U.S. Fish & Wildlife Service

Webless Migratory Game Bird Program

Project Abstracts – 2009

Cover Photographs: Graduate student Chad August (left) and technician James Gardner (right), from the University of Nevada Reno, gather data at a sandhill crane nest discovered during the summer of 2009 in northeast Nevada. *Inset:* The egg floatation method was used to determine incubation stage of sandhill crane eggs. *Photos courtesy of University of Nevada Reno*

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Compiled by Tom Cooper
Project Officer

U.S. Fish and Wildlife Service
Division of Migratory Bird Management
1 Federal Drive, Room 501
Fort Snelling, MN 55111

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HISTORY AND ADMINISTRATION OF THE WEBLESS MIGRATORY GAME BIRD PROGRAM, 1995-2009

THOMAS R. COOPER, U.S. Fish and Wildlife Service, Office of Migratory Bird Management, BHW Federal Building, Room 501, Fort Snelling, MN 55111, USA
DAVID D. DOLTON (retired), U.S. Fish and Wildlife Service, Office of Migratory Bird Management, PO Box 25486 DFC, Denver, CO 80225-0486, USA

Introduction

The Webless Migratory Game Bird (WMGB) Program is an outgrowth of the WMGB Research Program (1994-present) and the WMGB Management Program (2007-present). The revised WMGB Program was designed to provide cooperative funding for both research and management activities from the U.S. Fish and Wildlife Service (USFWS), state wildlife agencies, and other sources for projects benefitting the 16 species of migratory game birds in North America (Table 1).

Table 1. The 16 species of migratory shore and upland game birds eligible for funding through the Webless Migratory Game Bird Program.

Common Name	Scientific Name
King Rail	*Rallus elegans*
Clapper Rail	*Rallus longirostris*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Purple Gallinule	*Porphyrio martinica*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*
Wilson's Snipe	*Gallinago delicata*
American Woodcock	*Scolopax minor*
Band-tailed Pigeon	*Patagioenas fasciata*
Scaly-naped Pigeon	*Patagioenas squamosa*
Zenaida Dove	*Zenaida aurita*
Mourning Dove	*Zenaida macroura*
White-winged Dove	*Zenaida asiatica*
White-tipped Dove	*Leptotila verreauxi*

History

The WMGB Program is an outgrowth of several funding initiatives, both past and present. The first effort was the Accelerated Research Program (1967-1982). Congressional funding of the ARP was $250,000 annually. Of this total, $175,000 was contracted to states: $50,000 was used directly by the USFWS to support 2 field stations to study woodcock and doves; and, $25,000 was retained by the USFWS to administer the program. The ARP ended when funding for the program was eliminated due to USFWS budget constraints in 1982. In 1984, the International Association of Fish and Wildlife Agencies (now AFWA) formed the Migratory Shore and Upland Game Bird (MSUGB) Subcommittee. One goal of the subcommittee was to reinstate a webless game bird research program. To accomplish this goal, the subcommittee documented the past accomplishments of the ARP and lobbied for reinstatement of a webless research program. The efforts and persistence of the MSUGB Subcommittee came to fruition in the fall of 1994 when funding became available. The new program was titled the WMGB Research Program. Projects were selected for funding beginning in 1995 with funding being obligated for the entire project. Detailed information about the history of the ARP and WMGB Research Programs can be found in Dolton (2009).

The WMGB Research Program was funded at various levels during 1995-2006; however, funding was suspended due to budget limitations in 2003 and 2004. Funding was reinstated in 2005 at a level of $250,000/year, with $30,000 of the total being obligated for webless projects in USFWS Region 5 (Northeast U.S.). In 2007, The USFWS received additional funding for MSUGB work ($487,000/year). The primary purpose of the new funding was to address the management needs of MSUGB. From 2007-2009, funding was directed towards supporting mourning dove banding in several states and other management related projects for woodcock, rails, and sandhill cranes.

Another key contribution made by the MSUGB Committee was the publication of the book entitled *Migratory Shore and Upland Game Bird Management in North America* (Tacha and Braun 1994). This was a revised and updated version of the book edited by

Sanderson (1977). Priority research and management activities identified in these books served as a tool for evaluating proposals submitted to the WMGB Research Program for funding.

AFWA's MSUGB Working Group (formerly MSUGB Subcommittee) provided key support in acquiring the additional funding. Due to the addition of funding for management-related projects (as opposed to research only projects), cooperators made the decision to drop "research" from the title of the WMGB Program.

The MSUGB Working Group created the MSUGB Task Force in 2006 in order to update the priority research and management needs identified in Tacha and Braun (1994) and to develop funding strategies for the identified priorities. The task force decided that the best method to identify priorities and estimate costs for completing the priorities was to convene a series of workshops for the webless species identified in Table 1. The workshops were designed to include broad representation from experts (e.g., federal and state agencies, conservation organizations, and university researchers) for each species-specific group. To date, the MSUGB Task Force has completed strategies identifying priority information needs for:

(1) mourning and white-winged doves, (2) hunted rails and snipe, (3) sandhill cranes, (4) American woodcock, and (5) American coots, purple gallinules, and common moorhens. The final workshop covering the remaining species (Zenaida doves, white-tipped doves, scaly-naped pigeons, and band-tailed pigeons) is scheduled to be completed in early 2011. The completed priority information-need strategies are available on-line at: www.fws.gov/migratorybirds/NewReportsPublications/Research/WMGBMR/WMGBMR.html.

These webless funding programs have proved to be invaluable in providing much-needed funding for webless species that receive considerably less attention than waterfowl. To date, cooperators have completed a total of 84 research and management related projects supported by $3.8 million in WMGB Research and Management Program funds. The WMGB Program funds have generated matching contributions of $8.0 million from cooperators for a total $11.8 million being expended on webless species (Table 2). Projects completed through the program have resulted in improved knowledge and management of webless migratory game birds. Previous annual abstract reports containing results of projects completed through the program are available on-line at www.fws.gov/migratorybirds/NewReportsPublications/Research/WMGBMR/WMGBMR.html

Table 2. Summary of projects funded through the Webless Migratory Game Bird Program, 1995-2010.

Species Group	No. of projects	WMGBP Funds	Matching Funds	Total Project Cost
Doves and Pigeons	34	$1,719,176	$3,448,116	$5,167,292
American Woodcock	11	$738,964	$1,521,457	$2,260,421
Sandhill Cranes	13	$536,001	$1,570,511	$2,106,512
Hunted Rails and Snipe	19	$725,429	$1,407,310	$2,132,739
Webless Workshops[a]	7	$108,787	$27,714	$136,500
Total	84	$3,828,357	$7,975,108	$11,803,464

[a] Includes a series of 6 workshops held during 2008-10 where priority information needs for webless species were updated

Program Administration

The USFWS Project Officer for the WMGB Program distributes an annual request for proposals (RFP) in May to USFWS Flyway Representatives, Regional Migratory Bird Coordinators, USGS-Biological Research Division (BRD) Regional Offices, and the USGS Cooperative Research Units office. In addition, the funding opportunity is posted at: www.grants.gov.

Flyway Representatives are responsible for distributing the RFP to biologists in their respective states. State biologists, in turn, are asked to send the information to other state personnel, universities, and any others who may be interested. Migratory Bird Coordinators forward the letter to National Wildlife Refuges and other federal offices. USGS-BRD Regional Offices are asked to forward the RFP to all their respective Science and Technology Centers, while the Cooperative Research Units office distributes the RFP to all Cooperative Fish and Wildlife Research Units. Funding proposals may be submitted for any webless migratory game bird identified in Table 1. Proposals may be orientated toward research or management-related projects. At least 1/3 of the total project cost must come from a funding source other than the WMGB Program. In-kind services, such as salaries of state employees and vehicle expenses, are acceptable as matching funds. Additionally, a letter of support is required for each proposal from the state in which it originates. Proposals for the program are due by November 1 each year.

Four regional review committees (Fig. 1) that follow the boundaries of the North American Flyways (Fig. 2) rank all proposals submitted to the program. The Flyway-based committees are composed of individuals with knowledge of the research and management needs for these species. The chairperson of each Flyway-based review committee serves on a National Review Committee (NRC), which makes final project selections based on input from each Flyway-based committee. The NRC is composed of the Flyway-based Chairs, the U.S. Fish and Wildlife Service Program Manager, and Representatives from the Migratory Shore and Upland Game Bird Support Task Force. The NRC evaluates and ranks proposals based on how well the proposals address the priority information needs that have been identified for the 16 species of Migratory Shore and Upland Game Birds (see Appendix A for specific priorities). After project selection, the NRC is responsible for developing an explanation documenting why successful projects were selected for funding. In addition, the NRC provides unsuccessful applicants with comments on why their project was not funded.

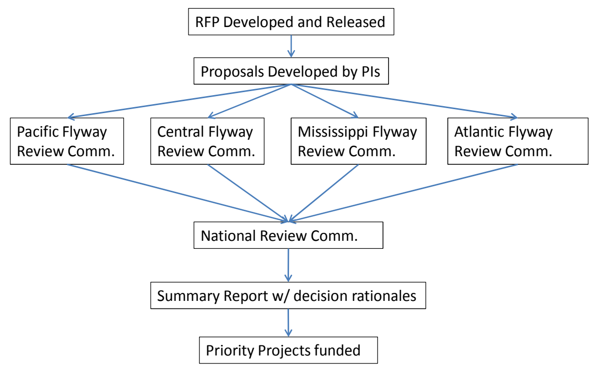

Figure 1. Diagram of review process for the Webless Migratory Game Bird Research and Management Program.

Figure 2. Map of North American Flyway boundaries in the United States. Proposals working with the 16 species identified in Table 1 will be accepted from throughout North America.

