*)
16:00	**L.2.2: Wortham**	**A History of U.S. Flyway Biologists/Pilots' Efforts in Mexico** (Jim Wortham*, Phil Thorpe)
16:20	**L.2.3: Fredrickson**	**Functional Aspect of Wetlands in Mexico's Arid Northern Highlands** (Leigh H. Fredrickson*)
16:40	**L.2.4: Vradenburg**	**Bosque del Apache NWR and Mexico: A History of International Collaboration** (John Vradenburg)
17:00	**L.2.5: Goodman^**	**A Stiff Comparison: Comparing Time-Activity Budgets of Stiff-Tailed Ducks in Puerto Rico** (Nick Goodman*, Jack C. Eitniear, James T. Anderson)
17:20	**L.2.6: Carrera-González**	**Closings Remarks: The Mexico Challenge in North American Waterbird Conservation** (Eduardo Carrera-González*, Alberto Lafón-Terrazas, Leigh H. Fredrickson)

Senate		
15:40 - 17:40	**L.3: Conservation Planning** (Chair: Kevin Ringelman)	
15:40	**L.3.1: Bartuszevige**	**Using Landscape Design to Develop a Waterfowl Conservation Plan** (Anne M. Bartuszevige*, Alex Daniels, Kyle Taylor)
16:00	**L.3.2: Fleming, K.**	**Decision Support for Land Acquisition in the National Wildlife Refuge System** (Kathleen Fleming, Keenan Adams, Sean Fields, and Ken Fowler)
16:20	**L.3.3: Doherty**	**Building the Foundation for International Conservation Planning for Breeding Ducks Across the US and Canadian Border** (Kevin E. Doherty*, Jeffrey S. Evans, Johann Walker, James H. Devries, David W. Howerter)
16:40	**L.3.4: Laing**	**Waterfowl Brigades: Preparing the Next Generation of Conservationists** (Jared D. Laing*)
17:00	**L.3.5: Devney**	**Contract, Farm and Farmer Influencers on CRP Enrollment Decisions** (John Devney*, Neeraj Dhingra, William Lesch, David Roberts, Cheryl Wachenheim)
17:20	**L.3.6: Ringleman**	**Estimating Carrying Capacity at Local Scales: A Case Study from Forsythe National Wildlife Refuge** (Kevin M. Ringelman*, Christopher K. Williams, Paul Castelli, Mason L. Sieges, Rebecca Kern, Ted Nichols, Steve Earsom)
Caucus		
15:40 - 17:40	**L.4: Contaminants, Disease, and Genetics** (Chair: Alan Leach)	
15:40	**L.4.1: Latty^**	**Prevalence and Potential Sources of Elevated Strontium in Waterfowl Eggs in Interior Alaska** (Christopher J. Latty*, Angela C. Matz, Keith A. Hobson, Tuula E. Hollmen)
16:00	**L.4.2: Miller^**	**Trace Elements in Eiders and Long-tailed Ducks of the Alaskan Arctic** (Micah W. C. Miller*, James R. Lovvorn, Angela C. Matz, Robert J. Taylor, Christopher J. Latty, David E. Safine)
16:20	**L.4.3: England^**	**Helminths and Health of Spring-Migrating Lesser Scaup in the Upper Midwest** (J. Conner England1*, Jeffrey M. Levengood, Heath M. Hagy, Rebecca A. Cole, John M. Kinsella)
16:40	**L.4.4: Spivey^**	**Influenza A Virus Dynamics in High-Latitude Wintering Populations of Mallards** (Timothy J. Spivey*, Mark S. Lindberg, Brandt W. Meixell, Kyle R. Smith, Jonathan A. Runstadler, David E. Stallknecht, Andrew M. Ramey)
17:00	**L.4.5: Meixell^**	**Seasonal Prevalence of Influenza in a Reservoir Host: Waterfowl Life History and the Dynamics of Viral Flow** (Brandt W. Meixell*, Nichola J. Hill, Eric J. Ma, Mark S. Lindberg, Todd W. Arnold, and Jonathan A. Runstadler)

17:20	**L.4.6: Lavretsky**	**Population Genomics and Hybridization between Lesser and Greater Scaup** (Philip Lavretsky*, Jeffrey L. Peters, Kevin G. McCracken)
17:40 - 19:00	*Dinner break - on your own*	
Caucus **18:30 - 20:00**	**Special Session: University-based Waterfowl Programs: Past, Present & Foresights** (Organizers: Rick Kaminski, Bart Ballard, Warren Conway, J. Brian Davis, John Eadie, Jake Straub) **Drinks and food** *available at 18:30* **Presentations, Panel Discussion & Interaction with Audience** *will begin 19:00*	
Annapolis Ballroom **19:00 - 22:00**	**Poster Session II**	
19:00 - 22:00	**Hospitality** *hosted by* ***California Waterfowl Association*** *- Parks Place*	

I.1: Plenary

I.1.1: Plenary Robert Clark

Using Population Models to Test Ecological Hypotheses and Guide Conservation Decisions

Robert Clark[1]*

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The North American waterfowl community has a rich history of accomplishment in areas as diverse as behavior, evolution, harvest management and population ecology. This is due in part to the remarkable diversity of waterfowl and an enduring commitment to managing populations for long-term sustainability and for access by people - both hunters and viewers. Understanding why some duck populations have declined or remain below conservation goals while others have increased dramatically is also an area of considerable recent concern to waterfowl ecologists and managers alike. Furthermore, determining how future climate and land use changes will affect duck populations is challenging but would inform long-term perspectives for habitat conservation initiatives at several spatial scales. The impressive breadth and scope of waterfowl monitoring programs – spanning long time series of species-specific abundance data and demographic and movement information – combined with models such as integrated population models creates unprecedented opportunities to test hypotheses about population responses to ecological drivers and management alternatives (harvest, habitat). Here, I review several recent controversies and long-standing uncertainties about the impacts of varying environmental conditions and management alternatives on duck populations, setting the stage for subsequent detailed case-studies focused on scaup, black duck and pintail, as well as white-fronted and brant geese.

I.1.2: Plenary Michael Schaub

Inference About Population Processes by Combining Counts and Demographic Data Using Integrated Population Models

Michael Schaub[1]*

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Integrated population models are powerful models that can be used to jointly analyse population counts and data that are specific on one or more demographic rates. Joint analysis of all available data sets has the advantage that demographic parameters for which no explicit data are available can often be estimated and that the precision of parameter estimates is improved. Both advantages are a direct consequence of the more complete extraction of the information in the data. A key part of an integrated population model is a state-transition model which links age- or stage-specific population sizes with demographic rates. I demonstrate how integrated population models work, show recent applications and highlight perspectives and challenges of their application for the waterfowl community.

J.1: Integrated Population Models to Inform Waterfowl Ecology and Conservation (Organizers: Todd Arnold, David Koons)

J.1.1: Weegman

Integrated Population Modelling Reveals a Perceived Source to be a Cryptic Sink

Mitch D. Weegman[1,2]*, Stuart Bearhop[1], Anthony David Fox[3], Geoff M. Hilton[2], Alyn J. Walsh[4], David J. Hodgson[1]

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Demographic links among fragmented populations are commonly studied as source-sink dynamics, whereby source populations exhibit net recruitment and net emigration, while sinks suffer net mortality but enjoy net immigration. It is commonly assumed that large, persistent aggregations of individuals must be sources, but this ignores the possibility that they are sinks instead, buoyed demographically by immigration. We tested this assumption using Bayesian integrated population modelling of Greenland white-fronted geese (*Anser albifrons flavirostris*) at their largest wintering site (Wexford, Ireland), combining capture-mark-recapture, census and recruitment data collected from 1982 to 2010. Management for this species occurs largely on wintering areas; thus, study of source-sink dynamics of discrete regular wintering units provides unprecedented insights into population regulation and enables identification of likely processes influencing population dynamics at Wexford and among 70 other Greenland white-fronted goose wintering subpopulations. Using results from integrated population modelling, we parameterized an age-structured population projection matrix to determine the contribution of movement rates (emigration and immigration), recruitment and mortality to the dynamics of the Wexford subpopulation. Survival estimates for juvenile and adult birds at Wexford, and adult birds elsewhere fluctuated over the 29-year study period, but were not identifiably different. However, per capita recruitment rates at Wexford in later years (post-1995) were identifiably lower than in earlier years (pre-1995). The observed persistence of the Wexford subpopulation was only possible with high rates of immigration, which exceeded emigration in each year. Thus, despite its apparent stability, Wexford has functioned as a sink over the entire study period. These results demonstrate that even large populations can potentially be sinks, and that movement dynamics (e.g., immigration) among winters can dramatically obscure key processes driving population size. Further, novel population models which integrate capture-mark-recapture, census and recruitment data are essential to correctly ascribing source-sink status and accurately informing development of site-safeguard networks.

J.1.2: Koons

Drivers of Lesser Scaup Population Dynamics at a Continental Scale

David N. Koons[1]*, Michael Schaub[2], Todd W. Arnold[3], Mitchell D. Weegman[4], Beth E. Ross[5], Jeffrey M. Warren[6,1], Christopher A. Nicolai[7], Robert G. Clark[8]

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Although once one of the most abundant ducks in North America, the lesser scaup (*Aythya affinis*) population declined precipitously during the 1980's. The population breeding in the traditional survey area has stabilized in recent years, but abundance is still ~13% below the long-term average. However, the timing of breeding population (BPOP) surveys (designed to match spring migration phenology of mallards) may not capture peak scaup abundance on breeding areas. Further, there are no direct sources of data to inform reproductive success over long periods of time. As a result, there exists persistent debate about the demographic parameters responsible for suppressed lesser scaup abundance. The integrated population modeling (IPM) framework, which allows one to jointly utilize the information contained in multiple datasets, could nevertheless be ideal for finally gaining insight into the drivers of population dynamics for waterfowl species of management concern like lesser scaup. Using such a framework to integrate BPOP survey data, banding data, and information from the parts collection survey, we estimated temporal variation in survival, reproductive success, population structure, total abundance, and population growth rates between 1957 and 2012 while reconciling bias that might be contained in any one dataset. We then used results from the IPM within recently developed 'transient' life table response experiments to identify the demographic parameters that contributed most to long-term changes in lesser scaup population dynamics. To parameterize biologically-meaningful IPMs, we developed a list of factors that could be affecting the lesser scaup population, and for which indices can readily be measured at large spatial scales and over long periods of time. We included these indices in the IPM framework to determine the relative contributions of these to lesser scaup population dynamics. This robust approach will help guide future research and management actions aimed at restoring the continental lesser scaup population. Furthermore, the IPM framework will serve as a template for researchers to work with managers and develop holistic management plans (incorporating a variety of data sources) for the conservation of migratory birds at large spatial scales.

J.1.3: Osnas

An Integrated Population Model for Northern Pintail to Guide Harvest and Habitat Management

Erik E. Osnas[1]*, G. Scott Boomer[2], Michael C. Runge[3], Robert G. Clark[4], James H. Devries[5]

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We developed an integrated population model of northern pintail to help guide harvest and habitat management. The model is an age- and sex-structured state-space projection of breeding population size from 1960 to 2014 that jointly estimates survival and productivity while accounting for the observation processes of decreased detectability during drought years (pintail "overflight") and increased juvenile vulnerability to hunting. We used bandings from pre- and post-hunting season to partition survival into seasonal components and wrote demographic parameters as functions of habitat and population size. We found strong evidence for density- and habitat-dependence on productivity, including a winter habitat effect on productivity ("cross-seasonal effect") but very little evidence for density or habitat effects on post-hunting survival, although habitat covariates were limited to historical rainfall data. In fact, process variance in productivity accounted for ~30% of process variation in annual population growth rate while survival accounted for relatively little process variation and was relatively constant across this time period even though estimated harvest rates changed nearly 2-fold. Only for juvenile cohorts was there a trend in survival. In this cohort, survival decreased when harvest rate was > ~10% during the 1960s through 1970s. In adult cohorts, harvest rates were never >10% and survival was relatively invariant. These results could be explained by: some form of compensation between harvest and non-harvest mortality when harvest rates are low; an improvement over time in an unmeasured habitat covariate that increased juvenile survival; and/or insufficient variation in harvest rates or habitat conditions to reliably detect an effect on adult survival. Because there was limited evidence for density-dependence in survival and harvest rates were low, individual heterogeneity may be a possible mechanism of compensation. In terms of harvest and habitat management, these results suggest that the waterfowl community should not expect large changes in continent-wide survival with changes in habitats or harvest rates of historical magnitude, except perhaps in juvenile cohorts, but wide-scale changes in breeding habitats could be expected to fundamentally alter population trajectories.

