Monitoring the Effects of Climate Change on Waterfowl Abundance in the Mississippi Alluvial Valley: Optimizing Sampling Efficacy and Efficiency

FY 2011

PROJECT DESCRIPTION

Given the potential for changes to wildlife distribution and abundance under various climate change scenarios, there is a need to effectively and efficiently collect indices of these metrics for wildlife populations. Wintering waterfowl, in particular, provide an excellent bellwether for the effects of climate change as changes in their abundance and distribution reflect both a direct response to climatic variables and an indirect response to climate change mediated through habitat alterations. The mallard is the most abundant duck in North America, and their numbers are often used as a surrogate to gauge the health of other waterfowl populations. The Mississippi Alluvial Valley (MAV) is an area of continental significance for migrating and wintering waterfowl under the auspices of the North American Waterfowl Management Plan, and the single most important region for wintering mallards. Therefore, MAV-wide monitoring of mallards (and other duck species) has the potential to provide some of the earliest indications of climate change impacts on wildlife.

OBJECTIVES AND ALTERNATIVES

1) Evaluate, design and conduct aerial surveys to estimate abundance precisely (coefficient of variation [CV] ≤ 15%) of wintering ducks (i.e., mallards, other dabbling ducks, diving ducks) within and among strata in the MAV of Arkansas, Mississippi, Louisiana, Kentucky and Tennessee during winter 2011-2012.
2) Assess the feasibility of developing a reliable visibility correction factor for detection of waterfowl during aerial surveys that can be applied within and among regions and years.
3) Develop a rapid method of using GIS for displaying waterfowl distribution and abundance within and among regions and years as determined from aerial survey data.
4) Evaluate the cumulative winter severity index (WSI) developed by Schummer et al. (2010) to predict waterfowl abundance using data collected in Arkansas during winters 2009-2011.

METHODS AND PROTOCOLS

A statistically robust stratified random sampling design for aerial surveys of mallards in the MAV was developed in the late 1980s and early 1990s; surveys based on this sampling design have been conducted by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) in the Mississippi MAV since 2005 and by the Arkansas Game and Fish Commission (AGFC) in the Arkansas MAV since 2009. However, changes in land use since the survey was designed may have made modifications of the original design necessary. We refined strata boundaries in Arkansas using USGS delimited watersheds as a guide in determining strata boundaries and surveyed the Arkansas MAV four times during winter 2011-2012 using this modified design. To evaluate the performance of this new design we compared three sampling designs: 1) simple random, 2) expert opinion-based strata (original design), and 3) watershed-based strata (new design). For each of the four survey periods and each of the three sampling designs, we calculated %CV of the estimated number of mallards and total ducks by bootstrapping the surveyed transects in each survey period 10,000 times each under each of the three sampling designs.

We also wanted to improve the accuracy of population estimates by developing a protocol to account for biases related to observer and habitat effects on detection. We chose the double-observer method because its relative low cost and ease of implementation made this method the most feasible for agency staff.

The Arkansas Cooperative Fish and Wildlife Research Unit recently developed a user-friendly, easily modifiable graphical user interface (GUI) that rapidly selects random transects by strata and generates files for input into computer programs and GPS units has greatly reduced the time staff spent preparing for the surveys. Even with the improved system for survey preparation, there was an additional need to further develop the GUI to quickly process and analyze the collected survey data.

DATA MANAGEMENT

The GUI was developed using program R and the outputs can be formatted as text or Excel files and the shape files can be exported as shapefiles or tiff files. The data are located at the Arkansas Game & Fish Commission.

DATA ANALYSIS / MODELS

We modified a previously created GUI in R that could quickly select random transects for surveys and also quickly analyze the collected data. Estimates of variance in stratified random sampling can also be computational complex so use of this GUI reduces the amount of time and statistical expertise required by users. We added additional features to the GUI such as the ability to create kernel density estimates, a data check to locate errors in data input, the ability to estimate abundance and variance by species group (e.g., all ducks combined), the ability to correct numbers of ducks observed for detectability, and generated a shapfile of the transects when new random transects were selected.

ACCOMPLISHMENTS AND MANGEMENT IMPLICATIONS

The %CV for all ducks and mallards was lower under the new watershed-based stratified random sample than under either the simple random or expert-based designs during all four survey periods. The watershed-based sampling design also estimates waterfowl abundance at a finer resolution using biologically meaningful strata.

Detection in closed canopy habitats (obs1 =0.36, obs2=0.86) was lower than detection in open canopy habitats (obs1 =0.88, obs2=0.99). Adjusting estimates for detection increased estimates of mallard abundance by a mean of 27% (SE = 7%) and total ducks by 24% (SE = 7%). The large variability in the magnitude (range 7 – 71% for all ducks) of the effect of adjustment appeared to have been due to variation in the percentage of ducks observed in closed canopy habitat (range 3 to 32%). Because detection was lower in closed canopy habitat, counts in closed canopy habitat had more impact on the population estimate than the same size count in open canopy habitat.

In evaluating the effects of the WSI on duck abundance in the Arkansas MAV, we found for dabbling ducks other than mallards, no model performed better than the null and only models containing year had strong support for diving ducks. The best model for predicting mallard abundance contained the WSI for the Arkansas MAV (w_i = 0.88). Mallards occurred in higher numbers when the weather conditions within the MAV were more severe. Number of all ducks combined also had a positive relationship with the WSI in the MAV but evidence for this relationship was not as strong (w_i = 0.48) and was likely driven by the inclusion of mallards. For mallards, there were a predicted 0.5 (95% CI 0.0 to 1.1) million mallards present within the Arkansas MAV with the mildest WSI and a predicted 2.7 (95% CI 2.1 to 3.3) million mallards during the most severe WSI.

PARTNERS

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MORE INFORMATION

Information from this project can be viewed at:

http://www.agfc.com/resources/Pages/ResourcesScientificReports.aspx

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