Literature Cited

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Appendix A – Priority Information Needs for Migratory Shore and Upland Game Birds

To date, priority information needs have been developed for the following groups: 1) mourning and white-winged doves; 2) hunted rails (sora, clapper, king, and Virginia) and Wilson's snipe; 3) sandhill cranes; 4) American woodcock; and 5) American coots, common moorhens, and purple gallinules. Priorities for band-tailed pigeon, scaly-naped pigeon, Zenaida dove, and white-tipped dove have yet to be developed, and will be available next year. Proposals should address the priorities listed below for each species group. A full description and justification of each priority is available on-line at <www.fws.gov/migratorybirds/NewReportsPublications/Research/WMGBMR/WMGBMR.html>.

Mourning and White-winged Dove Priorities:

- Implement a national banding program for doves
- Implement a national dove parts collection survey
- Develop independent measures of abundance and/or trends for doves
- Create a database of predictors of dove vital rates

Hunted Rails and Wilson's snipe Priorities:

- Implement a national monitoring program
- Continue to improve the Harvest Information Program sampling frame
- Improve the rails and snipe parts collection survey
- Estimate vital rates to support population modeling

Sandhill Crane Priorities:

- Improve Sandhill Crane Harvest-Management Decision Structures
- Improve the Eastern Population Sandhill Crane Survey
- Better understand distribution and population trends for sandhill crane populations in the west
- Assess Effects of Habitat Changes on the Rocky Mountain Population of Sandhill Cranes
- Improve Population Abundance Estimates for the Mid-Continent Population of Sandhill Cranes

American Woodcock Priorities:

- Develop a demographic-based model for assessing American woodcock population response to harvest and habitat management
- Develop communication strategies to increase support for policies and practices that benefit American woodcock and other wildlife of young forests
- Improve understanding of migration, breeding, and wintering habitat quality for American woodcock
- Improve the American woodcock Singing-ground Survey

American Coot, Common Moorhen, and Purple Gallinule Priorities:

- Implement a national marshbird monitoring program
- Support National Wetlands Inventory updates and improvements
- Continue to improve the Harvest Information Program sampling frame
- Determine the origin of harvest in select high harvest states in order to help inform monitoring programs

Webless Migratory Game Bird Research Program Projects
Progress to Date

Mourning Doves

MOURNING DOVE DEMOGRAPHICS AND HARVEST MANAGEMENT IN AN AGROFORESTRY COMPLEX

JOHN H. SCHULZ, Missouri Department of Conservation, Resource Science Center, 1110 South College Avenue, Columbia, MO 65201 (John.H.Schulz@mdc.mo.gov)
JOSHUA J. MILLSPAUGH, School of Natural Resources, University of Missouri-Columbia, 302 Anheuser-Busch Natural Resources Building, Columbia, MO 65211
THOMAS W. BONNOT, School of Natural Resources, University of Missouri-Columbia, 302 Anheuser-Busch Natural Resources Building, Columbia, MO 65211

Final Report

The National Mourning Dove Strategic Harvest Management Plan describes future harvest management decisions being based upon mechanistic population models, requiring modern estimates of demographic characteristics (e.g., recruitment, survival). Broad spatial scale estimates of survival and recruitment can be obtained from a sample of banded individuals along with a sample of wings from hunter-killed doves. However, the impacts of intensively harvested local populations are uncertain. Therefore, our objectives are (1) to estimate local mourning dove population characteristics (e.g., recruitment, survival) and local harvest characteristics (e.g., harvest rates, crippling rates) during 2005-2010, and (2) evaluate agroforestry practices while determining the efficacy of associated number of sunflower fields and field size to attract mourning doves for harvest on James A. Reed Memorial Wildlife Area (JARMWA) during 2005-2010. Knowledge generated from this multifaceted project will also guide management decisions for private landowners combining agroforestry practices and managed dove hunting fields, provide information about relationships between observed recruitment from radio marked doves and fall age-ratios from hunter-killed doves, provide comparisons of actual and reported crippling rates during the hunting season, and provide information on harvest rates on a heavily harvested local population of mourning doves. This year's abstract focuses on estimating recruitment on JARMWA along with estimates from seven other public conservation areas in Missouri.

We estimated recruitment of doves using a dual-ratio method which is suitable when juveniles and adults are distinguishable but assignment of individuals to sex is not readily possible in the juvenile age class. This method uses maximum likelihood estimation to solve the joint likelihoods of sex and age ratios from two survey periods (or data collection periods). The first survey estimates the sex ratio of adults in the breeding population, and the second survey estimates the ratio of juveniles to adults after recruitment is assumed to have occurred. Recruitment ($\hat{P}$) is estimated by:

$$\hat{P} = \frac{\hat{R}_2 + \hat{R}_2 \hat{R}_1}{\hat{R}_1}$$

Where $\hat{R}_1$ is the ratio of adult females to males in the first survey and $\hat{R}_2$ is the ratio of juveniles to adults in the second survey. Recruitment is expressed as the number of young per adult female in the population. Additional assumptions include: 1) all animals, males and females, have independent and equal probabilities of detection in the first survey; 2) all animals, adults and subadults, have independent and equal probabilities of detection during the second survey; 3) detection probabilities can be different between survey periods; 4) survival probability of adults is 1.0 between the two surveys; 5) juveniles recruit into the population with a sex ratio = 1.0.

A total of 6,651 doves were banded during 2005-2008 on eight public conservation areas in Missouri. Approximately half of the doves were of unknown sex either because the sex could not be determined or they were of HY status (Table 1). Of those AHY doves for which sex was determined, most were males (Table 1). A total of 30,808 wings were collected during the first two days of the hunting season from all areas over all years. Recruitment estimates were mostly high and variable across areas, thus our desire to look at statewide estimates (Table 2). The high variability in recruitment estimates is directly linked to variability in the sex and age ratios prior to, and at harvest, and uncertainty related to estimating the relatively small spatial extent of a migratory bird population.

Statewide estimates appear reasonable (with the exception of the 2007 estimate of 9.28 young/female), but local estimates from only a portion of the study appear valid and are within the range other productivity data for mourning doves across their range. Higher recruitment estimates could be due to a violation of assumptions through sample size or environmental driven bias or variability in preharvest and harvest sampling efforts. Because recruitment estimates are driven by sex and age ratios, bias in sampling can overestimate recruitment. The dual ratio estimator appears sensitive to estimates of preharvest sex ratios, in particular, the number of females captured preharvest (Figure 1). Harvest sample sizes might also affect estimator accuracy as age ratios become more variable with decreasing harvest. Based on these issues, sample size goals should be set at levels that may avoid inaccurate sex and age ratios. Although pooling data to obtain a statewide estimate of recruitment reduced variability enough to provide a more consistent estimate of productivity in the region, it may be important to investigate what processes are creating local variation in recruitment estimates.

These are preliminary results from the first 5-years of a 5-year field project; we anticipate one more year for analysis and reporting. The project is a cooperative venture including the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service), University of Missouri's Center for Agroforestry, University of Missouri School of Fisheries and Wildlife Sciences, U.S. Forest Service - North Central Forest Experiment Station, and Resource Science Division of the Missouri Department of Conservation.

Table 1. Sex and age structure of mourning dove populations at 8 areas managed by the Missouri Department of Conservation from 2005-2008[a]. Preharvest banding efforts recorded the number of after hatching year female (AHY_f) and male (AHY_m) doves and harvest wing collections observed numbers of hatching year (HY) and after hatching year (AHY) birds. Sex (R_1) and age (R_2) ratios were used to estimate annual recruitment for each area in addition to statewide estimates based data pooled across areas.

	Preharvest Banding			Harvest Wing Survey		
YEAR	AHY_f	AHY_m	R_1	HY	AHY	R_2
2005	143	404	0.35	1839	1218	1.51
2006	223	452	0.49	2391	1600	1.49
2007	97	488	0.20	1729	1124	1.54
2008	193	540	0.36	1636	1240	1.32

Table 2. Recruitment estimates (and standard error) for eight areas estimated statewide across Missouri during 2005-2008.

	2005		2006		2007		2008	
Statewide[b]	5.78[†]*	(0.47)	4.52[†]*	(0.29)	9.28[†]*	(0.93)	5.01[†]*	(0.36)

[a] Estimates not available for all areas in all years.
[b] Based on data pooled across areas in each year.
[†] Based on harvest sample size of ≥ 1000 wings.
* Based on preharvest sample of ≥ 100 AHY captures.