J.1.4: Arnold

An Integrated Population Model for American Black Ducks

Todd W. Arnold[1]*, David N. Koons[2], Michael Schaub[3]

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American black ducks (*Anas rubripes*) breed in forested regions of eastern Canada and the northeastern United States, where breeding population surveys are difficult to conduct due to dense forest cover and remote terrain. In this presentation, I develop an integrated population model (IPM) for black ducks during 1969-1998 that uses only harvest surveys and banding data. Use of harvest survey data allowed me to obtain Lincoln estimates of population size for adults and juveniles during late summer (i.e. fall flight) and for all ages combined during late winter (i.e. BPOP). Using banding data from before and after the hunting season (i.e. pre- and postseason) allowed me to partition annual survival into hunting season (~Sep-Feb) and breeding season (~Apr-Aug) components. Hunting season survival was strongly affected by harvest rate, especially for juveniles, but there was evidence of compensation between seasons (i.e., if hunting season survival was low, subsequent breeding season survival was high; r = -0.72). However, there was no evidence that population regulation resulted from density dependence, because vital rates were uncorrelated with estimates of population size. The ratio of juvenile to adult population size each fall provided a reliable estimate of annual fecundity, which was strongly correlated with vulnerability-adjusted age ratios based on the Parts Collection Survey (R^2 = 0.88), and fecundity explained the greatest amount of variation in annual population growth. I suggest that compensation of harvest in black ducks is best explained by individual heterogeneity in both natural and hunting mortality, and that black duck populations were more stable during this period than Mid-winter Survey data led us to believe.

J.1.5: Riecke^

Integrated Population Models: Derived Parameters and Sampling Variance

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Integrated population models have become increasingly popular management tools, where investigators seek to combine demographic and census data to better understand processes driving population dynamics. These models are particularly useful for identifying and exploring knowledge gaps within datasets, where biologically meaningful parameters, such as immigration, emigration, reproduction, and the relative contribution of unmonitored populations to lambda, can be derived from other sources of data. However, when uncontrolled sampling variance exists in the data, biologically meaningful, derived process parameters serve as additional error terms, where parameter estimates may be severely biased. We use Pacific black brant (*Branta bernicla nigricans*) and simulated waterfowl datasets to demonstrate covariance among derived process parameters such as immigration, reproduction, and the relative contribution of unmonitored populations, and sampling variance. Preliminary results indicate biological inference can be dramatically altered by model parameterization, where derived parameters can lead to potentially spurious conclusions in the face of uncontrolled sampling variance.

J.1.6: Arnold

Integrated Population Models to Inform Waterfowl Ecology and Conservation: Pitfalls and Promises

Todd W. Arnold[1]*, Robert G. Clark[2], David N. Koons[3], Erik E. Osnas[4], Thomas V. Riecke[5], Michael Schaub[6], Mitchell D. Weegman[7]

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Integrated population models (IPM) allow researchers to combine separate and independent datasets, such as breeding pair surveys, productivity estimates, band-recovery data, and harvest estimates, thereby facilitating development of long-term, cross-seasonal, and/or spatial comparisons of demographic performance and population dynamics. By sharing information among datasets, IPMs can improve the precision of vital rate estimates and diminish biases due to measurement error, and they can be used to estimate otherwise unmeasurable or unmeasured parameters, such as immigration and among-population movement rates. By leveraging information across datasets that inform the common process of population dynamics, IPMs are capable of providing improved insights for habitat and harvest management. However, IPMs can also highlight irreconcilable differences among existing data sets. Given the rich and long-term data sets available to waterfowl researchers, we believe that IPMs have a bright future for waterfowl ecology and management.

K.1: Looking Ahead Toward Future Management of Shallow Lakes (Organizers: Nicole Hansel-Welch, Mark Hanson)

K.1.1: Anteau

A Watershed Approach for Conservation of Prairie-Pothole Wetlands

Michael J. Anteau[1]*, Mark T. Wiltermuth[1], Lisa A. McCauley[2,3], Max Post van der Burg[1]

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Wetlands of the Prairie Pothole Region directly support production of 50-80% of North American ducks and provide critical spring stopover habitat for ducks bound for arctic and boreal breeding areas. These wetlands face a myriad of threats from interacting responses to changes in climate and land-use practices. Effective conservation of these wetlands requires considering connections of wetlands with their surrounding upland habitats, but may also require consideration of hydrologic connections among wetlands. For example, consolidation drainage is a practice of draining smaller and more temporarily ponded wetlands into larger ones in effort to increase tillable acreage for agriculture. We review impacts of consolidation drainage on ecological communities, wetland size, and water-level dynamics based on studies that examined responses of wetlands to climate variability and land use changes from 1937 to present. Our results suggest that consolidation drainage has caused marked increases in water levels and is essentially decoupling water-level dynamics from climate variation. Moreover, past consolidation drainage appears to progressively increase water levels through successive wetting and drying phases. Based on our results, flood abatement is an ecosystem service that is under threat in the current land-use paradigm. Furthermore, ecological communities in larger prairie wetlands are shifting towards those supported by permanent lakes. These results call to question whether current tools used for conservation of wetlands are adequate to protect ecosystem services provided by remaining wetlands. Moreover, they suggest that considering hydrologically defined wetland complexes (watersheds) when making conservation decisions would lead to more effective conservation, especially for larger prairie wetlands. Lastly, considering other ecological services, such as flood control, in addition to waterfowl conservation would allow the public and policy makers to make more informed cost/benefit decisions about wetland conservation; this could lead to strengthening of these programs which would benefit waterfowl.

K.1.2: Vitense^

Predicting Total Phosphorus and Assessing State Transition Risk in Shallow Lakes

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Shallow lakes provide critical habitat for migratory waterfowl and aquatic invertebrates, but they can become degraded due to excess nutrient input from intensive agriculture and because their interconnectedness allows exchange of nutrients, chemicals, and aquatic invasive species. Shallow lakes can quickly transition between two alternative stable states: a clear state dominated by submerged aquatic vegetation, which provides an important food source for waterfowl, and a turbid state dominated by phytoplankton. Theoretical models suggest that critical nutrient thresholds differentiate highly resilient clear lakes, lakes that may switch between clear and turbid states due to system perturbations (e.g., weather events, zooplankton community changes), and highly resilient turbid lakes. Managers need tools to help identify these critical nutrient levels, to determine where lakes sit in relation to these thresholds, and to clarify state-dependent relationships between nutrients and key system variables. Such tools would help managers assess the relative risk of lake transitions (from turbid to clear and vice versa) and subsequently, to identify and prioritize appropriate management actions. We developed an integrated framework, using Bayesian regression models with lake states and TP thresholds treated as latent variables, to (1) identify critical Total Phosphorus (TP) thresholds, (2) classify attracting lake states, and (3) estimate steady-state relationships between TP and chlorophyll a. We evaluated the method using data simulated from a stochastic differential equation model approximating shallow lake dynamics, finding that sample size and degree of system perturbation are limiting factors for the successful estimation of system parameters. We also applied the modeling framework to data from a multi-year study involving 118 shallow lakes in Minnesota. Our approach resulted in similar lake classifications as k-means clustering, but with the advantage that uncertainty in nutrient thresholds and lake states is properly accounted for when estimating state-dependent relationships. Lastly, we used linear mixed-effects models to predict TP levels from watershed and in-lake features. We found that percent woodland cover in the upstream watershed, lake depth, and benthivore abundance can be used to predict TP levels in Minnesota shallow lakes, and we discuss the possible influence of soil parent materials on predicted lake phosphorus levels. Together, these analyses provide a foundation for a decision support tool for shallow lake management, and future work will focus on translating our results into a simple tool to assess the relative state transition risk of shallow lakes.

K.1.3: Wiltermuth

Landscape-scale Evaluation of the "Alternative Stable State" Hypothesis Within Large Northern Prairie Wetlands in Context of Waterbird Conservation

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The "alternative stable states" hypothesis predicts two general alternative states in prairie pothole wetlands, one where primary productivity is dominated by phytoplankton and the other by submerged aquatic vegetation (SAV). Wetlands with SAV-dominated communities provide better habitat for most waterfowl species because they have food webs with higher densities of invertebrate prey than those of phytoplankton-dominated wetlands. If landscape conditions can be used to predict where or when these alternative states manifest, this information could help managers prioritize conservation efforts. We conducted a landscape-scale evaluation of the alternative stable state hypothesis by examining the distribution of remotely-sensed chlorophyll-a (chl-a) concentrations—a proxy for phytoplankton concentrations—during 2011 within 978 randomly selected semipermanently and permanently ponded wetlands in the Prairie Pothole Region of North Dakota. Under this hypothesis we predicted that two alternative states should be observable as a bimodal distribution in a large sample of wetlands. Additionally, we evaluated how wetland chl-a concentrations were related to consolidation drainage, upland land use, and fish abundance. The distribution of wetland mean chl-a concentrations was unimodal, skewed right, and lacked evidence of discontinuity. Chl-a concentration was positively correlated with the percent of the wetland basin filled by the pond ($\hat{\beta}$=0.009 ±0.002 SE) and negatively correlated with the percent of surrounding upland that was grassland ($\hat{\beta}$=-0.642 ±0.199 SE). Our evaluation did not support predictions of the alternative stable state hypothesis. Rather, our data suggest that these wetlands behave in a continuum of trophic structure, and the trophic structure is influenced by a continuum of perturbations. Accordingly, for the purposes of improving conservation planning, our findings suggest that a continuous model would be more useful than characterizing wetlands within the framework of alternative stable states. However, a longitudinal study is needed to examine if individual wetlands may have varying manifestations of alternative states.

K.1.4: Hanson

Rehabilitating Turbid Shallow Lakes: Harder Than We Think?

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Shallow lakes are critical for waterfowl and other wetland-dependent species, but many lakes are characterized by turbid conditions with poor water quality, sparse communities of plants and invertebrates, and limited habitat suitability. Lake managers must choose whether to focus rehabilitation on watershed improvements or on in-lake projects, and lake responses are frequently disappointing. We reviewed results of recent lake management efforts and compared these with patterns from studies that explored links between shallow lake communities and properties of adjacent watersheds. Whole-lake projects across Europe and North America indicate that reducing nutrient loading sometimes favors improvements, but that lakes often respond slowly to watershed-scale approaches and responses may not be evident for decades. Alternative strategies focusing on in-lake measures such as drawdowns or fish removals often stimulate rapid improvements, but benefits rarely persist beyond 5-10 years. Comparisons among shallow lakes highlight the fact that integrating features such as phytoplankton biomass and invertebrate community patterns are often only weakly related to land cover or other characteristics of watersheds. This seems surprising, but consistent with predictions of conceptual models for lake dynamics, and with empirical data showing resilience of both clear- and turbid-states. We suggest that effective shallow lake management in modern landscapes should be based on a tiered approach. Strictest protection should be applied to watersheds containing resilient clear-water shallow lakes. Other areas will benefit from restoration of cover types and other natural features in lake watersheds, but may also require perpetual in-lake intervention if projects are to achieve and maintain favorable conditions within decadal timeframes. Finally, extensive nutrient loading, hydrologic changes, and other factors have thoroughly exhausted ecological resilience in some turbid shallow lakes. Here, lakes may be so severely altered that improvements will be possible only in response to ongoing, intensive in-lake management such as biomanipulation, drawdown, and sediment removal.

K.1.5: Zimmer

Is Island Biogeography a Good Model for Biodiversity in Shallow Lakes?

