G.4: Techniques 1 (Chair: Don Kraege)

G.4.1: Evenson

Employing Digital Still Imaging and Observer Counts to Estimate Bias in Aerial Surveys of Wintering Sea Ducks

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To better understand the bias in aerial survey abundance estimation that results from aircraft and observer effects, we conducted a study to estimate availability bias, detection, and misidentification by collecting images and observer counts of wintering sea ducks. We employed a fixed-wing aircraft with two digital still-image cameras and two observers to survey multiple 50m-wide strip-transects. A forward-facing (FF) camera attached to the wing strut captured images of the transect 250-300m ahead of the aircraft, while a point-of-view (POV) camera mounted to the rear window captured images of the transect abeam of the aircraft. Comparing the FF to POV camera counts allowed estimation of availability bias, or aircraft effect (the proportion of birds that flew out of the transect or dove due to the aircraft). Analyses suggested that 5-30% of sea ducks dove or flew off-transect as the aircraft approached: 5% for goldeneye, 20% for long-tailed duck and surf scoter, 25% for white-winged scoter, and 30% for bufflehead. Comparing the POV camera to observer counts allowed estimation of detection (the percentage of birds within the transect that were detected by observers) and misidentification. Estimates of birds detected on transects ranged from 50% to 95%, varying by species and observer, with long-tailed duck detection being slightly higher than other species. Misidentification of surf and white-winged scoters was about 1% and 4-6%, respectively. Our results suggest that, due to a combination of aircraft and observer effects, current survey estimates could be increased by a factor of 1.3 to 2.2 depending on species. We are developing methods for additional studies to address these biases, as well as effects of transect width and aircraft type.

G.4.2: Yetter

Comparison of Aerial Waterfowl Survey Methods during Fall and Spring Migration

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Illinois provides important stopover habitat for migratory waterfowl. Consequently, the Illinois Natural History Survey has aerially inventoried waterfowl since 1948. However, inventory-style monitoring does not yield detection probabilities or variance estimates and locations are not random making population estimation difficult. We evaluated aerial line transect surveys of diving ducks (*Aythyini*) on Pool 19 of the Mississippi River during springs 2013–2015 and assessed aerial quadrat (1-mi2) surveys of waterfowl along the Illinois River during falls 2014–2015. For comparison, we estimated waterfowl abundance along both rivers using inventory methods. We used Program DISTANCE to generate detection probabilities and populations sizes. Spring transect surveys in 2013 were oriented perpendicular to the river and tended to underestimate populations of diving ducks on Pool 19. Detection probabilities exceeded 50% with coefficients of variation <9%, but encounter rate was extremely low (≤0.005) and variable (CV = 5.2–28.5%). We oriented transects parallel to the river during spring 2014, and estimated duck densities were greater from transect surveys than inventories ($\bar{x}$ = 43%, CV = 117%) and densities ranged from 0.06–10.7 ducks/ha. We noted inventory and transect surveys produced similar population estimates for most species when abundances were 10,000–150,000, but differences were common and pronounced when inventory abundances were outside this range. Preliminary analyses indicated detection probability exceeded 50% during surveys with coefficients of variation <13%. Duck abundance extrapolated from density estimates from a quadrat survey conducted during peak fall migration indicated quadrats were 17% less than the traditional inventory (538,960 ducks) on refuges. Our results suggest transect surveys oriented parallel to the river were logistically feasible and produced reasonable population estimates. Overall, parallel transect surveys appear to be a viable option for further evaluation along rivers, and we suggest comparison to statistically valid quadrat surveys for estimating waterfowl abundance along river systems.

G.4.3: Otto

Modeling Observer Detection Rates in Aerial Surveys

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Detection rates are estimated as part of wildlife surveys to correct for animals missed. Usually the detection is the function of the crew, all the observers together. The counts in aerial surveys are usually corrected by counts from a more reliable platform or the ground. While there are differences among crews there are often also strong differences among observers in the same craft. These differences have often been modeled by multiple observer sampling; here we describe double sampling approaches using the side-by-side transect counts with a random effect for observers. These model-based approaches to estimation are increasingly used in survey analyses due to the increasing availability of statistical software such as WinBUGS. Accommodation of these differences are especially important when experienced observers or pilot have consistent counts year after year in annual survey are paired with different, much less experienced observer that change each year. We describe models appropriate for waterfowl survey designs using paired transects (i.e., counts from different sides of aircraft) associated with ground counts that may or may not be associated with the aircraft observer data. Examples presented include the California Waterfowl survey and the Western Gulf Breeding Waterfowl Survey. Careful consideration of pairing of sample units from ground and aerial counts in waterfowl surveys is needed to ensure that sufficient information exists for estimation using these model-based approaches.