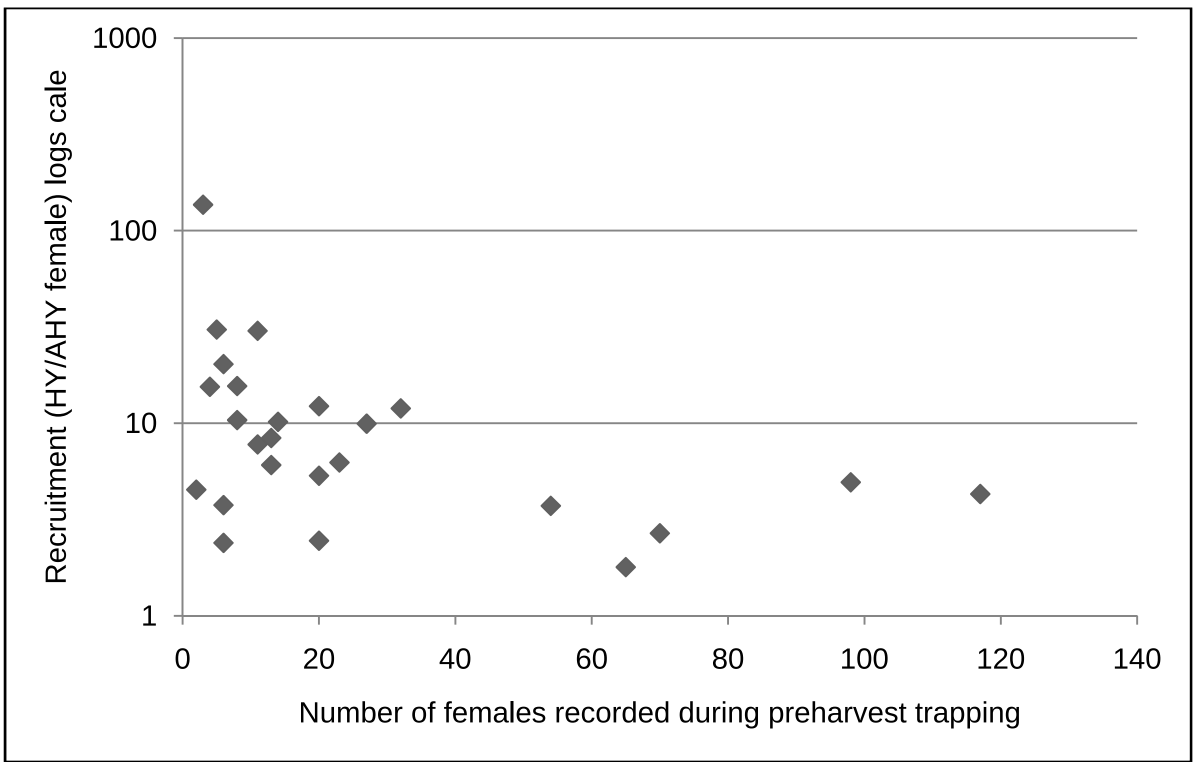

Figure 1. Sensitivity of recruitment estimator to low rates of after hatching year (AHY) female capture in preharvest survey.

DEVELOPMENT AND EVALUATION OF METHODS FOR REGIONAL MONITORING OF MOURNING DOVE RECRUITMENT

DAVID L. OTIS, U.S. Geological Survey, Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, IA 50011. (dotis@iastate.edu)

DAVID A. MILLER, Department of Natural Resource Ecology and Management and Ecology and Evolutionary Biology Program, Iowa State University, Ames, IA 50011. (millerda@iastate.edu)

Graduate Student: David Miller (Ph.D.); **Final Report**

Introduction and Objectives

Increased recognition of the importance of sustained recreational use and conservation of the mourning dove (dove; *Zenaida macroura*) has motivated a coordinated effort by state and federal agencies to improve the data sources and analytical tools necessary for informed harvest management. The Mourning Dove National Strategic Harvest Management Plan recognizes 1) the need to improve the knowledge base used for managing harvest of this important game bird and 2) the role of large-scale and long-term monitoring programs in meeting these information gaps. As part of this effort, our project addresses several objectives related to the establishment of long-term national program for monitoring of annual population recruitment.

Parts collections are a traditional method for estimating fall age ratios for game bird species. However, before a reliable operational wing survey can be implemented for doves, a number of issues needed to be addressed. These include the need to calibrate harvest wing age ratios to produce an estimate of true age ratios, to evaluate the efficiency of different sampling protocols to meet the information needs for doves, and to validate the accuracy of age ratio estimates using independent data. Finally, there is a continuing need to increase our understanding of the basic breeding biology of the species, which will in turn assist with interpretation of recruitment estimates.

The following objectives, all of which are important steps in the implementation of a national demographic monitoring program for doves, were included in our original proposal.

1. Calibrate juvenile to adult ratios of harvested doves in order to produce an unbiased estimate of annual recruitment of juveniles into the fall population from wing collections by:
   a. Estimation of regional primary molt rate of adult and juvenile doves and the age-specific proportion of molt completed birds obtained from a wing survey.
   b. Correct harvest age ratios for differential harvest vulnerability of juveniles and adults.
2. Evaluate potential sampling designs and logistical constraints for a national harvest wing survey for monitoring recruitment.
3. Determine the potential for employing recaptures from an intensive banding program to generate independent estimates of age ratios that can be used to validate wing survey estimates.
4. Improve understanding of intra-annual variation in reproductive output of breeding doves.

Methods

Data Collection. During the 2005 - 2008 late summer and early fall field seasons, 22 states banded >42,000 doves and collected > 125,000 wings from 76 unique degree blocks. Each bird was assigned an age and a molt score. Our estimation technique used these data to assign age classes to dove wings of unknown age at the time of the harvest survey based on projecting molt scores of doves banded in late summer to the time of the fall harvest. Almost all birds trapped as part of the late summer banding program can be identified to age, which provides an in initial distribution of molt scores in the local population. Our approach is to project this distribution forward to the beginning of hunting season, when a second independent molt distribution is derived from a sample of harvested wings. Estimates of adult and juvenile molt rates and the proportion of unknown birds in each age class were obtained by finding the best statistical fit of the 2 molt distributions. The performance of this statistical model was then using Monte Carlo simulation techniques. As a final step, we developed a predictive equation that can be used to correct future estimates of harvest age ratios derived from a parts collection survey.

In 2007, the USFWS –DMBM Harvest Survey Section initiated a companion 3-year nationwide mail survey wing collection program. Approximately 20,000 wings were returned by 1,500 cooperating hunters nationwide in each year. The primary goal of this complementary survey was to compare efficiency of field and mail sample collection protocols to inform the design of an operational harvest wing survey program. We also applied our predictive correction equation and a correction factor for relative age vulnerability to harvest derived from banding data to the mail survey data to obtain estimates of preseason age ratios in each year. We then used these estimates of annual recruitment to create descriptive maps of recruitment and to build exploratory regression models of recruitment as a function of regional climate parameters.

Participants at the 2010 dove wing survey in Kansas City, Mo. *Photo by Jeff Neal*

Results

Estimates of adult molt rate averaged 17.9 (sd = 3.34) d per feather for all sub-regions, and we estimated that juvenile birds took an average of 83.7 (sd = 25.2) d between molting their first and eighth primary. Our final prediction equation estimated the proportion of adults in the unknown age class as a function of latitude and longitude. The equation predicts that the proportion of adults in the unknown age class decreases with latitude in the eastern U.S., but gradually shifts to an opposite and more pronounced trend in more western longitudes. Monte Carlo simulations demonstrated that the estimator was minimally biased.

Using harvest age ratios from an independent sample of 41,084 wings collected from random hunters in the 2007 and 2008 mail surveys, we found that the average uncorrected harvest age ratio of known-age wings for states that allow hunting was 2.25 (sd = 0.85) juveniles:adult. The average corrected ratio was 1.91 (sd= 0.68). We used an independent estimate of differential vulnerability to adjust these corrected harvest age ratios, and estimated an average population preseason age ratio of 1.45 (sd = 0.52). Recruitment rates were highest in eastern states and in the northwest with lower average recruitment in the areas in between. Patterns were consistent between years (Fig. 1). The average state recruitment rate for each dove management units was 1.75 ± 0.52, 1.14 ± 0.31, and 1.22 ± 0.38 for the Eastern, Central, and Western management units, respectively. Our results provide a robust methodology for calibrating recruitment estimates for mourning doves and represent the first large-scale estimates of recruitment for the species. Methods can be used by managers to correct future harvest survey data to generate recruitment estimates that will inform harvest management strategies.

We will assist USFWS Harvest Survey Branch in 2010 in conducting comparative analyses of harvest age ratios and relative costs from the 2007 – 2009 field and mail survey collections. These results will be used by USFWS staff to make recommendations on the design of an operation wing collection program.

A manuscript on the correction technique and recruitment estimates has been accepted for publication. Two additional manuscripts derived from enclosure experiments conducted in Iowa on dove growth and developmental biology have also been accepted for publication. A manuscript on the exploratory analysis of the relationship between recruitment and climate variables is in preparation.