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The island biogeography model (IBM) predicts biodiversity will be maximized in large habitats close to or connected to other habitats, and this concept has become a core principal in conservation biology. However, few studies have tested the applicability of the IBM for shallow lakes, and one weakness is the IBM does not account for effects of biotic interactions on biodiversity. Biotic interactions involving fish are intense in shallow lakes, and benthivorous and planktivorous fish (hereafter fish) can induce shifts to turbid-water states which may reduce biodiversity. We used a two-prong approach to assess whether patterns of biodiversity in shallow lakes follow the IBM. First, we examined relationships among lake size, lake connectivity, fish biomass, turbid versus clear states, and species diversity of fish, aquatic invertebrates, and submerged aquatic plants. Second, we used sediment cores from lakes as case studies to explore long-term stability of lake communities relative to lake isolation and fish communities. Results showed fish biodiversity and biomass were highest in large, connected lakes, and these systems were more likely to be in turbid states. In contrast, biodiversity of invertebrates and aquatic plants showed no relationship with lake size and connectivity, likely due to negative effects of high fish abundance in large, connected lakes. Sediment cores indicated that small, more isolated lakes with low fish biomass have remained in stable clear-water states with high diversity over the last 150 years, while larger lakes with high fish biomass or with known human perturbations have shifted to stable turbid states with lower diversity. Our results indicate IBM does not predict biodiversity patterns of plants and invertebrates in shallow lakes very well, and that small, isolated shallow lakes are important reservoirs of biodiversity on the landscape. Management efforts should strive to protect these important ecosystems at the landscape scale.

K.1.6: Hansel-Welch

Management or Restoration - What Are We Doing with Shallow Lakes in Minnesota?

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The Department of Natural Resources in Minnesota has been working to increase waterfowl habitat in select shallow lakes for decades through water level drawdowns, chemical treatments and other means. Early attempts to improve habitat on these lakes were often referred to as “restorations.” Managers and the public often viewed these undertakings as one-time events and expectations were subsequent improvements would last indefinitely. However, many of the managed lakes have a long legacy of impacts from nutrient loading, changes in hydrology, decreased frequency of fish winterkill and other landscape alterations. Through on-going research on shallow lakes and wetlands in the state, more information is becoming available to managers so informed decisions can be made on where management efforts are more likely to have longer lasting results. In addition to research, monitoring efforts have increased with over 1600 point-intercept vegetation surveys conducted on ~1100 lakes across Minnesota since 2002. Before and after monitoring data of shallow lakes where various management tools have been applied and across different landscape settings illustrate the complexities of managing these systems. Examples will highlight the technical aspects, difficulties and successes of management aimed at improving waterfowl habitat and water quality. Efforts have also focused on communicating the need for continued monitoring and management intervention on impacted lakes. Protection of shallow lakes that remain in good condition is a priority as it seems that true “restoration” of lakes once they are impaired is a goal that may not be realistic.

L.1: Looking Ahead Toward Future Management of Shallow Lakes (Organizers: Nicole Hansel-Welch, Mark Hanson)

L.1.1: Hagy

Evolution of Backwater Lakes along the Illinois River with Waterfowl as a Sentinel of Change

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Backwater lakes within the Illinois River Valley (IRV) historically provided habitat for >20% of the Mississippi Flyway's mallard (*Anas platyrhynchos*) population during autumn, but use has declined more than 80% since the 1950s. Similarly and more dramatically, lesser scaup (*Ayathya affinis*) use has declined more than 90% since the 1970s. Despite declines in species historically common and widespread loss of aquatic vegetation communities in the region, use and peak abundances of several other species of waterfowl have dramatically increased within the last decade. For example, total use days for ducks (29,681,598 use days) during autumn 2013 were the highest recorded since 1985 in the IRV. Similarly, peak abundances of northern pintail (*Anas acuta*), American green-winged teal (*A. carolinensis*), gadwall (*A. strepera*), and northern shoveler (*A. clypeata*) were the greatest recorded since initiation of aerial surveys in 1948. Even diving ducks have increased in recent years. We estimated a peak abundance of 118,830 diving ducks along the Illinois River in 2013, which was 258% above the 5-year average. While species traditionally common, such as lesser scaup, have not recovered to historical use levels, other species have apparently responded to recent habitat restoration in the region (e.g., ring-necked duck [*Aythya collaris*] and ruddy duck [*Oxyura jamaicensis*; highest peak abundance ever recorded in 2013]). Waterfowl abundances in the IRV have increased concurrent with restoration of several backwater lakes in the region which provide a diversity of aquatic vegetation communities previously eliminated from the region. For example, Emiquon Preserve is a restored wetland complex that accounts for more than 30% of the total waterbird use days in the IRV. We will describe backwater lake restoration strategies used, illustrate how a few signature restoration projects can change patterns of waterfowl use for an entire region, and recommend indicators to assess restoration success and trajectory.

L.1.2: Evelsizer

Ten Years of Shallow Lake Renovations: Applying What's Been Learned to Future Management

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Does the outcome match the expectations? Shallow lake management is unique, fun, and at times really frustrating – much like a puzzle! Just when we think we have somewhat of a handle on them, something arises and we may not fully understand 'why'. Beginning in 2006, dedicated effort and funds were devoted to renovate degraded shallow lakes in Iowa. Since then, several shallow lakes and large marshes have undergone extensive measures in an attempt to improve their ecological health for wildlife, water quality, and overall recreational enjoyment. While many of these systems share similar characteristics, each one is also unique in how they've responded to active management scenarios. A wide variety of factors such as hydrology, watershed land use, and size can play into how a shallow lake system responds initially and then longer term to a renovation. In addition to those physical factors, water quality efforts and community support from local citizens has also been an important factor in managing a shallow lake renovation successfully. During these ten years lessons, observations, and data have been gathered. Our objective here is to share how larger projects such as shallow lake renovations that benefit waterfowl often means linking together and partnering with water quality interests, community citizens, fisheries managers and other partners to achieve an outcome that meets the expectations - because it is a puzzle, but often very rewarding!

L.1.3: Wrubleski

Restoring a Large Freshwater Coastal Wetland on the Prairies; Delta Marsh, Manitoba

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For over one hundred years, Delta Marsh has been an important waterfowl hunting area. However, similar to other shallow freshwater ecosystems, it is suffering from the effects of an artificially regulated water regime, eutrophication and invasive species, all of which have contributed to declining waterfowl numbers and hunting opportunities. A multi-agency partnership has embarked on a ten-year restoration project to address the factors contributing to the deterioration of the marsh. Complicating restoration efforts is the fact that Delta Marsh cannot be managed in isolation. It is intimately connected to Lake Manitoba with which it exchanges water, nutrients and fish. The first phase of the restoration project consists of management efforts to reduce the impacts of an invasive fish species, Common Carp (Cyprinus carpio), that overwinters in the lake. Experimental field studies have already demonstrated that Carp are responsible for several changes observed in the marsh, including increased turbidity, phytoplankton blooms and loss of submersed vegetation. Carp exclusion structures have been constructed on the channels connecting the marsh to Lake Manitoba, and are designed and operated to reduce Carp access to the marsh while minimizing impacts on native fish species that also use the marsh for feeding, spawning, and rearing. A five-year monitoring program will adjust management efforts as required to favor improvements and balance needs of the native fish community. Initial monitoring results are showing improved water clarity and increased abundance of submersed vegetation. Additional scientific investigations of marsh hydrology, hydraulics, and nutrient inputs are now underway. These investigations will inform additional management actions to further improve the quality of this important wetland.

L.1.4: Hutchins

Time-lapse Photography: Documenting Wetland Restoration and Shallow Lake Management in Minnesota

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A continuing challenge in planning and implementation of wetland management is for professionals as well as the general public to gain a comfort level with the high degree of variability common to wetlands with different geomorphic and hydrological settings. For the inexperienced, it is difficult to gain an appreciation for this variability without direct exposure to these conditions over time. In Minnesota, the use of time-lapse photography demonstrates one opportunity to speed the process of understanding wetland variability. The goal of this project was to establish time-lapse cameras at a variety of wetland restoration and shallow lake management projects occurring throughout Minnesota to serve as a new information and education tool. Additionally, the project serves as an assessment tool for wetland managers and researchers. Time-lapse photography is a technique used to document changes that occur slowly or over long periods of time. Photos from multiple years can be compressed into a short video presentation. This method enables managers to document shallow lake management and wetland restoration in an innovative way the public can see and understand. Time-lapse cameras record activities at project sites before, during, and after management or restoration, and the resulting video quickly shows the hydrologic and vegetative changes that occur over a period of two to three years. Seven sites portraying a range of wetland types and management activities were selected from across the state, including a wetland restoration on private land, management of a shallow lake through water-level drawdown, and hybrid cattail management on public land. Cameras were installed in 2013 and set to take one photo per hour of daylight. Photos were downloaded every 2-3 months. Some cameras will remain installed for up to 3 years. A sample video will be shown, and the completed videos will be posted to the Minnesota Department of Natural Resources website for public viewing.

L.1.5: Anthony^

Seed-Bank and Invertebrate Potential of Moist-Soil Wetlands in the Southwest

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Moist-soil wetlands across the U.S. provide food and habitat resources to waterfowl, shorebirds and other wildlife. However, there are few moist-soil wetlands in the arid Southwest U.S. which makes them invaluable for the conservation of migratory birds and other wetland dependent species. Waterfowl and shorebirds consume seeds and invertebrates to meet the nutritional needs of migration, molting and to a lesser extent, breeding while in the Southwest. Knowing how to optimize seed and invertebrate production in arid moist-soil wetlands is critical to wetland managers in arid landscapes. Our primary goal was to manipulate and test conditions in the greenhouse and on moist-soil wetlands that will yield the greatest biomass of invertebrates and seeds for waterfowl and shorebirds. Our secondary goal is to provide wetland managers and landowners at Sandia Wetland, Texas, with a chronology of bird use and a strategy for timing drawdowns and inundations on the moist-soil wetlands. We explored the use of e-bird.net, a website for birders to record their findings, in developing a preliminary chronology for shorebird and waterfowl at Sandia Wetlands, Texas. Data collected from the website indicates the presence of ducks and geese at the site from August-April with a peak in November. Shorebirds are present throughout the year but display a bimodal peak in August and April. Invertebrate production was compared across inundation levels by collecting water column and benthic core samples from within preexisting moist-soil wetlands within the Chihuahuan Desert. We assessed the effects of moist and flooded treatments on germination rates of wetland dependent plant species by experimentally maintaining soil samples under moist (i.e. no water above the surface of the soil) and waterlogged conditions (i.e. <4 cm water above the surface of the soil) in planting trays housed within a greenhouse. Soil samples for the seed bank germination experiment were attained from benthic core samples collected from three arid moist-soil wetland sites within the Chihuahuan Desert Biome of Texas and New Mexico. 204 benthic samples were collected for seed bank analysis and were divided in two equal samples. Upon germination and identification seedlings were removed at 30 day intervals, and any unidentified seedlings were planted in potting soil until identified. Seedlings were categorized as desirable/undesirable. Desirable species are those that provide energy or other nutrients useful for wintering and migrating waterfowl. Non-desirable species produce a lower quantity and quality of seeds. We took 2 soil core samples for invertebrate biomass analysis and recorded bird chronology and use twice a month throughout the length of inundation. Knowledge of migratory shorebird and waterfowl chronology is useful for timing the peak of migration within the inundation period of wetland impoundments. Our research will assist arid wetland biologists to make informed decisions for maximizing food resources for waterfowl and shorebirds in managed and unmanaged wetlands throughout the desert Southwest region of the United States and will specifically and directly impact wetlands at our study sites by providing a thorough management plan.

L.1.6: Hansel-Welch, Hanson

Discussion

K.2: Mexico's Rich Waterfowl History, Contemporary Wetland Challenges, and Maintaining Anatid Biodiversity (Organizers: Eduardo Carrera-González*, Alberto Lafón-Terrazas, Leigh H. Fredrickson)

K.2.1: Carrera-González

Introductory Remarks: International Cooperation Across North America a Key to Continental Waterbird Conservation

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The Anseriformes are the most widely distributed of all avian orders with a distribution globally from the sub-Antarctic islands in the southern hemisphere to the high Arctic islands in the northern hemisphere. This diverse order of 150 species exploits wetland niches across the globe without regard for political boundaries, global landforms, or any boundaries established by humans. The value of this resource associated with wetlands was identified 100 years ago with the Migratory Bird Treaty. This was the first recognition of the large spatial scale implication of protecting this highly migratory group of birds throughout North America in order to assure their existence far into the future.