G.4.4: Gilliland

Survey Design for Breeding Scoters: Helicopter vs. Fixed-wing

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Obtaining accurate estimates of population size from surveys is critical for effective management of populations. Current breeding ground surveys do not allow Scoter species identification and may suffer from biases related to detection. In this study, we assessed the effectiveness of helicopter surveys on 25 km^2 plots and fixed-wing surveys on 100 km long transects on a 22,000 km^2 study area in Labrador. We used a dependent double-observer approach to estimate detection probabilities from helicopters and distance sampling for the fixed-wing. Detection probabilities were high for the helicopter (0.99; 95% CI: 0.98-1.0), while detection probability for the fixed-wing was low (0.31; 95% CI: 0.27-0.36). Pair density estimates corrected for incomplete detection were similar between the two platforms for Black Scoters (~0.8 pr/km^2); however, the density for Surf Scoters estimated from the fixed-wing (0.05 pr/km^2; 95% CI: 0.03-0.10) was less than half that estimated from the helicopter (0.11± pr/km^2; 95% CI: 0.02-0.21). The species composition within the first 100 m distance band from the fixed-wing (46% Surf Scoter; 42% Black Scoters and 12% unknown scoters) was different with that recorded from the helicopter (69% Surf Scoters, 23% Black Scoters and 7% White-winged Scoters). These results suggest that Surf Scoters were often miss-classified as Black Scoters from the fixed-wing. Overall density estimates for scoters corrected for detection for scoters were 1.4 times greater when measured from the helicopter (0.23 pr/km^2; 95% CI: 0.22-0.24) than from the fixed-wing (0.16 pr/km^2; 95% CI: 0.11-0.22) suggesting that a larger proportion of the population was detectable from the helicopter than from the fixed-wing. Our results indicate that species identification from fixed-wing aircraft are not accurate and that detection probabilities are low. We suggest that procedures to estimate detection probabilities and unbiased assessments of species composition are necessary for Scoter species-specific population indices from aerial breeding-ground survey programs.

G.4.5: Roche

What the Four-Square-Mile-Survey Can Tell Us About Long-term Changes in Prairie Wetlands

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Many duck species breeding in the US Prairie Pothole Region (PPR) have demonstrated a preference to settle on partially vegetated wetlands (i.e. 'hemi-marshes'). However, wetlands in the PPR are sensitive to temperature and precipitation, making it likely the availability of the hemi-marshes preferred by breeding waterfowl will fluctuate over time. Since 1987, the ground-based Four-Square-Mile Survey (FSMS) has been used to produce estimates of breeding duck populations. While collecting duck counts, observers also were instructed to assign the vegetative cover type of surveyed ponds to one of four categories varying from nearly completely vegetated to no emergent cover. We used time-series data collected in South Dakota, North Dakota, and Eastern Montana (1987-2012) from ponds (n = 1,228) surveyed for at least 25 years (n = 31,758 pond-years) to describe how prairie wetlands had changed over time as measured by vegetative cover type. We then employed regression analysis to assess the relationship between wetland class and annual water level fluctuations and vegetative cover type. Except for temporary wetlands, prairie wetlands have generally become less vegetated and more open since surveys began in 1987. These changes have been the most pronounced for semi-permanent wetlands. Annual water level fluctuation partially explained vegetative cover type, but we suspect this relationship interacts with as of yet unexamined factors including wetland use, seasonal water level change, and wetland hydrology. For example, less vegetated wetlands may represent a shift toward deeper wetlands with implications for food availability and accessibility for breeding and staging waterfowl. Furthermore, less vegetated wetlands may reduce vegetative cover for overwater nesting and brood rearing ducks in the PPR.

G.4.6: Shaffer

Is the Waterfowl Breeding Population and Habitat Survey Conducted Too Early for Late-nesting Species?