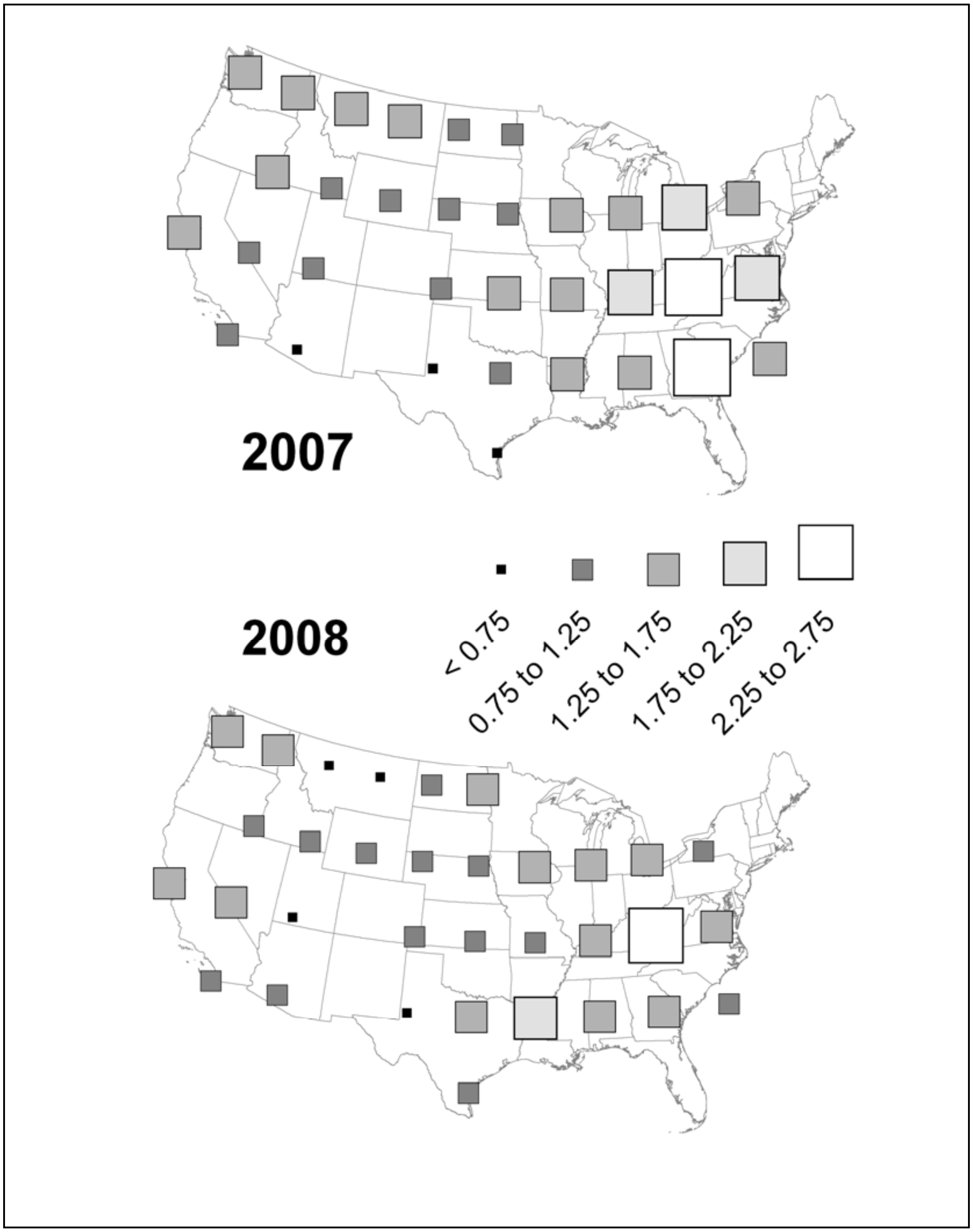

Figure 1. Regional mourning dove recruitment rates from across the United States during 2007 and 2008.

MOURNING DOVE RECRUITMENT AND BREEDING-SEASON SURVIVAL IN TENNESSEE

RUSSELL R. SKOGLUND, Tennessee Wildlife Resources Agency, Ellington Agricultural Center, P.O. Box 41489, Nashville, TN 37204

STEVEN E. HAYSLETTE, Department of Biology, Box 5063, Tennessee Technological University, Cookeville, TN 38505 (shayslette@tntech.edu)

Graduate Student: Russell Skoglund (Ph.D.); **Final Report**

Introduction

Mourning doves (*Zenaida macroura*) are the most abundant and widespread game birds in North America, and they rank among the 11 most abundant bird species on the continent (Baskett and Sayre 1993, Tomlinson et al. 1994). Likewise, mourning dove hunting is one of the most popular and financially important forms of hunting in the United States. More mourning doves are harvested in the U.S. each year than any other species of migratory game bird (U.S. Fish and Wildlife Service 2007). Call-count indices have indicated long-term declines in mourning dove populations in all 3 dove management units (Dolton and Rau 2005), raising concerns about factors driving dove population dynamics and lack of information needed to understand them. Of particular concern has been the lack of a rigorous, data-driven process for making mourning dove harvest management decisions. Central to such a process are quantitative population models that incorporate dove life-history characteristics and simulate year-to-year population dynamics based on survival and recruitment. Information needed for these models includes annual estimates of age-specific survival rates and annual recruitment/productivity estimates.

A recent (unpublished) briefing statement by David Dolton regarding implementation of the National Plan listed development of annual estimates of recruitment for each management unit as a research priority. Previous nesting studies (Sayre and Silvy 1993, Hayslette et al. 2000, Miller et al. 2001) have generated estimates of reproductive parameters such as nesting success and fledglings produced/minimum number of nesting pairs, but such studies do not permit direct documentation of reproductive output per female and do not address fledgling survival. Thus, information generated by these studies generally is of limited value in assessing recruitment in mourning dove populations. Radiotelemetry offers an alternative approach to estimating recruitment that addresses both of these limitations. In addition to their utility in population modeling efforts, estimates of recruitment/female generated using radio telemetry may be used to evaluate newly-developed approaches to estimating mourning dove recruitment at large scales, including the use of pre-hunting season age ratios estimated using wing collections made during the hunting season (Nichols and Tomlinson 1993, National Mourning Dove Planning Committee 2003).

The overall goal of this study was to evaluate the feasibility of using radio-telemetry to develop estimates of population parameters necessary to better understand dynamics in a local mourning dove population in central Tennessee. Specifically, we wanted to estimate recruitment (no. young recruited to fall population per adult female) and breeding-season (May-September) survival, and to identify factors limiting the success of this approach. Secondarily, we wanted to estimate harvest and crippling loss rates in that population.

Methods

Field work took place during May-September 2007 and 2008 on Stonewall Farm, a 162-ha former cattle farm in western Wilson County, Tennessee. The farm is approximately one-half early successional fields (both native warm-season and cool-season grasses) and one-half upland forest. Centrally located on the property is a 2.5-ha dove field planted annually for dove hunting. Hunting took place on our study area on 1 and 3 September 2007, and on 1 September 2008.

We trapped mourning doves during March-September each year using Kniffin modified funnel traps baited with wheat and proso millet. We subcutaneously implanted radio transmitters in mourning doves during this period each year using the methods of Schulz et al. (1998). Our initial plans were to radio mark only adult females and nestlings approximately 8 days old. However, because very few doves, in general, were captured prior to May 2007, and only a single adult female was captured and radio marked by 1 June 2007, we implanted transmitters in all doves captured after that date, including all doves captured in 2008. Radio marked doves were monitored daily from date of implant through early September each year. We attempted to establish location of radio marked doves daily using hand-held receiving equipment and triangulation. If location of a radio marked dove appeared to remain constant >2 days, we attempted to visually locate the dove to confirm mortality or nesting. Cause of mortality was identified, if possible, and date of mortality was then assigned as the first date at that location. Nests of radio marked doves were monitored every 2 days until young fledged or the nest failed. We did not attempt to implant transmitters into nestlings prior to fledging, because of concerns about safety of nestlings and limited prospects of meaningful data, given the small number of nestlings located (see Results Section). For each adult dove tracked to 1+ nesting sites, we calculated total number of known fledglings produced by that adult during that breeding season, and we calculated the mean value of this productivity measure for each year.

We compiled encounter histories for all doves trapped and implanted with radios each year. We identified doves that were documented alive on or after day 14 post-implant, and retained these for inclusion in survival analyses, assuming that fate after this point was not affected by capture, handling, surgery, or acclimation to radios. Among doves that were not located alive on or after day 14, we classified each dove as dead (found dead on or before day 14) or missing (never located subsequently). We compared fate at the 14-day mark (alive, dead, or missing) between years, pooling doves across all age and gender classes, using a log-likelihood *G*-test of independence and Williams' correction. Pooling across years, we compared fate at day 14 (alive versus dead/missing) among age/gender classes (AHY males, AHY females, HY doves) similarly. For doves dead or missing on day 14, we compared fate (dead versus missing) among age/gender classes (AHY males, AHY females, HY doves) using the same methods. For doves documented alive on or after day 14, we estimated survival of HY and AHY doves separately by year using a staggered-entry, Kaplan-Meier (K-M) product-limit approach (Pollock et al. 1989) and the methods of Schulz et al. (1996). Doves that were lost permanently (never located after a certain point) were censored on the last date of location. Doves that went missing for >14 days and were subsequently relocated were censored on the last date of location and added as a new entry in the data set, if relocated alive.

Based on encounter histories, we identified doves documented alive on or near the study site on the day of a hunt (1 and 3 September 2007, 1 September 2008) as at-risk to harvest on those days. Harvest and crippling rates were estimated as number of radio-marked doves harvested or crippled (mortally wounded but not recovered) during a hunt divided by the total number of doves at-risk to harvest on that date.

Results

Totals of 72 and 185 mourning doves were trapped, banded, and implanted with radio transmitters in 2007 and 2008, respectively (Table 1). Of these, only 15 were AHY doves in 2007, and 36 were AHY in 2008. Overall, the majority (57.6%) of doves radio-marked were documented alive on or after day 14 post-implant, but fate (alive, dead, or missing) 14 days post-implant varied between years (G_a = 30.8, $P <$ 0.001). In 2007, over half (51.4%) of doves implanted went missing prior to day 14 post-implant and were not documented subsequently, while 18.1% were documented dead on or before day 14, and 30.6% were documented alive (Table 1). In 2008, most (68.1%) doves implanted were documented alive on or after day 14; 20.5% were missing at that point, and only 11.4% were known dead.

Pooled across years, fate (alive versus dead/missing) at 14 days post-implant was not independent of age/gender class (G_a = 9.5, P = 0.009); 79.5% of AHY males were documented alive on or after 14 days post-implant, while only 50.0% and 53.9% of AHY females and HY doves, respectively, were documented alive on or after 14 days (Table 1). Among doves not documented alive after 14 days, however, fate (dead versus missing) was independent of age/gender class (G_a = 0.2, P = 0.922); percentage of each age class known dead within 14 days ranged 30.5-37.5% of those not documented alive at 14 days.

Among radio marked doves documented alive 14 days post-implant, we documented totals of 15 and 39 deaths in 2007 and 2008, respectively. These included 1 AHY female, 5 AHY males, and 9 HY doves in 2007; and 1 AHY female, 7 AHY males, and 31 HY doves in 2008. Kaplan-Meier survival estimates declined to 0 for both AHY and HY doves by 83 days and 73 days post-implant, respectively, in 2007 (Tables 2 and 3). Numbers of both AHY and HY doves at risk at any point were low (AHY = 5 or fewer, HY = 11 or fewer) throughout the study period in 2007. In 2008, 3 of the 8 AHY mortalities and 5 of the 31 HY mortalities were doves found dead >14 days after they were last located. Thus, they were not included as mortalities in K-M analysis, as they were censored at the point they were last documented alive. Number of AHY dove at-risk at any point in 2008 ranged 1-17, but dropped to 0 after day 84 (11 August), at which point survival was 0.751 (SE = 0.375; Table 4). Subsequently, an AHY dove was relocated alive on 30 August, 59 days after its previous location, and was then found dead on 1 September. This mortality was not included in K-M analysis, as survival during the intervening 59 days (during which the dove was censored and no other doves were at-risk) could not be estimated. Among HY doves in 2008, number at risk at any point ranged 3-65 (Table 5). Period HY survival rate (through 4 September) was 0.213 (SE = 0.060).