In 1936 Mexico joined the Migratory Bird Treaty to protect the migratory bird resource and their wetland habitats. Unfortunately the progress that Mexico has made lags well behind the efforts in the United States and Canada in developing state and federal conservation programs, the funding for these programs, and the education of professionals to address the challenges of managing the migratory bird resource and the associated habitats. There is a growing attempt to address these deficiencies by state, federal, and nonprofit groups throughout Mexico. This session focuses on the history of Mexico's efforts to meet the responsibility of protecting and managing the migratory bird resource and their habitats.

K.2.2: Valverde

A Historical Perspective on the Conservation of Waterfowl in Mexico

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The path to conservation in Mexico took a very different route compared to the United States. Undoubtedly the concentrations of migrant and wintering anatids numbering in the hundreds of thousands during the most social part of the annual cycle in Mexico made concerns for depressed breeding populations difficult to promote at the southern terminous of continental populations until pressure came from the northern breeding areas. Thus interest in continental conservation within Mexico was delayed until 1936 when Mexico became the third country as a signatory to the Migratory Bird Treaty. Even then pressure to develop national programs were slow to develop. On 2 February 1952, the "Ley Federal de Caza" was published. It was then that hunters as well as diverse wildlife users were aware of "Departamento de asuntos de fauna silvestre" an official authority dealing with the conservation of birds. This Federal Law (Act) was attempting to promote hunting regulations nationwide where traditionally hunters considered wildlife ownership (patrimonia nacional) as a national endowment. For the next 11 years there were actions linked to management concerns expressed in essays by concerned biologists. Then in 1963 Rachel Carson publish Silent Spring which was instrumental in promoting investments in conservation. Unfortunately seven more years passed before management programs were established and the "Direccion General de Fauna Silvestre" was born. This presentation documents the slow but steady development of a national conservation program linked to the protection of continental bird populations through the Migratory Bird Treaty.

K.2.3: Lafón-Terrazas

The Current State of Policy and Legislation Related to Environmental Resources in Mexico

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Environmental legislation in Mexico related to waterfowl and their habitats, has a degree of complexity that does not allow the flexibility required for decision-making by a single agency. In the case of wetlands, their management and conservation involves at least 20 laws and 11 different agencies at the federal level, plus a similar number of state and municipal departments. Considerations for the management and protection of wetlands in Mexico include a legal framework that range from the Politic Constitution of the United Mexican States, through the General Law of National Assets, the National Water Law and it´s Regulations, Federal Sea law, General Law of Ecological Balance and Environmental Protection, General Wildlife Act and its Regulations, Sustainable Forest Development Act and its Regulations, and the General Law of Sustainable Fisheries and Aquaculture. Added to this array of legislation are international commitments that have to be considered when discussing conservation and / or management of water bodies and wetlands. For the management and sustainable use of animals such as wildlife (geese, ducks and cranes) the following laws and regulations are of importance: General Wildlife Act and Regulations, General Law of Ecological Equilibrium and Environmental Protection, Law Federal Firearms and Explosives Federal Law, Federal Water Law, Mexican Official Standard 059. Despite this legislation, the effectiveness of the waterfowl management and habitat protection requires actions to be implemented at the field level in order to guarantee that wetlands are protected and managed.

K.2.4: Carrera-González

Distribution and Status of Mexico´s Wetland Resources

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With 142 wetland ecosystems enlisted as Ramsar sites and a recent published Wetland´s National Policy, Mexico is looking for ways to guarantee the long term conservation of these important wetland ecosystems. Achieving this goal in Mexico becomes a unique challenge where social and economic development is considered an essential component to improve the quality of life for its citizens.

México has recently recognized the importance and value of their wetland resources, and focused more attention on the conservation of these ecosystems. Protecting wetland areas at state and federal levels was the foundation of historic public policy related to natural resources. As a result, conservation of wetlands tended to be mostly coincidental when the driving interest in developing a protected area happened to also overlap with the presence of wetlands. Thus, wetland conservation was not usually a driving force behind conservation.

Some initiatives have been developed in Mexico to identify and protect Wetlands of International Importance as the most effective mechanism to promote the explicit recognition of the value of wetland ecosystems. Nevertheless, Mexico has made significant progress in inventorying and classifying habitats across the entire country, with an explicit emphasis and priority placed on regions with significant wetland resources for waterfowl and shorebirds. Once in place, these inventories are proving useful as the foundation for promoting subsequent conservation activities by local, state and federal governmental entities, as well as non-governmental conservation organizations.

Wetland inventory information is a valuable tool to support management and conservation decisions to guarantee wetland viability for wildlife and man because of the major threats these wetland ecosystems are facing from urbanization, aquaculture, and agriculture. The available literature, official information, and results obtained with the current efforts resulting from the wetland inventory and classification about the distribution, function, and value of wetlands in Mexico still lacks a comprehensive overview of wetland ecosystems. These short comings should direct more attention to wetland efforts for a great number of resident and migratory wildlife species that are directly depending on wetlands to fulfill their life cycle needs.

K.2.5: Lafón-Terrazas

Initial Efforts for Waterfowl Monitoring in Mexico

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The development of monitoring programs for waterfowl and other waterbirds in Mexico have developed slowly. This presentation document the results of an initiative of DGVS Dirección General de Vida Silvestre – General wildlife management- from SEMARNAT Secretaría de Medio Ambiente y Recursos Naturales – Ministry of Environment and Natural Resources and the combined effort by state and federal governments, research and education institutions as well as a diversity of non- governmental organizations that conducted a waterfowl survey in different regions of the country. This task required the integration of multi-disciplinary, inter-institutional teams that collaborated under a tight budget.

Before inventory implementation, meetings were held to develop a methodology appropriate for the diversity of habitats to be surveyed. Adjustments in methodology were made for each region and especially for areas with marine and mangrove swamp environments. A training software was used to assess individual and group ability to conduct inventories. This training resulted in techniques designed to improve accuracy. These techniques led to determine a national average error between 14% and 18% which was accepted as adequate, considering the limited training provided for participating technicians.

Areas were selected for inventories and then prioritized based on high waterfowl use and personnel to conduct the inventories. Furthermore to optimize the use of resources, support from other organizations were included. With support from other organizations, SEMARNAT delegations and private individuals, inventories were implemented in 4 regions and 15 States, including 85 specific sites such as lakes, lagoons, and other water reservoirs. The inventory was conducted by 123 technicians who used 5 airplanes in Chihuahua, Yucatán, Coahuila, Zacatecas and Durango states, 4 airboats in Sinaloa and Nayarit plus 14 boats and rafts and 21 vehicles throughout Mexico.

Results indicated 21 species of ducks, 5 species of geese as well as 31 other wetland associated species were encountered. Total encounters included 918,834 ducks and 131,931 geese. Nevertheless, it is important to remember that important waterfowl areas such as Tamaulipas and the peninsula of Baja California were not part of this survey and that estimates have been made for as many as 7 million wintering waterfowl in Mexico. This single attempt at a nationwide coordinated survey suggests more logistic and monetary support is still needed to carry out a waterfowl survey that provides information as well as answers to questions regarding the necessary administrative organization for the conservation of natural resources in Mexico.

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K.2.6: Carrera-González

Distribution and Composition of the Mexican Waterfowl Harvest

Eduardo Carrera-González[1]*, Alberto Lafón-Terrazas[2], Leigh H Fredrickson[3]

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To properly manage migratory waterfowl on a continental basis, an accurate, systematic and annual estimate of waterfowl harvest in North America is essential. Unfortunately the sophisticated programs necessary to assess harvest in Mexico lags behind those of the United States and Canada. Efforts to assess a national waterfowl harvest in Mexico have failed because the focus has either been on some localized regions or for specific wetlands. Unfortunately the federal government has lost its authority to enforce the law or to establish a system for the collection and use of important information as a tool to improve wildlife management and conservation decisions. Thus the decentralization of wildlife management to some northern Mexican states as well as the way wildlife is managed in Mexico compromises the efforts to collect these harvest data country wide.

In 1995 the first and only effort to determine waterfowl harvest and hunter activity nationwide was conducted throughout Mexico with less than 100,000 waterfowl harvested annually in the most important and traditional sites of waterfowl use in Mexico. Since then, no other effort to guide harvest management decisions has been conducted to estimate total waterfowl harvest, species composition or origin of hunters.

Since the mid-1990s, changes in wildlife management were made in the administration and system operations, unfortunately data gathering remains limited. Thus, this deficiency reinforces the need to establish a national program that guarantees harvest data collection. At present just partial data from harvest and the economic benefits from hunting activity exist in Mexico. These limited data remain valuable as a justification to encourage the federal government to help launch the Mexican Wildlife Fund which supports wildlife conservation but with a focus on those species with economic importance.

L.2: Mexico's Rich Waterfowl History, Contemporary Wetland Challenges, and Maintaining Anatid Biodiversity (Organizers: Eduardo Carrera-González, Alberto Lafón-Terrazas, Leigh H. Fredrickson)

L.2.1: Lafón-Terrazas

Distribution and Productivity of the Mexican Ducks and Related Species

Alberto Lafón-Terrazas[1]*

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One of the conservation initiatives in Mexico focuses on six native species (Mexican duck, muscovy duck, fulvous whistling duck, black-bellied whistling duck, mottled duck, and masked duck). Unfortunately conservation efforts are primarily through publicity and nesting boxes which have largely failed to meet conservation goals. Foremost among the compromising factors is the lack of basic information about these species including ecology, populations, and distributions.

Some information is available for the muscovy duck (*Cairina moschata*) and the triguero duck (*Anas diazi*). For example the distribution of the triguero duck appears to be expanding beyond the Mexican Altiplano mainly to the Pacific coast (Sonora, Sinaloa and Nayarit). Today the species is reported in areas where it was nonexistent two decades ago and in some areas is abundant enough to cause crop damages. In the case of the resident mottled and masked duck there is so little information that information is lacking on both abundance and distribution. This lack of information is of concern to properly protect these resident birds before they might be exploited.

L.2.2: Wortham

A History of U.S. Flyway Biologists/Pilots' Efforts in Mexico

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The U.S. Fish & Wildlife Service enjoys a rich history of cooperation with Mexico in monitoring and managing our shared waterfowl resources. From the early day when George and Dorothy Saunders explored the northern highlands with their Jeep, "Chico", or in 1947 when Flyway Biologists/Pilots first flew waterfowl surveys in Mexico piloting a WWII surplus Grumman Goose to the present, we have identified that Mexico has important implications for annual ecology of many North American migratory birds.

Waterfowl surveys within Mexico evolved to become regularly scheduled aerial surveys across the east coast, central highlands, west coast and Baja. Some surveys such as those for Gulf Coast redheads or Pacific black brant were conducted annually, while other broad scale surveys were completed every third year and included habitats in nearly every State within Mexico. Still only a fraction of the ducks, geese, and other marshland birds living or wintering below the U.S. border were observed and many crucial habitats remain poorly understood. For certain species, such as black brant or white-fronted geese, wintering monitoring efforts within Mexico became an important part of continental population management plans. However, most surveys were aimed at providing general trend analyses or identifying patterns of distribution of birds within Mexico.

Presently, many of these FWS-supported aerial surveys in Mexico have fallen victim to budget cuts and security concerns. More support is needed to prioritize information needs and to design statistically viable monitoring surveys to meet those demands. One solution is to continue cooperative work with Federal, State, academic institutions, and NGOs within Mexico to further develop aerial survey resources in-country to complement FWS capabilities. Earlier collaborative workshops have been successful in sharing survey design and operational techniques and in mentoring Mexican natural resource pilots. In addition, emerging aerial remote sensing technologies can be explored for potential application to environmental pressures imposed on waterfowl or their habitats.