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Since 1955, the internationally coordinated Waterfowl Breeding Population and Habitat Survey (WBPHS) has provided annual estimates of North American breeding duck numbers by species. The survey consists of a single aerial count accompanied by a count from the ground that provides a correction factor for birds not seen from the air. In the Eastern Dakotas (strata 25–49), timing of the survey (typically early to mid-May) coincides with onset of nesting for early nesting species, such as mallard (*Anas platyrhynchos*) and pintail (*A. acuta*) but precedes that of late-nesting species like lesser scaup (*Aythya affinis*) and gadwall (*Anas strepera*). The Four-Square-Mile Survey (FSMS) is a ground-based survey of breeding ducks that has been in existence since 1987. FSMS is a pond-based survey that utilizes both early (early to mid-May) and late (late May to early June) counts to arrive at estimates of breeding duck numbers. In an effort to understand if timing of the WBPHS introduces bias in estimates of late-nesting species, we compared population size estimates for the Eastern Dakotas from the FSMS between early and late counts for 10 duck species. We then relied on a database of duck nests (N=89,364) from the last 50 years to quantify the onset of nest initiation for the same species. We used results of that analysis to classify each of the 10 species as an "early" or "late" nester. We then correlated abundance estimates from the WBPHS with abundance estimates from either the early or late count from the FSMS, depending on whether the species was an early or late nester. A weak correlation for a late-nesting species may provide evidence that the WBPHS may be conducted too early to adequately determine settling patterns and breeding population size of that species.

H.4: Techniques 2 (Chair: Mike Buxton)

H.4.1: Hidden

How Many Birds Are We Missing? Assessing Waterfowl Distribution and Abundance in Missouri Using an Aerial Strip-transect Survey

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Wetlands at the confluence of the Missouri and Grand Rivers (GMR) in central Missouri can provide the necessary nutrients and refuge that migratory waterfowl require during autumn migration and wintering. The region contains four public wetland areas providing high quality wetland habitat for migratory waterfowl as well as a substantial number of recently restored wetlands on private lands. Although aerial surveys have been used to document fall and winter waterfowl use of public wetland areas for over 50 years, and have well documented waterfowl estimates, minimal effort has been dedicated to estimating waterfowl abundance and distribution beyond the boundaries of the intensively managed wetland areas. The goal of this study was to assess waterfowl abundance and distribution outside of public wetland areas in the GMR ecoregion in northern Missouri. We divided the ecoregion into four strata based on land cover variance and expected waterfowl density. Stratum 1 included area outside the GMR floodplain and beyond 30km of any public wetland area, Stratum 2 included area outside the GMR floodplain and within 30km of a public wetland area, Stratum 3 included the GMR floodplain within 30km of a public wetland area, and stratum 4 included the GMR floodplain beyond 30km of a public wetland area. We used a Geographic Information System to create a database of strip-transects oriented to avoid directly following land features such as rivers and valleys. To identify survey transects within each stratum we used a weighted random selection process, in which transects with greater wetland density had a greater selection probability. Three surveys were conducted using a fixed wing aircraft during fall/winter 2014 using a double-observer removal method where both observers kept observations separate until the survey was completed. We used window markers calibrated for 250-m transect width at 150-m height above ground level while maintaining a flight speed of approximately 150-km/hour to ensure consistency in detection probability. We estimated population indices (Î) and used Petersen estimates with a mark-recapture framework to correct population indices and estimate population abundance (N) for each stratum. Estimated waterfowl density was relatively low (0.01-0.27 birds/ha) and mean estimates of variance for both (Î) and (N) were relatively high (CV= 0.76 and 0.77 respectively). Stratum 3 had the greatest mean density of dabbling ducks (0.27 birds/ha). Mallards (*Anas platyrhynchos*) were the most abundant duck species observed among surveys with a mean density of 0.1 birds/ha among strata. Low density estimates and high variance among transect observations indicate that autumn and winter waterfowl distributions in northern Missouri are highly aggregated and spatially heterogeneous. Our findings suggest that wetlands outside public wetland areas can provide habitat for approximately 250,000 waterfowl during peak migration, representing up to 27% of the waterfowl population in the ecoregion. Our results emphasize the potential importance of wetlands outside intensively managed wetland areas in providing wetland habitat for migratory waterfowl, however based on our low density estimates and high variance we are exploring additional methods to reduce variance among and within survey strata.