In 2007, totals of 14 and 11 HY doves were documented in the study area on 1 and 3 September, and were deemed at-risk to harvest on those days (Table 1). Harvest and crippling rates were 7.1% (1 radio marked dove harvested) and 14.3% (2 radio marked doves crippled), respectively, on 1 September, and 18.2% each (2 radio marked doves harvested and 2 doves crippled) on 3 September. In 2008, totals of 1 AHY and 25 HY doves were documented in the study area (at-risk to harvest) on 1 September (Table 1). Harvest rate of HY doves was 12.0% (3 radio marked doves). No radio marked AHY doves were harvested in 2008, and no doves of either age class were crippled.

Among the 5 AHY females radio marked in 2007, 2 were tracked to active nests. These females were monitored through a total of 4 nesting attempts; mean total fledglings/female during this monitoring period was 2.0. Among the AHY doves radio marked in 2008, 2 females and 2 males were tracked to active nests. The 2 females were monitored through a total of 3 nesting attempts; mean total fledglings/female during this monitoring period was 1.5. The 2 males also were monitored through a total of 3 nesting attempts; mean total fledglings/male during this monitoring period was 0.5.

Discussion

Our study highlights the limitations of small-scale radio telemetry studies in estimating and understanding population parameters for a highly-mobile species such as mourning doves. Efforts to estimate dove productivity were hampered by difficulty capturing sufficient numbers of adult females on our study area. Relatively low numbers of adult female doves captured during the breeding season using these methods has been reported elsewhere (Schulz et al. 1996). Low numbers of doves of both genders captured March-May 2007, in particular, appeared to reflect low numbers of doves using the study area in general during that period, likely due to unusually cold and dry conditions. Drought conditions prevailed in this area during early spring 2007, and an unusually severe period of subfreezing weather occurred during 6-9 April 2007, followed by severe drought conditions (University of Tennessee Agricultural Experiment Station 2007). An increase in numbers of doves trapped and radio marked June-August 2007 reflected increased numbers of doves using the area as precipitation increased in mid- and late-summer.

Additionally, relatively large dove home ranges and associated difficulty relocating doves using hand-held, ground-based tracking methods in the interface between rural farmland and suburban residential areas in which we worked resulted in large numbers of censored doves, limiting our ability to estimate productivity, survival, harvest, and crippling loss meaningfully and cost-efficiently. Across both years and all gender/age classes, 42% of radio marked doves were not relocated alive on or after day 14, and thus contributed nothing to survival, recruitment, or harvest estimates. Of these doves not documented alive, 69% went missing permanently, representing complete loss of transmitter and other resources invested for ~29% of doves implanted and released, before any data could be collected. We suspect that many doves used our study site foraging habitat, where they were caught and transmittered, but ranged widely away from the area and into the suburban landscape for nesting and other activities. Adequately covering this broad area effectively was impossible with the ground-based tracking methods we used. These results are consistent with other mourning dove telemetry research, in which a high percentage of radio marked doves were censored (Schulz et al. 1996).

Cost-efficiency of data collection was higher for AHY male doves than for AHY females or HY doves, as AHY males were more likely to be documented alive on or after day 14 post-implant. To our knowledge, this lower level of initial censoring among AHY males has not been reported previously. Higher levels of initial censoring among AHY females than among males may have been related to reproduction-related stress in females, and concomitant increased susceptibility to capture and surgery-related stresses. Relatively high levels of initial censoring among HY doves may have been due to similar susceptibility to capture and surgery-related stresses, and/or greater likelihood of leaving the study site and surrounding vicinity. Generally lower levels of initial censoring in 2008 than in 2007 may have been due to generally milder (cooler and wetter) weather conditions in 2008, and/or increased proficiency with surgical procedures and/or tracking methods.

Our results for 2008 are consistent with the idea that survival of AHY doves generally is higher than HY survival, a pattern documented previously (Martin and Sauer 1993, McGowan and Otis 1998, Otis 2002, Otis et al. 2008). Survival of AHY doves in our study (0.751) was comparable to AHY spring/summer survival documented in Missouri (0.716; Schulz et al. 1996). Otis et al. (2008) calculated annual survival of adult and juvenile mourning doves based on broad-scale, multi-state banding efforts conducted 2003-2005. In Tennessee, survival of adult and juvenile doves during this period was relatively low (0.265 and 0.184, respectively). If these estimates are representative of long-term average annual survival of doves in Tennessee, survival estimates on our study area in 2008 suggest that the spring/summer (breeding season) period was not a major mortality period for doves in that year, and that mortality during this period did not constrain overall annual dove survival and related population status. This conclusion seems to have been year-specific, however, as estimates of survival for the 2007 breeding season were considerably lower, perhaps because of drought conditions during this time.

In interpreting survival rates calculated here, we caution that sample sizes were relatively small, particularly during 2007, and that precision of period survival estimates was concomitantly poor. Pollock et al. (1989) indicated that precision of staggered-entry K-M survival estimates is poor unless >20 animals are at risk at any given time, and they recommended maintaining 40-50 animals at risk at all times to achieve adequate precision. Such sample sizes at risk were impossible in our study due to limited funds for transmitters, limited numbers of doves using our study area during study periods, and limits to our tracking methods. Numbers of AHY doves at risk were <20 during throughout 2007 and 2008 study periods, and numbers of HY doves at risk were <20 throughout the 2007 period. Number of HY doves at risk was >20 during much of the 2008 study period (~40 days, 8 July-13 Aug and 30 Aug-1 Sep; Table 4), but was >40 for only 14 days (10-23 July; Table 4).

Relatively low numbers of radio marked doves using our study area on days the area was hunted each year limited precision of harvest and crippling loss estimates. Despite the fact that our study area was only hunted 1 or 2 days during the early segment of the Tennessee mourning dove season each year, our estimated HY harvest rate on 1 September 2008 (12%) matched the 3-year (2002-2005) estimated juvenile harvest rate for the state of Tennessee (Otis et al. 2008). Likewise, if pooled across 1 and 3 September 2007, our 2007 harvest rate estimates matched this 3-year harvest rate value, as well (3 harvested out of 25 at-risk, 12%). This result underscores the fact that in Tennessee, as well as elsewhere, most mourning dove harvest takes place on opening day, or otherwise very early in, the early dove hunting season. The relatively high harvest rate (12%) estimated for Tennessee here and in Otis et al. (2008), underscores the importance and popularity of mourning dove hunting in Tennessee. In analyses of 2002-2005 banding data (Otis et al. 2008), only Georgia and Mississippi had higher harvest rates (~15% each) in the Eastern Management Unit, suggesting that dove hunting pressure in Tennessee is as high or higher than in other southeastern states, even those in the deep south.

Crippling loss, although an important consideration in evaluating the overall effects of harvest on populations of doves and other hunted species, is relatively unknown in mourning dove hunting. Haas (1977) estimated rate of loss of unretrieved doves during hunts in South Carolina as 23-29% during years of relatively low harvest, and 28-48% in high-harvest years. Our estimates, although imprecise, were lower than these values (14.3% and 18.2% in 2007, 0% in 2008), suggesting that hunter behavior, ground cover, and/or other factors may have differed between hunts on our study area and those of Haas (1977). Particularly curious is the complete lack of crippling loss among radio marked doves in 2008, considering the fact that 26 such doves were documented on the study area on the day of this hunt. Nevertheless, estimated crippling loss rates in 2007 were higher than estimated harvest rates, underscoring the importance of accurately quantifying crippling loss and including this form of harvest-related mortality in evaluation of harvest effects on dove population dynamics.

In conclusion, our ability to meaningfully estimate population parameters such as recruitment and survival using radio telemetry was limited by several factors. Productivity estimates were limited by number of adult females trapped on our study area. Survival estimates were limited by overall numbers of doves trapped on the area, particularly AHY doves; poor precision was a consequence of relatively low numbers of doves at risk at any point each year. Additional sample size issues arose with censoring of doves not documented alive on or after 14 days post-implant; this was more of a problem with AHY females and HY doves than with AHY males. We documented comparatively high breeding season survival among AHY doves in 2008, but lower survival among HY doves during the same period. We also documented relatively high rates of harvest in both years, and a crippling rate higher than the harvest rate in 2007. Our results and those of others suggest that for adequate numbers of doves at-risk in telemetry studies during time periods and in habitats such as ours, required sample sizes of implanted doves must be adjusted for relatively high levels of permanent initial censorship (29% in our study), if meaningful estimates of population parameters are to be obtained. The required adjustment is greater for AHY females and HY doves than for AHY males. Additionally, tracking methods capable of covering broader areas more effectively (e.g., large, fixed antennae with automated receiving or aerial tracking) may reduce rates of initial (or subsequent) censorship, and provide for a higher percentage of implanted doves at-risk during radio telemetry studies of mourning dove populations.

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Table 1. Total numbers, 14-day post-implant fates, and harvested numbers of hatching-year (HY) and after-hatching-year (AHY) male (M), female (F), and unknown-gender (U) mourning doves studied using radio telemetry, Wilson County, Tennessee, USA, May-September 2007 and 2008.

				Fate 14 Days Post-Implant			Harvest		
Year	Age	Gender	Implanted	Alive	Dead	Missing	At-Risk	Harvested	Crippled
2007	AHY	M	10	6	1	3			
		F	5	2	1	2			
	HY	U	57	14	11	32	14	1	2
							11	2	2
2008	AHY	M	29	25	2	2	1		
		F	7	4	1	2			
	HY	U	149	97	18	34	25	3	

Table 2. Kaplan-Meier survival estimates and associated data for radiomarked hatching-year mourning doves, Wilson County, Tennessee, USA, June-September 2007.