L.2.3: Fredrickson

Functional Aspect of Wetlands in Mexico's Arid Northern Highlands

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The southern terminus for significant numbers of North American waterbirds is found in the arid highlands of northern Mexico which seems like an unusual place to have a high concentration of wetland dependent birds. Nevertheless, in the Mexican states of Chihuahua, Durango, and Zacatecas there are significant areas of alluvial fans, playa like basins, and shallow lakes that provide diverse wetland resources on an erratic basis because of the variability associated with the climatic, topographic, and geomorphic setting in an arid mountain systems with monsoonal influences from Pacific air movements. Diverse taxonomic groups take advantage of these desirable wetland conditions with abundant foods. Among these are migrant and wintering anatids, gruiforms, and chadriiforms. Large numbers of white-fronted and snow geese along with a mix of dabbling ducks including teal, wigeon and pintail are joined by resident Mexican ducks. Sandhill cranes and long-billed Curlew's occur in significant numbers along with a number of different shorebirds. Historically a few whooping cranes also exploited these habitats.
The unique combination of monsoonal rains that occur erratically across the states in summer and the geomorphic conditions associated with these landforms, soil textures, and subsurface hydrology create ideal bare mineral soil substrates for the germination of wetland plants that have adequate hydrologic inputs for growth and a potential for flooding at the time of fall migration because of changes in temperature and transpiration.

Unfortunately these wetlands are under siege by a variety of factors including urbanization and agriculture. Undoubtedly rapidly changing agricultural programs are having a negative impact on the presence and condition of many wetland basins. These modifications are especially disconcerting in Mexico because their conservation programs are in the early stages of development and reflect the challenges that the United States faced in the 1930s and 40s.

L.2.4: Vradenburg

Bosque del Apache NWR and Mexico: A History of International Collaboration

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Effective landscape level wetland management requires an appreciation for resource production, distribution, and availability across large scales as well as sharing expertise and coordinating actions among professionals across political boundaries. A good example of successful collaboration across political boundaries is the effort at Bosque del Apache NWR, a refuge well known for providing important wetland resources for wetland dependent waterbirds in New Mexico. Historically Bosque del Apache NWR along with other sites in the Middle Rio Grande Valley were stopover sites for migrating waterbirds winging south into the wetland rich areas of the Mexican Highlands.. Changes in distribution, timing, and energetic value of wetland and agricultural resources in the Middle Rio Grande Valley resulted in over wintering of some waterbird populations further north than occurred historically such as the entire Rocky Mountain Population of Greater Sandhill Cranes which now winters in southern New Mexico with few individuals venturing into traditional wetland wintering areas in Mexico. Biologist at Bosque del Apache NWR understood that the more information for annual conditions in Mexico guided the more effective distribution of food resources to maximize waterfowl use in New Mexico and to promote migration to Mexico. In the early 1990s, biologists from Bosque del Apache NWR began conducting annual wetland and agriculture surveys in Chihuahua, Durango, and Zacatecas with the goal to establish an enhanced working knowledge of habitat conditions in northern Mexico to coordinate with understanding wetland and crop energetic value throughout the Middle Rio Grande Valley in combination with management efficiency of Bosque del Apache NWR. This effort partitioned food resources to when and where birds most needed them in New Mexico. Because of this large scale effort, international relationships developed and evolved between colleagues of both nations. Collaboration with the University of Chihuahua and nonprofits like Profunda and DUMAC fostered questions that developed into graduate research programs that spanned international boundaries. Bosque del Apache NWR provided technical and monetary support for several Mexican students and conversely Mexico housed and supported students from several universities. International work and current efforts strive to further enhance the relationships across the international border through workshops, mentoring, and increased collaboration.

L.2.5: Goodman^

A Stiff Comparison: Comparing Time-Activity Budgets of Stiff-Tailed Ducks in Puerto Rico

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Puerto Rico harbors three taxa of stiff-tailed ducks: Masked Duck (*Nomonyx dominicus*), Northern Ruddy Duck (*Oxyura jamiacensis jamaicensis*), and West Indian Ruddy Duck (*Oxyura j. jamaicensis Gmelin*). These duck taxa are commonly located in the same wetlands and have similar niches, yet information is lacking about their behavior, habitat use, and niche partitioning. Time-activity budgets are useful in collecting this information and understanding species ecology. We collected 24 hour time-activity budgets on each taxa of stiff-tailed ducks in Puerto Rico from January to April 2015 by observing them for 5 consecutive minutes and recording a behavior activity every 10 seconds. The behavioral activities were classified using 8 categories: (1) Aggression, (2) Feeding, (3) Inter-dive loaf, (4) Resting, (5) Locomotion, (6) Courtship, (7) Comfort movement, and (8) Sleeping. We tested these 8 activities using multivariate analysis of variance for differences among taxa, between sexes, and among sampling times (3 diurnal and 3 nocturnal). We collected a total of 1,647 behavioral observations: Masked Duck n=93, Northern Ruddy Duck n=1,246, and West Indian Ruddy Duck n=308. Our results from the first of 2 field seasons indicate that all activities except aggression, inter-dive loaf, and courtship differed among taxa and sampling times, while the activities rest and sleep differed between sexes ($P<0.05$). The most common activity varied by taxa: Masked Duck (locomotion; 35.2%), Northern Ruddy Duck (sleep; 30.1%), and West Indian Ruddy Duck (rest; 33.1%). This comparison of preliminary data shows that the 3 taxa of stiff-tailed ducks behave differently. Another field season along with additional data analyses should yield valuable information to improve management and conservation of all 3 taxa.

L.2.6: Carrera-González

Closings Remarks: The Mexico Challenge in North American Waterbird Conservation

Eduardo Carrera-González[1]*, Alberto Lafón-Terrazas[2], Leigh H Fredrickson[3]

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Mexico faces many of the same challenges associated with habitat degradation throughout North America and around the globe. In the case of Mexico many of these changes have occurred recently and have progressed at a very rapid rate. These changes have important implications for the long term sustainability of habitats that support both resident and migratory species. To be a full participant in the migratory bird treaty Mexico is making a more concerted effort to engage in the conservation movement in many different ways but the challenges are great and resources are few. Foremost among these initiatives are the building of a professional core of individuals with adequate education and experiences to deal with this broad array of challenges. Within this framework the expertise provided by nations with a long and more comprehensive approach to conservation of the migratory bird resource is an essential ingredient for a more rapid development of programs in Mexico. This wrap up is an attempt to summarize these efforts and to identify key ways in which support is likely possible from within Mexico and from beyond its borders.

K.3: Population Dynamics (Chair: Matt Dyson)

K.3.1: Malachowski^

Seasonal and Annual Survival Rates and Cause-specific Mortality of the Endangered Hawaiian Duck

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The Hawaiian Duck (*Anas wyvilliana*) is the only endemic dabbling duck remaining in the main Hawaiian Islands. Relatively common during the early 1900s, the Hawaiian Duck has since experienced a significant population decline because of factors that include wetland loss, overharvest, introduced predators, and hybridization with feral Mallards (*Anas platyrhynchos*). Although we know the general causes of population decline, we know nothing about the relative importance of these threats or the particular period of the annual life cycle when their impact is most severe. A critical obstacle in developing population models and effective recovery plans for Hawaiian Duck involves the lack of information on key demographic parameters, such as seasonal adult survival rates and cause-specific mortality. During November 2012 – December 2014, we radio-tagged and monitored 117 adult Hawaiian Ducks (nfemale= 50, nmale= 67) on the island of Kaua'i to estimate sex-specific seasonal and annual survival, determine causes of mortality, and identify factors influencing survival. We captured birds during November-December 2012-2013 using baited swim-in traps at Hanalei National Wildlife Refuge, and we marked birds with coelomically implanted radio-transmitters with percutaneous antennas and mortality sensors. We monitored location, status, and habitat use at least twice per week from December 2012 to December 2014. We supplemented ground-based tracking with periodic aerial telemetry. For each bird location, we recorded habitat type, and we summarized habitat use for each individual by month and life history stage. Each bird was then categorized based on their primary habitat use for each month and life history stage. When mortality signals were detected or if mortality was suspected, we attempted to recover the carcasses as quickly as possible and determine cause of mortality by necropsy and external examination. We will format survival data into a live-dead encounter history and use known-fate analyses to estimate how survival rates vary with covariates. Individual covariates will include body condition index, life history stage, and primary habitat use. Based on the a priori model set and model selection results, we will use Akaike's Information Criterion values corrected for small sample sizes (AICc) and AICc weight to select the most parsimonious models. Based on competitive models, we will determine the amount of evidence for each covariate and estimate effect sizes. Model averaging procedures will be used to estimate bi-weekly survival, and derived estimate procedures will be used to estimate seasonal and annual survival for each sex. Similar to other *Anas*, we predict that females will have lower survival than males, particularly during the breeding season when females are likely more susceptible to predation at upland nesting sites. We also predict that both sexes will have lower survival rates during remigial molt due to increased vulnerability to predation. Last, we predict that mammalian predation will be a disproportionately high cause of mortality since these island-endemic dabbling ducks evolved in mammalian predator-free environments and may lack effective non-native predator avoidance behavior. An understanding of factors influencing adult survival will help inform wetland management efforts, predator control programs, and conservation plans for the endangered Hawaiian Duck.

K.3.2: Warren

Within-season and Carry-over Effects of Reproductive Effort on Survival in Female Lesser Scaup

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Costs of reproduction can occur either concurrent with a given reproductive activity (e.g., increased predation risk for females attending a nest), or in a sequential manner where an individual survives the reproductive event but is in a reduced condition that results in lower survival the subsequent season. We are using a 10-year data set of uniquely marked female lesser scaup (*Aythya affinis*) to explore hypotheses of within-season and carry-over effects of reproductive effort on seasonal survival. During 2005–2014 we marked 1913 female scaup (nasal-marker and band n = 1033; band-only n = 880) and conducted pre- and post-breeding season surveys to resight nasal-marked birds and recapture band-only birds. Measures of reproductive effort (water conditions and breeding propensity) and reproductive success (nesting success and hen success) were quantified annually; dead recoveries were received annually. We are using live encounters and dead recoveries in a multi-state capture-recapture framework to fit models of seasonal survival while accounting for marker loss. Our analysis will provide insight into the relative costs of reproduction, as well as information on temporal dynamics of female breeding season survival, an important demographic rate for lesser scaup.

K.3.3: Messmer^

Associations of Western Boreal Forest Duck Populations to Indices of Spring Phenology

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The western boreal forest (WBF) of North America supports 12 to 15 million breeding ducks annually, and >50% of the breeding populations of several species. The WBF's waterfowl habitat and populations were thought to be relatively stable, but this perception is changing in light of evidence that the region's climate, habitat, and duck populations are dynamic and changing. In particular, advancing spring phenology, as indexed by the duration of spring snow cover, has been shown to be correlated with population dynamics of some species like lesser scaup (*Aythya affinis*; the most abundant boreal duck). To further examine the relationship between spring phenology and duck population dynamics, we used an independent, satellite-observed, index of spring phenology, normalized difference vegetation index (NDVI), which has been successfully applied in other animal ecology studies. For each Canadian WBF survey stratum in the May/June Breeding Waterfowl Survey, we modeled the annual signal of NDVI and extracted several seasonal indices. Our objectives were to evaluate associations of these NDVI covariates to duck population dynamics. We predicted that (1) population growth of late-breeding species would be negatively related to early timing of the start and peak of NDVI-estimated growing season (as in previous studies that indexed phenology with snow cover duration), and (2) population growth rates of all species would be positively related to length of growing season, because longer growing seasons may increase time available for renesting and brood rearing. We also explored the possibility that growing season productivity (area under the NDVI-growing season curve) could be positively related to population growth, through bottom-up enrichment effects. In each case, interactions with latitude were considered, as it is expected that NDVI effects would be strongest at more northerly latitudes where mean growing season length is already very short, seasonality of prey is presumed to be stronger, and for which spring migration is the most protracted. Similar to other studies in the Canadian WBF, we did not observe overall decreasing trends in NDVI variables during the 1982 to 2013 period. For duck populations, we fit models representing Gompertz density dependent growth and controlling for mean survey date, to assess the effects of the NDVI covariates. In our preliminary analysis, estimated effects of NDVI-derived start of season and timing of peak did not clearly support the previous finding on differential responses of species based on timing of breeding. Counter to expectation, several species had negative responses to overall length of season and none were positive. Finally, variation in growing season productivity was weakly associated with only a few species' population dynamics. Overall, most statistically significant NDVI covariate effects were relatively small in magnitude and explained only a small amount of variation in population growth. Mean survey date appeared to be an important factor with a negative effect for several species. This could indicate asynchrony of survey timing and migration or nesting, or this methodological variable could be confounded with an important biological process. Species-specific responses, including implications and caveats will be discussed for the suite of NDVI covariates.