H.4.2: Brown

Survey of Wetland Management Techniques in California – The 50 Buck Duck

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Migrating and wintering waterbirds of the Pacific Flyway depend on the wetlands of the Central Valley of California every fall, winter and spring. Of the remaining 120,000 hectares of wetlands, two thirds are privately owned, yet considerable uncertainty exits as to how these wetlands are managed. This information represents a critical need for conservation planning by the Central Valley Joint Venture given that the quality of wetland habitat is a direct result of the management actions implemented each year. To date, a systematic evaluation of the management practices implemented on private wetlands in California has not been completed. To address this need, we conducted the first comprehensive survey of wetland management techniques in use on 168 properties in California. The properties surveyed by our study comprise 26,716 hectares of California wetlands and $2,836,500 in annual management expenditures, ranging <$1,000 to >$50,000 with an average $18,910. Funds are used to perform manipulations such as summer irrigations (56.9% of participants), disking (86.6% of participants), and maintaining brood rearing habitat (80.5% of participants). Those managers performing the needed soil and water manipulations also experience increases in the average number of waterfowl harvested each year ($X2 = 53.36$, $P < .0001$). Our results indicate not only that private landowners are performing the needed management practices to produce quality wetland habitat and increase moist-soil seed production, but they are performing these actions at great personal cost averaging $50 per bird harvested.

H.4.3: Nicolai, C.

Geolocators: Breeding Probability and Movement of Three Species of Ducks

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Geolocators have had limited use in waterfowl even though they are commonly used on non-game birds. In western Nevada, we attached 16 and 48 geolocators on mallards and female wood ducks, respectively in 2013. We attached 50 additional geolocators on each of the following species in 2014/15: mallards, canvasbacks, and female wood ducks. For mallards and canvasbacks, we were interested in assessing what proportion of the annual cycle is spent in large scale habitats (i.e., joint ventures) and assumed that hunter recoveries would facilitate downloads of the geolocators. Based on band recoveries, we knew that the intensively monitored wood duck population in western Nevada did not disperse much from the study site (<17% of recoveries were away from study area), but we were interested in using geolocators to assess breeding propensity. Both annual releases of mallards were immediately before hunting seasons and 4 individuals were shot and reported as direct recoveries each year; no indirect recoveries have been obtained yet. Canvasbacks were fitted in February 2015 and have not yet been exposed to hunting. We have retrieved and downloaded 29 of the geolocators from the first cohort of wood ducks. Of those, 25 had year round data and showed 100% breeding probability. One of these individuals moved to breed in western Montana and returned to western Nevada and was recaptured. However, we were concerned as geolocatored wood ducks had to survive and be recaptured to provide breeding data.

H.4.4: O'Connell^

Backscatter-brained: Using Radar Imagery to Determine Wetland Inundation Patterns

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Monitoring wetland inundation is critical to the management and conservation of waterfowl. Different inundation regimes impact the biogeochemical processes and thus productivity of wetlands. Inundation, or lack thereof, can have an even more direct impact on waterfowl, waterbirds and shorebirds; if a wetland is not inundated during the period when one of those functional groups are in the area, then it is not available to that group. Relying on the National Wetlands Inventory (NWI) alone and lacking the data necessary to consider wetland availability during biologically important periods, managers may substantially underestimate the amount of wetlands needed to support waterfowl, waterbirds and shorebirds. Determining the timing and extent of Illinois wetland inundation is an important step towards making informed decisions in wetland management in the state. Ground surveys are labor intensive and optical remote sensing techniques struggle to accurately resolve wetland inundation where there is heavy vegetative cover. Synthetic aperture radar (SAR) has been used to detect inundation in multiple wetland cover types and may be an efficient method of recording inundation patterns in Illinois. A pilot study testing the use of SAR imagery to these ends was conducted on imagery of the Cache River watershed prior to the commencement of a state-wide survey in order to assess feasibility and identify potential pitfalls. Archival PALSAR L-band imagery was attained for four seasons over a one year period and was classified without ground survey to determine inundated wetlands. The results were compared to NWI and were compared among seasons. Inundated wetlands were detected to cover a much smaller area than the total NWI polygon area (46%), but seasonally matched the hydrologic record of the Cache River during the same time frame (R2 = 0.83). Only a small portion of detected inundation persisted throughout spring, summer and fall (17%), highlighting the ephemeral nature of inundation in the watershed during the period evaluated. Further analysis of SAR imagery with in situ validation is necessary to determine the accuracy of the technique. Beginning in spring of 2015, ground surveys crews have been mapping the extent of wetland inundation in ~90 wetland plots throughout Illinois. The ~50ha plots cover multiple cover types including forested, scrub/shrub, emergent and open water wetlands. Surveys are timed to coincide with the spring waterfowl migration, the summer waterbird nesting season and the autumn shorebird migration. The resulting thematic maps will be used to train and validate a random forest classification model of inundation from newly-acquired PALSAR-2 L-band imagery. Several image resolutions will be compared to determine the most cost-efficient method before the model is expanded to cover the entire state. Successful implementation of the model will allow managers to monitor inundation in the state's wetland at a level that was previously unattainable.