Day	Date	No. at risk	No. deaths	No. censored	No. added	*S*	SE
1	06/23/07	1	0	0	1	1.000	0.000
4	06/26/07	3	0	0	2	1.000	0.000
8	06/30/07	4	0	0	1	1.000	0.000
19	07/11/07	4	0	1	0	1.000	0.000
20	07/12/07	4	0	0	1	1.000	0.000
23	07/15/07	7	0	0	3	1.000	0.000
27	07/19/07	8	0	0	1	1.000	0.000
28	07/20/07	9	0	0	1	1.000	0.000
33	07/25/07	10	1	0	1	0.900	0.090
34	07/26/07	9	0	0	0	0.900	0.095
39	07/31/07	10	0	0	1	0.900	0.090
42	08/03/07	11	0	0	1	0.900	0.086
48	08/09/07	11	0	1	0	0.900	0.086
49	08/10/07	10	0	0	0	0.900	0.090
51	08/12/07	10	1	0	0	0.810	0.112
52	08/13/07	9	0	0	0	0.810	0.118
54	08/15/07	9	0	1	0	0.810	0.118
55	08/16/07	8	0	0	0	0.810	0.125
56	08/17/07	8	1	1	0	0.709	0.135
57	08/18/07	6	0	0	0	0.709	0.156
59	08/20/07	7	0	0	1	0.709	0.145
60	08/21/07	7	1	1	0	0.608	0.144
61	08/22/07	5	0	0	0	0.608	0.170
63	08/24/07	5	2	0	0	0.365	0.130
64	08/25/07	3	0	0	0	0.365	0.168
71	09/01/07	3	1	0	0	0.243	0.122
72	09/02/07	2	0	0	0	0.243	0.149
73	09/03/07	2	2	0	0	0.000	0.000

Table 3. Kaplan-Meier survival estimates and associated data for radiomarked after-hatching-year mourning doves, Wilson County, Tennessee, USA, June-September 2007.

Day	Date	No. at risk	No. deaths	No. censored	No. added	*S*	SE
1	06/01/07	1	0	0	1	1.000	0.000
6	06/06/07	2	0	0	1	1.000	0.000
8	06/08/07	3	0	0	1	1.000	0.000
9	06/09/07	4	0	0	1	1.000	0.000
20	06/20/07	5	0	0	1	1.000	0.000
21	06/21/07	5	1	1	0	0.800	0.160
22	06/22/07	3	0	0	0	0.800	0.207
23	06/23/07	3	1	0	0	0.533	0.210
24	06/24/07	2	0	0	0	0.533	0.258
27	06/27/07	3	0	0	1	0.533	0.210
37	07/07/07	4	0	0	1	0.533	0.182
41	07/11/07	4	1	0	0	0.400	0.155
42	07/12/07	3	0	0	0	0.400	0.179
45	07/15/07	3	1	0	0	0.267	0.132
46	07/16/07	2	0	0	0	0.267	0.161
50	07/20/07	4	0	0	2	0.267	0.114
73	08/12/07	4	1	0	0	0.200	0.089
74	08/13/07	3	0	0	0	0.200	0.103
75	08/14/07	3	0	1	0	0.200	0.103
76	08/15/07	2	0	0	0	0.200	0.126
78	08/17/07	2	0	1	0	0.200	0.126
79	08/18/07	1	0	0	0	0.200	0.179
83	08/22/07	1	1	0	0	0.000	0.000

Table 4. Kaplan-Meier survival estimates and associated data for radio marked hatching-year mourning doves, Wilson County, Tennessee, USA, May-September 2008.

Day	Date	No. at risk	No. deaths	No. censored	No. Added	*S*	SE
1	05/21/08	3	0	0	3	1.000	0.000
2	05/22/08	4	0	0	1	1.000	0.000
3	05/23/08	5	0	1	1	1.000	0.000
5	05/25/08	6	0	0	2	1.000	0.000
6	05/26/08	7	0	0	1	1.000	0.000
7	05/27/08	9	0	0	2	1.000	0.000
8	05/28/08	10	0	0	1	1.000	0.000
10	05/30/08	11	0	1	1	1.000	0.000
20	06/09/08	10	0	1	0	1.000	0.000
22	06/11/08	9	1	0	0	0.889	0.099
23	06/12/08	8	1	0	0	0.778	0.130
24	06/13/08	7	0	0	0	0.778	0.139
27	06/16/08	8	0	0	1	0.778	0.130
29	06/18/08	10	0	0	2	0.778	0.116
30	06/19/08	12	0	0	2	0.778	0.106
31	06/20/08	12	1	0	0	0.713	0.110
32	06/21/08	11	0	0	0	0.713	0.115
34	06/23/08	11	1	1	0	0.648	0.116
35	06/24/08	13	0	0	4	0.648	0.107
36	06/25/08	16	0	0	3	0.648	0.096
37	06/26/08	16	1	0	0	0.608	0.095
38	06/27/08	16	0	0	1	0.608	0.095
41	06/30/08	16	0	1	0	0.608	0.095
42	07/01/08	20	0	1	5	0.608	0.085
43	07/02/08	19	0	1	0	0.608	0.087
44	07/03/08	20	0	0	2	0.608	0.085
48	07/07/08	20	1	1	0	0.577	0.084

Table 4. Continued.

Day	Date	No. at risk	No. deaths	No. censored	No. Added	*S*	SE
49	07/08/08	25	0	0	7	0.577	0.075
50	07/09/08	38	0	0	13	0.577	0.061
51	07/10/08	43	0	0	5	0.577	0.057
52	07/11/08	44	0	2	1	0.577	0.057
53	07/12/08	49	0	0	7	0.577	0.054
56	07/15/08	58	1	6	9	0.567	0.049
57	07/16/08	55	0	0	4	0.567	0.050
58	07/17/08	59	0	0	4	0.567	0.049
59	07/18/08	60	0	0	1	0.567	0.048
63	07/22/08	65	0	8	5	0.567	0.046
64	07/23/08	57	0	24	0	0.567	0.049
65	07/24/08	33	0	0	0	0.567	0.065
66	07/25/08	35	1	0	2	0.551	0.062
67	07/26/08	34	0	1	0	0.551	0.063
68	07/27/08	33	0	0	0	0.551	0.064
69	07/28/08	33	3	0	0	0.501	0.062
70	07/29/08	30	0	0	0	0.501	0.065
71	07/30/08	30	0	4	0	0.501	0.065
72	07/31/08	26	0	6	0	0.501	0.069
73	08/01/08	20	0	0	0	0.501	0.079
79	08/07/08	23	0	2	3	0.501	0.074
80	08/08/08	21	0	0	0	0.501	0.077
83	08/11/08	33	0	10	12	0.501	0.062
84	08/12/08	23	2	0	0	0.457	0.070
85	08/13/08	21	2	0	0	0.414	0.069
86	08/14/08	20	5	7	1	0.310	0.058
87	08/15/08	8	0	0	0	0.310	0.091
92	08/20/08	8	0	2	0	0.310	0.091

Table 4. Continued.

Day	Date	No. at risk	No. deaths	No. censored	No. Added	*S*	SE
93	08/21/08	6	0	0	0	0.310	0.105
102	08/30/08	21	5	0	15	0.236	0.045
103	08/31/08	20	0	1	4	0.236	0.046
104	09/01/08	21	0	11	2	0.236	0.045
105	09/02/08	10	0	0	0	0.236	0.065
107	09/04/08	10	1	9	0	0.213	0.060

Table 5. Kaplan-Meier survival estimates and associated data for radio marked after-hatching-year mourning doves, Wilson County, Tennessee, USA, May-September 2008.

Day	Date	No. at risk	No. deaths	No. censored	No. Added	*S*	SE
1	05/20/08	1	0	0	1	1.000	0.000
2	05/21/08	3	0	0	2	1.000	0.000
3	05/22/08	4	0	0	1	1.000	0.000
4	05/23/08	5	0	1	1	1.000	0.000
8	05/27/08	5	0	0	1	1.000	0.000
9	05/28/08	9	0	0	4	1.000	0.000
11	05/30/08	12	0	0	3	1.000	0.000
17	06/05/08	13	0	0	1	1.000	0.000
18	06/06/08	13	0	1	0	1.000	0.000
21	06/09/08	13	0	0	1	1.000	0.000
23	06/11/08	14	0	0	1	1.000	0.000
26	06/14/08	16	0	0	2	1.000	0.000
28	06/16/08	17	0	0	1	1.000	0.000
30	06/18/08	17	0	2	0	1.000	0.000
31	06/19/08	15	1	0	0	0.933	0.062
32	06/20/08	14	0	1	0	0.933	0.064
33	06/21/08	13	0	0	0	0.933	0.067
36	06/24/08	14	0	0	1	0.933	0.064
37	06/25/08	15	0	0	1	0.933	0.062
38	06/26/08	15	1	0	0	0.871	0.081
39	06/27/08	14	0	0	0	0.871	0.084
42	06/30/08	14	0	1	0	0.871	0.084
43	07/01/08	13	0	0	0	0.871	0.087
44	07/02/08	13	0	1	0	0.871	0.087
45	07/03/08	14	0	0	2	0.871	0.084
49	07/07/08	14	1	0	0	0.809	0.095
50	07/08/08	15	0	0	2	0.809	0.091

Table 5. Continued.