K.3.4: Sheppard^

Vital Rates of New Zealand Mallards

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Effective management of wildlife populations requires knowledge of population demographics, including parameters (e.g., vital rates) that affect population size and growth rate. Furthermore, identifying critical habitats required for various stages of the annual cycle (i.e., nesting, brood rearing) is necessary to implement effective management programs. Mallards (*Anas platyrhynchos*) are widely harvested in New Zealand and the primary driver of game bird license sales throughout the country. Yet, despite evidence of pronounced population declines in several regions of the country in the past decade, information regarding demographics of breeding mallards are lacking. We radiomarked 300 female mallards during 2014 and 2015 in two study areas in New Zealand to investigate breeding ecology and survival rates of females, nests, and ducklings. During the 10-month monitoring period, pre-nesting females were tracked three times a week, nests were monitored every 7–10 days, females with broods were tracked every 2–5 days, and post-breeding females were tracked weekly. We determined female age as either after second year (ASY) or second year (SY), and examined effects of female body condition and habitat variables (e.g., nest and brood-site characteristics) in relation to breeding propensity, clutch size, initiation date of the first nest, and daily survival rates of females, nests and ducklings. Mallards laid an average of 10.5 eggs, with larger, older females initiating nests earlier but laying less eggs than HY females. Breeding propensity was 96% and only a few structurally small, HY females did not breed. Some females initiated up to 4 nests and spent as many as 81 days laying or incubating eggs ($\bar{x}$ = 41.6, SD = 17.5). On average, 82% of females renested following failure of the first nest and 25% of females renested following brood loss. Throughout the 163-day nesting season, cumulative female survival rate was 76.5% with most deaths occurring during post-nesting (e.g., molt) or incubation. Nest survival averaged 56.1% and was positively associated with the number of surrounding roadsides. Females tended to nest along roadsides in dense nesting cover or hedgerows and along ditch banks, whereas females with broods tended to use effluent ponds, drainage ditches, and pastures. Duckling survival was low, but varied tremendously between study sites, averaging 15% in the Waikato site to 30% in the Southland site. In comparison to North American studies, New Zealand mallards had similar adult survival during the breeding season, greater nest success, but lower duckling survival. The extended breeding season in New Zealand allows for female mallards to renest frequently following failure of both nests and broods, but it is unclear whether high breeding propensity, double-brooding, and renesting efforts are enough to offset poor duckling survival rates. Future analyses will include vital rates presented here along with information pertaining to harvest rates and band returns in perturbation and population growth models to further understand factors that affect mallard productivity in New Zealand.

K.3.5: Leach

Probability of Mate Change and Its Effects on Demographic Rates of Black Brant

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Arctic-nesting geese, including black brant (*Branta bernicla nigricans*), have a perennial socially monogamous mating system, which we hypothesize results from fitness benefits of fidelity. We hypothesized that after brant switch mates survival and breeding probability may be reduced. Further, we predicted that newly formed pairs would have lower rates of mate fidelity than those having bred together previously. To examine these questions we used longitudinal data of color marked brant breeding at the Tutakoke River brant colony on the Yukon-Kuskokwim Delta, Alaska. From 1990-2014, we encountered 3,066 adult females and 3,055 adult males who had at least one marked mate during their lifetime. Of these, 904 (29.4%) females and 237 (7.8%) males switched mates and bred after being widowed or divorced. We estimated the fitness costs of mate change, for experienced breeders (> 2 previous breeding attempts), using the Barker robust design implemented in Program Mark via RMark. To estimate the probability of mate change we used multi-strata robust design models. We found that adult female survival declined from 0.90 (95% CI ± 0.01) for females breeding with a familiar mate to 0.85 (95% CI ± 0.01) for those having changed mates. Males suffered similar reductions in survival and generally survived at rates that were 2% lower than females. Similarly, the probability of breeding in year t+1 for individuals breeding with a new mate was reduced by 15% for females and nearly 50% for males. Mate fidelity in year t+1 was 0.88 (95% CI ± 0.02) for females and 0.95 (95% CI ± 0.02) for males breeding with a familiar mate in year t. As predicted mate fidelity was reduced to 0.65 (95% CI ± 0.14) for females and 0.80 (95% CI ± 0.15) for males, breeding with an unfamiliar mate in year t. In conclusion we report one of the few demonstrations of long-term fitness benefits of mate fidelity in a long-lived bird. We suspect that mate change results in individuals being unpaired for at least part of the winter thereby reducing their social status in wintering flocks and thus vital rates.

K.3.6: Riecke^

Response of Long-lived Waterfowl to Latitudinal Fitness Variation

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When faced with declining environmental conditions, organisms have three options: move, persist, or die. We use a model organism, the Pacific black brant (*Branta bernicla nigricans*), to examine how individuals and populations of long-lived waterfowl choose among these three options. The black brant is a small, sub-arctic and arctic-nesting goose, occurring in coastal estuaries and wetlands along the Pacific coast. Brant primarily breed on the Yukon-Kuskokwim River Delta (YKD), Alaska, where populations have declined substantially since the 1980's, and remain significantly below historic levels. Concurrently, the brant population on the Arctic Coastal Plain has increased, where gosling growth and post-fledging survival rates on the ACP are greater than those of brant fledged on the YKD. Pre-breeding, non-breeding, and failed breeders from the YKD use the ACP as molting habitat during summer, indicating knowledge of alternate habitats. Moreover, brant wintering distributions have shifted northward, potentially in response to environmental changes. A study of brant population ecology was initiated in 1984 at the Tutakoke River Brant Colony on the YKD. Since the projects inception, greater than 45,000 individual brant have been uniquely marked with tarsal bands, with greater than 100,000 subsequent recaptures, 65,000 non-breeding re-sights, and 2,000 hunter recoveries. Given the observed latitudinal fitness relationships, we used the Barker Robust Design in Program MARK to test for temporal trends in site fidelity and natal philopatry, which would potentially be indicative of an individual-choice based range shift. We did not detect temporal trends in site fidelity, which for adult females was constant, and essentially equivalent to 1. Natal philopatry was related to environmental conditions during growth. These findings have important implications for the conservation of long-lived waterfowl in the face of climate change, where life-history strategies may affect response plasticity to environmental change.

K.4: Harvest (Chair: Matt Chouinard)

K.4.1: Boomer

Analyzing the Relationship between Midcontinent Mallard Harvest and Survival Probabilities

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The relationship between annual survival and harvest is a key source of uncertainty in the harvest management of midcontinent mallards (*Anas platyrhynchos*). Consequently, current efforts to update the midcontinent mallard Adaptive Harvest Management (AHM) model set require reliable estimates of survival and harvest probabilities. While contemporary estimates of harvest probabilities are available from operational AHM protocols, estimating historical harvest probabilities is problematic because band reporting probabilities have varied over time and space in relation to changing band inscriptions and reporting methods. Our research objective was to estimate cohort-specific survival, harvest, and band reporting probabilities with a Brownie model that integrates all preseason band recovery information for midcontinent mallards marked from 1987–2014. We used a random effects parameterization within a hierarchical, Bayesian estimation framework to model temporal variation in reporting probabilities specific to each band inscription while explicitly modeling the process correlation between harvest and survival probabilities for each cohort. Similar to previous reward band investigations, we found that reporting probabilities increased significantly over the 1990's even for birds marked with AVISE and ZIP bands. Commensurate with the liberalization of harvest regulations, harvest probabilities for each age and sex cohort increased. Adult male harvest probabilities have averaged 0.09 (SD = 0.003) since 1987. Overall, annual survival rate estimates for juvenile males and females declined as harvest probabilities increased, suggesting evidence for additive harvest mortality (ρ = -0.67, -0.45, for juvenile males and females respectively). We found similar patterns for adult males (ρ = -0.35) but the evidence for adult females was not as strong (ρ = -0.11). Juvenile to adult harvest vulnerability ratios have increased for male and female midcontinent mallards, suggesting that the ratios used in AHM models should be updated. These results will provide the basis for updating population models for use in midcontinent mallard AHM.

K.4.2: Sedinger, B.^

Exploring Compensation in Duck Mortality: Do Harvest Regulations Really Matter?

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Compensation in the mortality process has been proposed as a population level response to exploitation by some species. In North America we have a rich, albeit relatively short, water-fowling tradition with hunters harvesting millions of ducks and geese every fall. Despite decades of modern harvest management and research, the response of populations to harvest is still not well understood. To explore this question in ducks, we conducted an experiment in Western Nevada from 2011-2014 where we manipulated daily bag limits for wood ducks (*Aix sponsa*) across years while maintaining a monthly capture-mark-recapture program that began in 2007. In 2011 and 2013, duck hunters were permitted 1 wood duck per day. In 2012 and 2014, duck hunters were permitted 7 wood ducks per day. First we looked at the influence harvest regulations had on direct recovery rates. We hypothesize that direct recovery rates will respond to changes in harvest regulations with more liberal restrictions resulting in higher harvest rates. Second, we analyzed capture-mark-recapture and band recovery data to explore how this wood duck population responds to annual variation in harvest pressure. We hypothesize that variation in harvest rates will result in no overall change in annual survival rates. If we observe a negative relationship between harvest rate and survival rate during the hunting season, we expect to see a positive relationship between the harvest rate during the preceding winter and survival during the following spring and summer. We analyzed these data using multistate framework in program MARK and included environmental and individual covariates to explore potential sources of variation in survival probability and harvest vulnerability. We estimated seasonal survival rates, encounter probabilities and transition probability from the non-hunting season to harvested state and from the hunting season to harvested state. This research sheds new light on our understanding of duck harvest dynamics and will help inform duck harvest management into the future.

K.4.3: Vaske

Improving the Accuracy of Self-reported Waterfowl Harvest Estimates

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Imprecision in respondent recall can cause response heaping or spikes in frequency data for particular values (e.g., 5, 10, 15). In human dimensions research, heaping can occur for variables such as days of participation (e.g., hunting, fishing), or animals / fish harvested. Distributions with heaps can bias population estimates because the means and totals can be inflated or deflated. Because bias can result in poor management decisions, determining if the bias is large enough to matter is important. This presentation introduces the logic and flow of a deheaping program that estimates bias in means and totals when people use approximate responses (i.e., prototypes). The program can make estimates even when spikes occur due to bag limits. The program is available online, and smooths heaps at multiples of 5 (numbers ending in 5 and 0) and 7 (e.g., 7, 14, 21), and produces standard deviations in estimates. The program is illustrated using 25 years of waterfowl harvest estimates from Illinois. Discussion focuses on improving the accuracy of harvest estimates for adaptive harvest management.