H.4.5: Webb

How Will Predicted Land Use Change Affect Mallard Spring Migration Stopover Ecology? Inferences from an Agent-based Model

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Habitat loss, habitat fragmentation, overexploitation and climate change pose familiar and new challenges to conserving natural populations throughout the world. One approach conservation planners may use to evaluate the effects of these challenges on wildlife populations is scenario planning. We developed an agent-based model to evaluate the effects of future land use and land cover changes on spring migrating dabbling ducks in North America. Our model was based on theoretical and empirical research for the mallard within a major stopover area in the Mississippi Flyway. We assessed the effects of three future climate scenarios (Intergovernmental Panel on Climate Change scenarios A1B, A2, B1) on mallard stopover duration, movement distances and mortality. We specifically focused on migration stopover duration because previous research has demonstrated that individuals arriving earlier on the nesting grounds exhibit increased reproductive fitness. Compared to present conditions, all three modeled scenarios predicted increased stopover duration and movement distances of agent mallards. Although all three scenarios presented migrating mallards with increased amounts of wetland area, scenarios also contained substantially less cropland, which decreased overall energetic carrying capacity of the study area. Furthermore, future climate patterns may alter spatial distribution of croplands in North America, increasing uncertainty regarding availability of waste grain as a food source to mallards. Predicted increases of wetland area within the study area may provide other dabbling ducks species with food resources of greater nutritional value compared to cropland. However, increased yearly variability in precipitation patterns due to climate change will pose new challenges to wetland managers and conservation planners within the next 50 years.

H.4.6: Laborde, Jr.

A Contrast of Alternative Survey Methodologies in the 2015 Survey of Louisiana Waterfowl Hunters

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We surveyed 2 random samples of 2,500 Louisiana waterfowl hunters each (random mail and mixed-mode methods), 24,842 waterfowl hunters for which we had e-mail addresses after drawing our random samples (e-mail method), and 1 convenience sample (open web method) following the 2014-2015 hunting season. We asked identical questions about waterfowl hunting effort, success, satisfaction, attitudes toward proposed regulations, and demographics. We hypothesized no statistically significant differences (≤ 0.05) between responses to the random mail and mixed-mode methods, but significant differences between the randomly selected methods and the e-mail and open web methods. We further hypothesized no difference between any of the methods in attitudinal responses. After elimination of duplicate responses, we received 603 usable responses to the random mail survey, 426 usable responses to the mixed-mode survey, 4,873 usable responses to the e-mail survey, and 1,480 usable responses to the open web survey. We randomly subsampled 426 responses from each survey method and compared results by methods using generalized linear models (GLMs) with Tukey-Kramer *post hoc* tests. In tests of 3 variables measuring effort and success, 6 variables measuring hunter satisfaction, 6 variables measuring attitudes towards proposed regulations, and 7 demographic variables, we identified no significant differences between the random mail and mixed-mode methods. We identified no significant differences between any of the 4 methods in responses to 6 attitudinal variables. Compared to the random mail and mixed-mode survey respondents, e-mail survey respondents were not significantly different in demographic variables, satisfaction, or regulatory preferences, but differed in days hunted and years of participation. Respondents to the open web survey were more avid, harvested more waterfowl, and were less satisfied with season dates. The cost per usable response for the random mail, mixed-mode, e-mail, and open web surveys were $85.41, $70.42, $0.36, and $1.18, respectively. Analysis of attitudes towards proposed regulations would lead to identical managerial conclusions irrespective of survey method.