Day	Date	No. at risk	No. deaths	No. censored	No. Added	*S*	SE
51	07/09/08	16	0	0	1	0.809	0.088
52	07/10/08	17	0	3	1	0.809	0.086
53	07/11/08	14	1	0	0	0.751	0.100
54	07/12/08	13	0	0	0	0.751	0.104
57	07/15/08	14	0	1	1	0.751	0.100
58	07/16/08	13	0	0	0	0.751	0.104
59	07/17/08	13	0	1	0	0.751	0.104
60	07/18/08	12	0	0	0	0.751	0.108
66	07/24/08	12	0	5	0	0.751	0.108
67	07/25/08	7	0	0	0	0.751	0.142
72	07/30/08	7	0	2	0	0.751	0.142
73	07/31/08	5	0	2	0	0.751	0.168
74	08/01/08	3	0	0	0	0.751	0.216
80	08/07/08	3	0	2	0	0.751	0.216
81	08/08/08	1	0	0	0	0.751	0.375
84	08/11/08	1	0	1	0	0.751	0.375

VOLUNTARY LEAD SHOT INGESTION RATE OF MOURNING DOVES (*ZENAIDA MACROURA*)

DONALD W. SPARLING, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale IL 62901, USA (dsparl@siu.edu)
RICHARD S. HALBROOK, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale IL 62901, USA
STEPHANIE C. PLAUTZ, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale IL 62901, USA

Graduate Student: Stephanie Plautz, M.S.; **Final Report**

Introduction and Objectives

Mourning doves are at especially high risk of ingesting spent Pb shot on dove fields, public lands managed specifically to attract doves in an effort by conservation managers to halt declining hunter participation and provide easily accessible mourning dove hunting areas. By concentrating hunters, these areas also concentrate Pb shot deposition, some of which may then be ingested by foraging doves. Studies of collected or hunter-harvested doves have reported ingestion rates ranging from 1-6.5% of the sampled mourning dove population. Risk from ingesting Pb shot increases under stressful environmental conditions and when doves ingest a hard or nutrient-poor diet. For example, Pb-dosed birds held at cold temperatures have greater tissue Pb concentrations and potentially more than double the mortality of those kept at room temperature. Doves on a hard seed diet retain Pb shot in the gizzard for a shorter time than those on a soft pelleted diet, but conversely, have greater mortality and tissue Pb concentrations. This is a result of the increased rate of gizzard grinding and thus pellet breakdown. Additionally, dietary protein and Ca can reduce Pb toxicity, but the nutritional content of the diet appears to influence Pb absorption only in combination with environmental stressors in upland game

While many questions concerning Pb shot ingestion in mourning doves have been answered, almost all research has been done in very controlled situations that are detached from natural conditions. Therefore, the objective of the current study was to examine the relationship between shot availability and ingestion in mourning doves on the bare soil of a disked field, under controlled conditions that simulated field exposures. Kidney, liver, and blood Pb concentrations and blood chemistry variations including packed cell volume (PCV), heterophil:lymphocyte ratio (H:L) ratio, and delta-aminolevulinic acid dehydratase (ALAD) activity were evaluated relative to the number of Pb shot ingested.

Methods

Mourning doves were trapped at 3 sites on the Southern Illinois University Carbondale (SIUC) campus in Carbondale, Illinois, USA (37°72'N, 89°22'W). Birds were housed and Pb shot ingestion trials were held at the Cooperative Wildlife Research Laboratory Wildlife Annex of SIUC. On the treatment field, approximately 2.5 m of short mowed grass separated the disked soil from tall grass (≥1 m) on 3 sides. A 40 m section of mowed grass was present on the fourth side. Because the field had no history of hunting, it was not tested for the presence of Pb shot and we assumed there were no available Pb shot in the field pre-treatment.

Birds were trapped, aged and sexed and banded with a non-FWS metal tag during February – August 2008 at 3 sites in Carbondale, Illinois. Doves were then held in outside cages for 5-13 weeks prior to the beginning of treatment to allow for acclimation to captivity and to ensure a similar nutritional plane among individuals. The birds were fed ad libitum.

Open-bottomed, 0.61 m^3 treatment pens made from hardware cloth roofed were placed on freshly disked field and held a single bird. For a 7 d pretreatment period birds were again fed ad libitum with the same diets as in group housing. Prior to exposure to Pb each bird was weighed, x-rayed to ascertain the absence of Pb and bled to collect 0.3 ml of blood. We conducted 3 trials using 80 doves each, for a total of 240 birds. The first 2 trials were held during July 2008 and used only after-hatch-year (AHY) birds, while the third trial was held during October 2008 with only hatch year (HY) birds, as identified via plumage characteristics.

In each trial, we randomly assigned 35 birds to each of the low and high shot density treatments and 10 birds to a control group. Negative controls (no Pb) were present in all three trials and in the 2nd and 3rd trials we dosed 5 birds with 2 #7 lead shot to serve as positive controls.

Following the pre-treatment period, we loosely mixed 125 mL of feed with #7.5 Pb shot at a density of 0 (control), 11 (low density), or 223 (high density) shot/buried feed pan. These densities corresponded to 0, 1.5 million, and 29.5 million shot/ha. Birds were exposed to lead shot for 4 days. On day 2 post-treatment, we collected and x-rayed (SY-31-100P, Soyee Products, Inc., Thompson, Connecticut, USA) all doves for the presence of Pb shot in their digestive systems and returned them to their treatment pens. At day 4 post-treatment, we gathered and x-rayed the birds, collected 0.3 cc of blood, weighed them and euthanized them using CO_2 asphyxiation. The kidneys and liver of each bird were removed and frozen at -4ºC for analysis. All handling procedures and euthanasia techniques were approved by SIUC's Institutional Animal Care and Use Committee (protocol A-3078-01).

We measured ALAD activity post-treatment for all doves and compared it their respective pre-treatment levels. We judged that those birds whose ALAD activities were reduced ≥30% compared to pre-treatment levels had ingested Pb shot. All such birds also had Pb shot present in their digestive systems on one or more x-ray days. We analyzed blood, liver and kidney from the birds (n = 16) that had ingested Pb shot, either voluntarily or via dosing and from randomly selected 5 control birds, 10 low shot density birds, and 10 high shot density birds from each trial.

In addition to ALAD we evaluated PCV and H:L ratio of the blood. We digested liver, kidney, and blood samples in nitric acid prior to measuring Pb concentration using a graphite furnace atomic absorption spectrophotometer (Perkin Elmer 4100ZL, Waltham, Massachusetts, USA) following EPA Method 200.9 (U.S. Environmental Protection Agency 2001). We also analyzed 2 samples each of food, oyster shell grit, and water provided to the doves for Pb concentration.

Results

Overall, 6 (2.9%) of the 205 birds exposed to Pb shot voluntarily ingested ≥1 Pb shot. Five birds in the high shot density group ingested one shot apiece and 1 bird (2.9%) in the low shot density group ingested one shot. Pooling the results from the 3 trials, there was no statistical difference between the shot ingestion rates in the high (4.9%) and low (1.0%) shot density treatments (t_{141} = 1.67, P = 0.0977; Table 1). Eight (50%) of the birds that ingested Pb shot either voluntarily (2/6 birds) or via dosing (6/10 birds) eliminated at least one shot as detected by x-ray on day 2 through day 4. No doves died from the direct effects of Pb poisoning during the 4 days post-treatment.

There was a difference in both liver and kidney Pb wet weight concentration (χ_3^2 = 35.0908, P < 0.0001 and χ_3^2 = 38.8429, P < 0.0001, respectively) by Pb ingestion group. Pb concentrations in tissues were greater in dosed birds than in those that voluntarily ingested Pb shot, and both were greater than controls and doves that did not ingest shot (Figure 1).

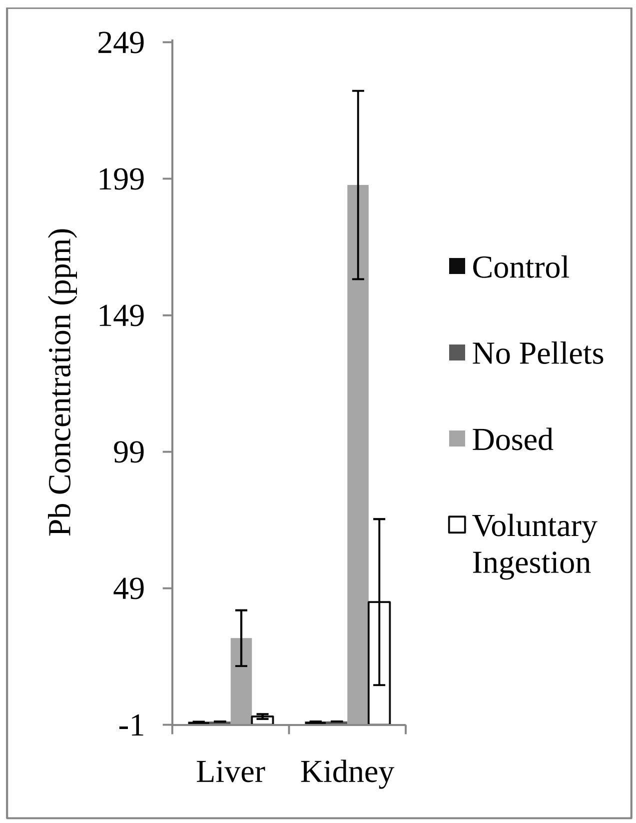

Figure 1. Liver and kidney lead concentrations (mean ± SE) in ppm wet weight of wild mourning doves held in captivity in a lead shot ingestion study during 2008 in Carbondale, IL, USA.