K.4.4: Deane1^

Harvest and Non-harvest Mortality Relationships for Lesser Scaup Breeding in Southwestern Montana

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Following improved wetland and habitat conditions across the prairie-pothole region, most focal duck species surpassed long-term population goals established within the North American Waterfowl Management Plan (NAWMP) in the mid-to-late 1990s. But lesser scaup (*Aythya affinis*), which breed throughout the Boreal Forest, the prairie-potholes, and inter-montane wetlands of the West, experienced a decline in abundance beginning in the mid-1980s and their population has since remained more than 20% below the NAWMP population goal for lesser scaup. Accordingly, considerable attention has been directed towards understanding what factors may be limiting their population, including the role of harvest. Lower Lake is part of Red Rock Lakes National Wildlife Refuge in southwestern Montana and is the site of a long-term, intensive study of lesser scaup ecology and demography. Here, lesser scaup breed at densities that are among the highest observed in North America despite some of the most variable and extreme conditions experienced by the specie throughout its breeding range. Preliminary Brownie model estimates (uncorrected for reporting rate) indicate that this population is harvested at rates similar to the continental population with juveniles being harvested at an annual average rate of 9.1% (95% CI = 7.7 - 10.7%) and adults at an average annual rate of 3.6% (95% CI = 2.2 - 6.1%). Since 2005, ~1,300 female and ~1,700 male lesser scaup have been banded on the study site and an additional ~1,000 females have been nasal-marked. In addition, ~1,400 resightings have been collected for nasal-marked hens at Lower Lake and ~340 dead recoveries of lesser scaup banded on the study site have been reported from Canada, the Continental U.S., and Mexico. Hierarchal, multi-state modeling techniques and the use of multiple data types, such as live resightings and dead recoveries, are useful for distinguishing sampling error from process co-variation between competing risks of mortality. Using these models and data from 2005 through the end of the 2015 hunting season, I will present (1) estimates of harvest and natural mortality rates for lesser scaup banded and nasal-marked on Lower Lake; (2) how non-harvest mortality varies in relation to harvest mortality; (3) an assessment of the degree to which harvest mortality varies in response to changes in hunting regulations. These results will be used to help inform lesser scaup harvest demography, a key structural uncertainty in current harvest models identified in the draft scaup conservation action plan.

K.4.5: Soulliere

Trends in North American Diving Duck Hunting Community with Focus on Scaup

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Scaup – lesser (*Aythya affinis*) and greater (*A. marila*) – are especially important diving duck species to North American hunters. We used waterfowl harvest and hunter-survey data to evaluate and compare distributional change in duck hunter numbers and related diving duck harvest. Numbers of duck hunters in the United States declined since the 1970s, driven primarily by declines in the Mississippi Flyway. However, the proportion of U.S. hunters harvesting ≥1 scaup annually increased during this 4-decade period, and the proportion of hunters harvesting a diving duck of any species increased substantially. Numbers of duck hunters in Canada declined starkly since the 1970s, whereas the proportion of Canadian hunters harvesting scaup and other diving ducks was relatively stable. The importance of diving ducks and scaup in individual hunter's harvest was relatively small compared to dabbling ducks, but diver importance varied over time and across regions in the U.S. and Canada. Although the proportion of successful hunters taking diving ducks has increased in the U.S. and remains stable in Canada, we found a downward trend for those "specializing" in diver hunting, particularly in historically important diver-hunting states and provinces of the Mississippi Flyway. We discuss implications of these changes and how they might be considered in harvest and habitat management to help sustain traditions associated with hunting scaup and other diving ducks.

K.4.6: Open

L.3: Conservation Planning (Chair: Kevin Ringelman)

L.3.1: Bartuszevige

Using Landscape Design to Develop a Waterfowl Conservation Plan

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Despite our best efforts, we are still losing wetland habitat at an alarming rate. Traditionally, we create conservation plans that reflect what the landscape and habitats once were; our intent is to go back to some arbitrary point in time. However, a rapidly changing climate has forced us to look forward and try to predict where conservation will be most needed in the future. Landscape design is a relatively new concept in the landscape ecology literature; it uses the science of landscape ecology (e.g., understanding pattern and process) to design landscapes that will meet conservation goals and provide for societal needs. The Playa Lakes Joint Venture has adopted a landscape design approach to update their conservation planning for playas to support stated NAWMP continental waterfowl goals. With input from partners, we hypothesized on the important drivers that would effect change on the landscape, modeled current and future scenarios, identified playas where conservation effort would best be spent and, with the broader partnership, identified conservation opportunities to bring the design to fruition. Our partnership identified tillage likelihood, wind energy development, oil and gas development, High Plains Aquifer depletion and climate change as the most important drivers in the western Great Plains. We developed tillage likelihood, wind development risk and oil and gas development risk models, based on published models. To understand climate impacts to agriculture in the region, we used National Agriculture Statistics Service crop data and World Bank data. The result is a cutting edge, progressive plan that allows our partnership to envision a future of playa conservation and achievement of the new NAWMP waterfowl goals, which spurred the development of innovative conservation opportunities.

L.3.2: Fleming, K.

Decision Support for Land Acquisition in the National Wildlife Refuge System

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One of the 3 primary conservation goals of the USFWS National Refuge System's (NWRS) new strategic growth policy is to acquire lands that contribute to the waterfowl population objectives of the North American Waterfowl Management Plan (NAWMP). We discuss the ongoing development of a science-based decision support tool (DST) to prioritize land acquisition to achieving NAWMP continental population objectives, and associated step-down objectives of the Migratory Bird Joint Ventures (JVs). This process consists of several steps. First, an interim decision tree was developed through collaboration with USFWS Migratory Bird Program staff, utilizing a combination of waterfowl survey data and population/habitat models to characterize landscapes in the US in terms of their potential to support populations of high-priority waterfowl species. Ranking criteria for breeding populations were based on waterfowl abundance; criteria for migrating/wintering populations were based on an index of harvest. Second, JV expertise was solicited through a structured decision making process and subsequent meetings with JV science coordinators, to refine ranking criteria and identify potential conservation planning datasets which could be incorporated into the tool as surrogates for abundance. These included food energy by land-cover type and wetland density. Third, collaborative data sharing relationships will be established between NWRS and the JVs, to provide ongoing data support for future funding allocation decisions. By leveraging JV expertise and data, the NWRS can acquire land more effectively to benefit priority waterfowl species in the US.

L.3.3: Doherty

Building the Foundation for International Conservation Planning for Breeding Ducks Across the US and Canadian Border

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We used publically available data on duck breeding distribution and recently compiled geospatial data on upland habitat and environmental conditions to develop a spatially explicit model of breeding duck populations across the entire Prairie Pothole Region (PPR). Our spatial population models were able to identify key areas for duck conservation across the PPR and predict between 62.1 – 79.1% (68.4% avg.) of the variation in duck counts by year from 2002 – 2010. The median difference in observed vs. predicted duck counts at a transect segment level was 4.6 ducks. Our models are the first seamless spatially explicit models of waterfowl abundance across the entire PPR and represent an initial step toward joint conservation planning between Prairie Pothole and Prairie Habitat Joint Ventures. Our work demonstrates that when spatial and temporal variation for highly mobile birds is incorporated into conservation planning it will likely increase the habitat area required to support defined population goals. A major goal of the current North American Waterfowl Management Plan and subsequent action plan is the linking of harvest and habitat management. We contend incorporation of spatial aspects will increase the likelihood of coherent joint harvest and habitat management decisions. Our results show at a minimum, it is possible to produce spatially explicit waterfowl abundance models that when summed across survey strata will produce similar strata level population estimates as the design-based Waterfowl Breeding Pair and Habitat Survey (r^2 = 0.977). This is important because these design-based population estimates are currently used to set duck harvest regulations and to set duck population and habitat goals for the North American Waterfowl Management Plan. We hope this effort generates discussion on the important linkages between spatial and temporal variation in population size, and distribution relative to habitat quantity and quality when linking habitat and population goals across this important region.

L.3.4: Laing

Waterfowl Brigades: Preparing the Next Generation of Conservationists

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Hunter numbers are declining at alarming rates. At the same time, an increasingly urban population with a lack of understanding for the natural world and how it functions is now the norm. Over 20 years ago Bobwhite Brigades was created to address both of these issues, and today continues strongly with 5 camp themes covering bobwhite, bass, buckskin, ranch, and waterfowl. It is a hands-on, wildlife intensive, youth leadership development camp that strives to put conservation leaders in every community. The motto for Brigades is, “tell me and I forget, show me and I understand, involve me and I remember.” That theme is central in all camps and they strive to put conservation professionals presenting information to kids from ages 13-17 every summer. The waterfowl brigades was developed five years ago and covers information on all topics relevant to waterfowl conservation. Topics covered include all aspects of biology, ecology, and management, along with shooting and hunting. A strong emphasis is put on habitat management in Texas, including plant identification and the concepts and principles of moist soil management. It is like an entire college level course presented in 5 days. A typical day at camp starts at 6:00am and isn’t over until midnight at the earliest. Along with the science, the kids are involved in leadership and team-building exercises throughout camp. The kids are all presented with the opportunity to return for a waterfowl hunt the following winter as well, and many are still hunting today. These youth will be leaders in our community in the future, and whether they stay with hunting or not, or pursue a degree in natural resource management or not, they are well aware of the challenges in the conservation world and will use this knowledge to assist them in decision making throughout their life.

L.3.5: Devney

Contract, Farm and Farmer Influencers on CRP Enrollment Decisions

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The Prairie Pothole Region (PPR) of the United States including parts of Montana, North Dakota, South Dakota, Minnesota and Iowa is the most important waterfowl production area in North America, covering approximately 185,000 square miles of wetlands. It is a rich habitat of many species although nearly half of the prairie potholes and surrounding grasslands have been converted for production. Fluctuations in commodity prices have been presented as the primary cause for this land-use turnover, including of land prior-enrolled in the Conservation Reserve Program (CRP). Program contract design and other factors also influence program enrollment decisions. To better understand this relationship, interviews were conducted with 87 farmers and ranchers throughout the PPR. Detailed feedback was gathered about the CRP and other programs and practices that influence waterfowl habitat in the region. A choice experiment was conducted during the interview process to specifically assess farmer design preferences for CRP contracts. An increase in the maximum allowable payment, length of contract, and the government's share of establishment cost increased intended enrollment, whereas, a fixed-term contract length and imposing land use restrictions on enrolled land decreased intended enrollment. Relative importance of contract attributes depended on farm and farmer characteristics and farmer attitudes and behaviors. For example, interviewees who expressed specific concerns in response to an open-ended question about the CRP including: differing guidelines for maintenance, inconsistent eligibility criteria, rules for mid-term management, and contract terms were less likely to enroll in CRP. Key lessons from the research include that (1) the right to hay or graze contract land is important for farmers in the region, particularly those with livestock; (2) an adjusted payment scheme may increase enrollment; (3) rental rate is important; and (4) farmer concerns can help explain program enrollment. A mail survey to 5,000 PPR landowners followed the interviews. It is currently underway; and the forthcoming data is expected to strengthen and broaden that from the interviews.

L.3.6: Ringelman

Estimating Carrying Capacity at Local Scales: A Case Study from Forsythe National Wildlife Refuge

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The management of North American waterfowl on the wintering grounds is based on the premise that the amount foraging habitat can limit populations. To estimate the carrying capacity of winter habitats, managers use bioenergetic models to quantify energy (food) availability and energy demand, and use these models as planning tools to meet regional conservation objectives. Regional models provide only coarse estimates of carrying capacity because habitat acreage, habitat energy values, and temporal trends in population-level demand are difficult to quantify precisely at large scales. Here, we take advantage of a wealth of detailed data collected on American Black Ducks (*Anas rubripes*) at Forsythe National Wildlife Refuge, New Jersey to create a detailed local model of carrying capacity. We used a meta-analysis of >2200 core samples collected from Atlantic coast habitats to estimate food supply and we used 24-hr black duck time budgets to estimate daily energy expenditure. We then estimated population-level energy demand by scaling a ground-survey-based migration curve to fit mid-winter waterfowl survey and aerial transect survey data. We also built migration curves and coarsely estimated population energy demand for other waterfowl to create a complete local carrying capacity model. Our results show that peak abundances of waterfowl in November approach the local carrying capacity of Forsythe refuge. This model allows for relative assessment of biases and uncertainties in carrying capacity modeling, and serves as a framework improving local and regional waterfowl management tools.

L.4: Contaminants, Disease, Genetics (Chair: Alan Leach)

L.4.1: Latty^

Prevalence and Potential Sources of Elevated Strontium in Waterfowl Eggs in Interior Alaska

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Studies have implicated strontium (Sr) as a contaminant of concern in avian population declines. Previous work on contaminants in eggs of waterfowl breeding in Interior Alaska found an inverse relationship between egg Sr concentrations and eggshell thickness and measurable levels of radioactive Sr in egg contents and shell. Strontium is a naturally occurring alkaline earth metal with no known biological function in birds. It is chemically similar to calcium, which can lead to substitution for calcium in tissues, affecting physiological processes and mechanical characteristics. We measured Sr concentrations in the eggs of five species of waterfowl in Interior Alaska at three locations. To determine potential sources, we compared eggshell chemistry with food and water chemistry at breeding sites. We also examined eggshell d13C and d15N to assess if trophic level and/or nutrient allocation strategy affected eggshell Sr concentrations. Preliminary data suggests eggshell Sr varied by species, site, and year and was related to local water chemistry and the nutritional strategy of the hen during egg production.

L.4.2: Miller, M^

Trace Elements in Eiders and Long-tailed Ducks of the Alaskan Arctic

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Increasing industrialization in the Arctic calls for collection of reference data for assessing changes in contaminant levels. For migratory birds, identifying and interpreting changes in trace element burdens on Arctic breeding areas requires insights into factors such as gender, body size, or wintering area that may modify patterns independently of local exposure. In the Alaskan Arctic, we determined levels of trace elements in liver and kidney of Pacific common eiders *Somateria mollissima v-nigrum* and long-tailed ducks *Clangula hyemalis* from the Prudhoe Bay oil field, and of king eiders *S. spectabilis*, spectacled eiders *S. fischeri*, and Steller's eiders *Polystica stelleri* from near the town of Barrow. Small-bodied Steller's eiders and long-tailed ducks from the different sites had similarly low levels of Se, Cd, Cu, and Pb, perhaps reflecting high rates of metabolic depuration during long spring migrations through areas of low exposure. Adult male spectacled eiders had much higher levels of Se, Cd, and Cu than did male king eiders of similar body size; however, these differences were not apparent in adult females, possibly because depuration into eggs and longer occupancy of non-marine habitats by females offset differing exposure at quite different wintering sites. Female common eiders at Prudhoe Bay had very high levels of Pb not seen in other species, likely resulting from local exposure. Reasons for substantial variations in Hg levels were not apparent. Future research should further explore reasons for variation among species and sexes to identify exposure routes leading to future changes.

L.4.3: England^

Helminths and Health of Spring-Migrating Lesser Scaup in the Upper Midwest

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The continental lesser scaup (*Aythya affinis*) population has declined for more than 40 years, and the breeding population has remained well below the goal of 6.3 million set by the North American Waterfowl Management Plan. Although many mechanisms have been proposed as factors in the decline of scaup (e.g., habitat degradation and loss, pollution, climate change), research indicates that females reach the breeding grounds in poor body condition due to the lack of adequate forage along spring migration corridors, particularly in the upper Midwest. Additionally, infection with exotic trematodes mediated by the invasive faucet snail (Bithynia tentaculata) may lead to further declines in body condition and the consequential deaths of thousands of lesser scaup annually. Remarkably, few researchers have examined the associations of intestinal helminths and health parameters in migrating lesser scaup. To date, most parasite assessment has been performed on birds that were found dead. For this study, the collection of random individuals across a continuum of body condition and parasite loads allowed us to examine sub-lethal effects of helminthiases. Our objectives were to 1) quantify and compare intestinal helminth infections; 2) examine body composition (i.e., protein and lipid content of carcasses) and blood parameters (i.e., plasma metabolites, packed cell volume, white blood cell differentials); and 3) compare these parameters with other metrics of waterfowl health and wetland condition for spring-migrating female lesser scaup. During the spring migrations of 2014 and 2015, we experimentally collected 130 foraging female lesser scaup, obtained blood and tissue samples, removed and preserved intestines, determined total lipids and protein from carcasses, and enumerated and identified all helminths in a 10% aliquot of intestinal ingesta. Preliminary analyses indicated that % carcass lipids ($F_{2,56}=4.87$, $P=0.01$) and packed cell volume ($F_{2,57}=10.78$, $P<0.001$) generally decreased with collection latitude. Plasma metabolites differed across regions in both years of the study, with the northernmost region having the lowest quality scores (2014 - $F_{14,88}=3.70$, $P<0.001$; 2015 - $F_{21,161.35}=1.71$, $P=0.035$). Further analyses suggest that intestinal helminth loads are indeed negatively impacting the health of lesser scaup in the upper pools of the Mississippi River where faucet snails are present. Most scaup collected from northerly pools of the Mississippi River were infected with the invasive trematode species *Cyathocotyle bushiensis* and *Sphaeridiotrema pseudoglobulus* and were typically in poorer condition than scaup without infections. Due to the complexity of host-parasite interactions, parasitism is often misunderstood and therefore overlooked as an influential regulator of wildlife populations. However, when parasitic infections result in the reduction of host survival and/or fecundity in a density dependent manner, the idea becomes plausible. To understand the effect of a parasite on a host population, one needs to understand the effect of a parasite on the individual host, the prevalence and intensity in the host population, and the context within which the interaction is occurring. These findings emphasize the need for continued investigations of the effects of parasites on waterfowl populations during critical periods of their annual cycle.

L.4.4: Spivey^

Influenza A Virus Dynamics in High-Latitude Wintering Populations of Mallards

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Mallards (*Anas platyrhynchos*) wintering in urban areas of Alaska provide a unique opportunity to study infection dynamics of influenza A viruses (IAVs) in a natural reservoir host. While previous studies support high infection rates of waterfowl in Alaska during autumn, infection dynamics throughout winter are unknown, and can be investigated due to the non-migratory nature of these populations. We screened Mallards captured in both Fairbanks and Anchorage, Alaska for active infections and previous exposure to IAVs, using molecular methods and a standard serologic assay. Additionally, we used a virus neutralization procedure to characterize the immune response of mallards found to be seropositive upon multiple capture occasions. A total of 500 birds were captured in Fairbanks during the fall/winter of 2012-2013 and 2013-2014, and a total of 699 birds were captured in Anchorage during the fall/winter of 2014-2015. Results from the winter of 2012-2013 in Fairbanks indicate rates (> 10%) of active IAV infection during the months of September, December, and April, highlighting the potential for circulation of IAVs during this time. Antibodies were detected throughout the August to April sampling period in both populations during all three years of the study. In both wintering populations of mallards, sero-prevalence increased from the first sampling period in August-September to subsequent sampling periods in fall/winter. The individual immune response of mallards, as characterized via virus neutralization, revealed instances of both sero-conversion and sero-reversion. Our results establish baseline information regarding influenza A dynamics during the wintering period in two understudied populations of mallards in Alaska.

L.4.5: Meixell^

Seasonal Prevalence of Influenza in a Reservoir Host: Waterfowl Life History and the Dynamics of Viral Flow

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Many pathogens show temporal patterns in transmission that are synchronous with the life cycle of their hosts. For example, avian influenza in migratory ducks is characterized by low levels of infection during winter and spring followed by a sharp rise in prevalence that peaks during late summer in correspondence with completion of the breeding season. To better understand the processes regulating viral flow across the seasonal rise and fall of influenza prevalence, we coupled results from intensive field surveillance at a high density waterfowl breeding area with phylogenetic network analysis of virus sequences. During 2008-2010, we captured and sampled approximately 20,000 ducks of 15 species throughout the ice-free season at a study site in Interior Alaska. We modeled variation of influenza prevalence relative to season date and a suite of host traits including species, age (duckling/juvenile/adult), and foraging behavior (dabbling/diving) to identify factors explaining variation in influenza infection. Using a subset of influenza-positive samples that yielded full genome sequences (n = 545), we characterized viral flow among hosts relative to sources of variation in prevalence. Prevalence was lowest in May and June during pre-nesting and nesting (<1%), moderate in July (4-8%) when ducklings accounted for the majority of infections, and highest for flighted juveniles (10-14%) and adults (6-10%) during autumn staging in August and September. Network analysis revealed that viral flow occurred primarily within species and age classes (i.e., duckling to duckling) during July, but as mobility of ducks increased later in the breeding season, viruses were increasingly connected across species and ages. Our results demonstrate a strong relationship between dynamics of viral flow and seasonal changes in waterfowl behavior, highlighting the role of young in virus transmission, and suggesting that virus dispersal is limited by host-host interaction during periods of reduced host mobility.

L.4.6: Lavretsky

Population Genomics and Hybridization between Lesser and Greater Scaup

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Estimating the frequency of hybridization is important when attempting to incorporate such interactions into conservation efforts. Along with the mitochondrial DNA (mtDNA) control region, 3,589 nuclear markers across the Z-chromosome (N = 140) and autosomes (N = 3,448) were isolated using ddRAD-seq methods to estimate the extent of hybridization between lesser (*Aythya affinis*) and greater (*A. marila*) scaup. Overall marker divergence was consistent with a scenario of genetic drift acting on markers with different effective population sizes. Population structure recovered across marker types followed current taxonomy, which included significant structure between lesser and greater scaup, no structure within lesser scaup, but differentiation between Eurasian and North American greater scaup subspecies. Estimated gene flow rates using autosomal markers suggested asymmetrical gene flow from lesser into greater scaup, which corresponded with mtDNA results in which four greater and one lesser scaup were found with introgressed mtDNA. Finally, methods were developed to mimic a breeding experiment in which empirical data was used to simulate a hybridization event (F1) and nine generations (F2-F10) of backcrossing to determine whether assignment probabilities of <99% were indicative of hybrid ancestry. In short, a total of four hybrid classes (i.e., F1, F2, F3/F4, and F5/F6) were distinguishable, with admixed histories effectively lost within the sixth generations of backcrossing. We concluded that the low interspecific assignment probabilities (range = 0.011 – 0.043) recovered for two lesser and nineteen greater scaup were consistent with the F4/F5 generation, which further supported asymmetric gene flow. These results suggest that although the two species are known to hybridize in captivity, the propensity to do so in the wild appears to be relatively low. In general, conservation efforts can benefit from these methods, which provide power for classifying hybrids and estimating the time until admixed histories are effectively lost, and thus “purity” restored.

Workshop: University-based Waterfowl Programs: Past, Present & Foresights - Presentations, Panel Discussion & Interaction with Audience (Organizers: Rick Kaminski, Bart Ballard, Warren Conway, J. Brian Davis, John Eadie, Jake Straub)

Richard M. Kaminski[1], Bart M. Ballard[2], Warren C. Conway[3], J. Brian Davis[4], and John M. Eadie[4]

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University students, faculty, and staff have made significant contributions in teaching, research, management, and outreach related to waterfowl and wetlands, and many of these students subsequently have served the waterfowl and other natural resources profession since the 1930s. We define university-based waterfowl programs as those offering courses in waterfowl and wetlands ecology and providing faculty-mentored research and outreach opportunities for graduate and undergraduate students. Despite global ecological and economical values of waterfowl, university-based waterfowl programs in North America have declined since the 1990s for various academic, administrative, and economic reasons. From a 2000 survey, the majority of 76 universities with natural resources curricula across the United States and Canada reported they employed ≥1 faculty who specialized in waterfowl ecology and management, but only half said they would seek another person with this expertise if their current faculty member departed the institution. A follow-up survey of the same universities in 2012 revealed that a further decline of about 20% has occurred. We all are affiliated with universities with endowed programs centered around or involving waterfowl, wetlands, and/or wildlife conservation. Our objectives for this special session are to: (1) present brief case-histories describing the teaching, research, and outreach vision, mission, and roles in each of our endowed programs; (2) discuss positive impacts of these roles on waterfowl and wetlands science and conservation and graduation of students into professional positions; (3) highlight accomplishments and frustrations, with suggestions for management or resolution of the latter; and (4) discuss needs for retaining existing and establishing additional university-based waterfowl programs in the future. Additionally, we will attempt to include a "perspectives" commentary by a donor(s) responsible for an endowment or a representative from a NGO which endorses continued need for these endowments to sustain this valuable university niche for waterfowl science and conservation.

Food and Drinks served at 18:30 in Caucus room

Presentations, Panelists, and interactions with the Audience will begin at 19:00.

Thank You Reception Sponsors

*Speaker; ^Student