In split plot ANOVAs on blood Pb concentration and physiological variables, we focused on the group*time interaction because it examined the effect by Pb ingestion group across time in the variable of interest, thus integrating the time and group effects. Blood Pb concentrations had a significant group*time effect ($F_{3,89} = 27.62$, $P < 0.0001$; Figure 2). Concentrations of blood Pb were different post-treatment ($F_{3,89} = 37.32$, $P < 0.0001$), as they were greater in dosed birds and those that voluntarily ingested shot than in controls and birds that did not ingest shot ($P \leq 0.05$). However, the group*time interaction was not significant for PCV ($F_{3,220} = 0.99$, $P = 0.3985$; Figure 3). This variable did not differ by group pre-treatment ($F_{3,220} = 0.67$, $P = 0.5723$), but did post-treatment ($F_{3,220} = 3.74$, $P = 0.0119$) because the PCV of dosed birds was lower than that of any other group ($P \leq 0.05$). H:L ratio had a significant group*time interaction ($F_{3,32} = 7.75$, $P = 0.0005$). H:L ratio did not differ by group pre-treatment ($F_{3,32} = 1.43$, $P = 0.2526$), but did post-treatment ($F_{3,32} = 15.43$, $P < 0.0001$) when the H:L ratio of dosed birds was greater than that of any other group ($P \leq 0.05$). The group*time interaction term was significant for ALAD activity ($F_{3,228} = 984.43$, $P < 0.0001$; Figure 4). ALAD activity did not differ by Pb ingestion group pre-treatment ($F_{3,228} = 2.17$, $P = 0.0923$), but did post-treatment ($F_{3,228} = 141.02$, $P < 0.0001$) because enzyme activity was lower in birds that ingested shot either via dosing or voluntarily than in birds that did not ingest shot ($P \leq 0.05$). Body weight did not have a significant group*time interaction ($F_{3,105} = 1.20$, $P = 0.3131$) and was not different by ingestion group either pre- ($F_{3,105} = 0.80$, $P = 0.4969$) or post-treatment ($F_{3,105} = 0.31$, $P = 0.8216$).

Discussion

The shot ingestion rates of 4.9% for the high shot density treatment, 1.0% for the low shot density treatment, and 2.9% overall observed in the current study were within the range of 0.2-6.5% reported in previous studies of hunter-harvested birds (Kendall et al. 1996, Schultz et al. 2007). However, the overall shot ingestion rate of 2.9% reported in the current study was lower than the 5.1% (6 of 117) reported by Schulz et al. (2007). Although the HY doves in trial 3 appeared to ingest more shot than the AHY birds in trials 1 and 2, we did not test for differences in shot ingestion rates among trials because the small number of birds that ingested shot would have made comparisons meaningless (Johnson 1999).

Like previous studies, the current study did not demonstrate a clear difference in shot ingestion rates by availability ($P = 0.0977$). Five birds in the high shot density treatment (5 of 102 birds, 4.9%) ingested shot compared to 1 in the low shot density treatment (1 of 103 birds, 1.0%). Schulz et al. (2007) reported that equal numbers of birds consumed shot at low, medium, and high shot density treatments, although the sample size was small. Hunter-harvested dove studies have also failed to demonstrate a relationship between availability and ingestion (Lewis and Legler, 1968, Best et al. 1992, Schulz et al. 2002). However, the lack of correlation between the prevalence of ingested shot in a sample of hunter-harvested doves and the shot density in the field over which they were harvested may be due to the mobility of mourning doves. Their harvest over a field with a certain shot density does not mean that all their principle foraging areas contain comparable Pb shot densities.

Tissue Pb Concentrations

Pb concentrations were greater in dosed birds than in controls or those that voluntarily ingested shot for liver and kidney, but were not statistically different for blood. Elevated blood Pb results in increased erythrocyte fragility and destruction, decreases bone marrow function, and lessens blood flow to the central nervous system via capillary damage and cerebral edema (Bauck and LaBonde 1997). Tissue Pb concentrations were higher in kidney than in liver tissue, and comparable to those reported by previous studies (Kendall et al. 1996; Schulz et al. 2006; Schulz et al. 2007). To better compare the effects of shot ingestion on dosed birds and those that voluntarily ingested shot, 'shot-days' were calculated as a rough metric of the amount of Pb consumed by each bird and the time it was retained. A shot-day was one Pb shot retained in a bird's digestive system for one day. For example, if a bird was dosed with 2 shot on day 0 and retained them through day 4, it retained 2 shot for 4 days, for a total of 8 shot-days. Dosed birds had an average of 6.1 shot-days per bird, while birds that voluntarily ingested shot had an average of 2.5 shot-days. This was probably the basis of the differences in tissue Pb concentrations and physiological variables seen in the 2 groups. Fifty percent (3/6) of the birds that voluntarily ingested shot contained ≥1 toxic tissue Pb concentration and 33% (2/6) contained ≥1 lethal tissue Pb concentration as defined by Franson (1996). In contrast, 100% (10/10) of the dosed birds contained ≥ 1 lethal tissue Pb concentration.

Physiological Variables

Packed cell volume (PCV) is a measure of the oxygen carrying capacity of the blood and is indirectly related to Pb concentration in the body. For a healthy dove PCV is normally 40-50% (Schulz et al. 2006). The difference in PCV in dosed birds before and after treatment in this current study is comparable to that found by Schulz et al. (2006). A significant reduction in PCV may not have been observed in those birds that voluntarily ingested shot in this study because of the short time between Pb shot ingestion and euthanization.

The H:L ratio is a measure of physiological stress and increases with Pb concentration (Schulz et al. 2006). In a healthy mourning dove the H:L ratio is about 0.25 but is highly variable among individuals. The H:L ratios observed in this current study were comparable to those of Schulz et al. (2006, 2007).

ALAD is an enzyme in the heme biosynthetic pathway whose activity is reduced in the presence of Pb. However, there are no reported toxicological affects associated with a reduction in ALAD activity in the absence of anemia, which can be indicated by a decrease in PCV (Kendall et al. 1996). ALAD activity levels of all doves that ingested Pb shot in the current study dropped to <10% of pre-treatment levels, comparable to the 87-93% declines seen in previous studies (Kendall and Scanlon 1982; Kendall et al. 1982).

Population Level Effects of Pb Shot Ingestion

A risk assessment by Kendall et al. (1996) stated that a reasonable LD_{50} for wild mourning doves under ambient conditions is 440 mg Pb or 4 #6 Pb shot, but the data from this study suggest a lower value. Of the birds that ingested 2 or 3 #7.5 Pb shot in this study, 100% (11/11) contained ≥1 lethal tissue Pb concentration. The lack of lethal tissue Pb concentrations in the one dove that ingested 4 Pb shot was probably due to the short retention time of those shot. Four shot were visible on the day 2 x-ray but none on day 4. Of the 4 birds that ingested 1 shot each, 25% had ≥ 1 lethal tissue Pb concentration. This data suggests an LD_{50} of less than 2 #7.5 Pb shot for mourning doves. Even if a bird is not directly killed by Pb poisoning, Pb toxicosis can result in weight loss, weakness, twitching, and convulsions that can increase the animal's susceptibility to predation and reduce its survival (Bauck and LaBonde 1997).

Assuming that 10% (Kendall et al. 1996) of the 450 million mourning dove population feeds in high risk areas, such as managed dove fields, and 2.9% of those ingest shot, 1.31 million birds are at risk of Pb shot ingestion. If the true shot ingestion rate is closer to 1.0%, then 0.45 million birds are at risk of shot ingestion as compared to 2.21 million birds at a 4.9% Pb shot ingestion rate. If 75% of these birds die either from direct effects of Pb shot ingestion or Pb toxicity-induced increased susceptibility to predation, between 0.34 million and 1.66 million mourning doves would die from Pb shot ingestion each year.

Acknowledgements

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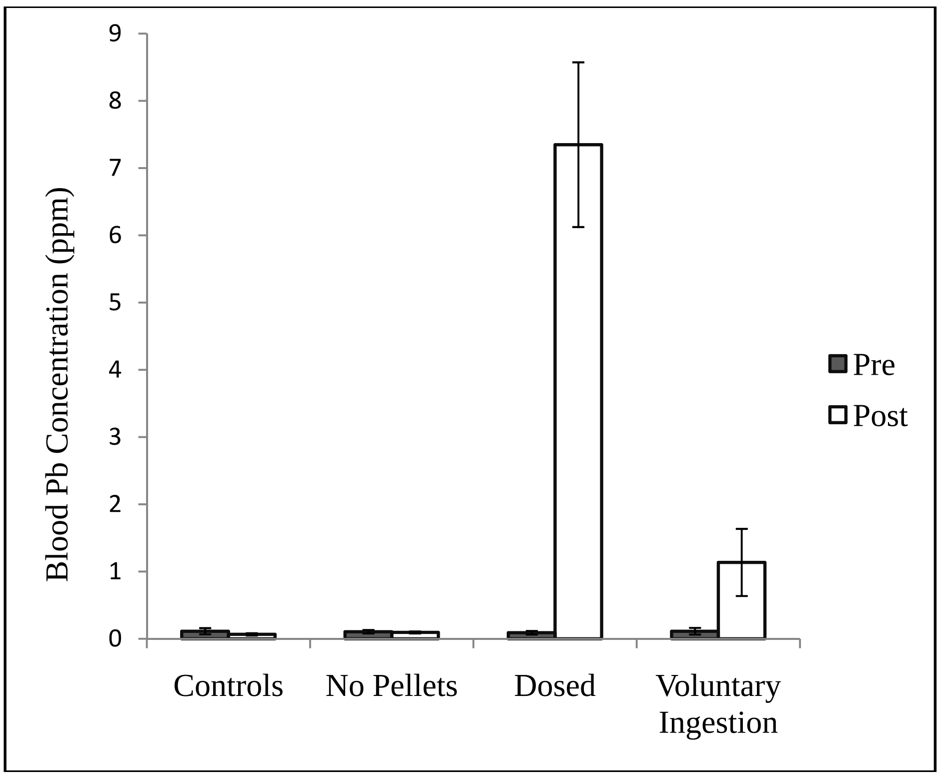


Figure 2. Blood lead concentrations (mean ± SE) pre- and post-treatment in ppm wet weight of wild mourning doves held in captivity in a lead shot ingestion study during 2008 in Carbondale, IL, USA.

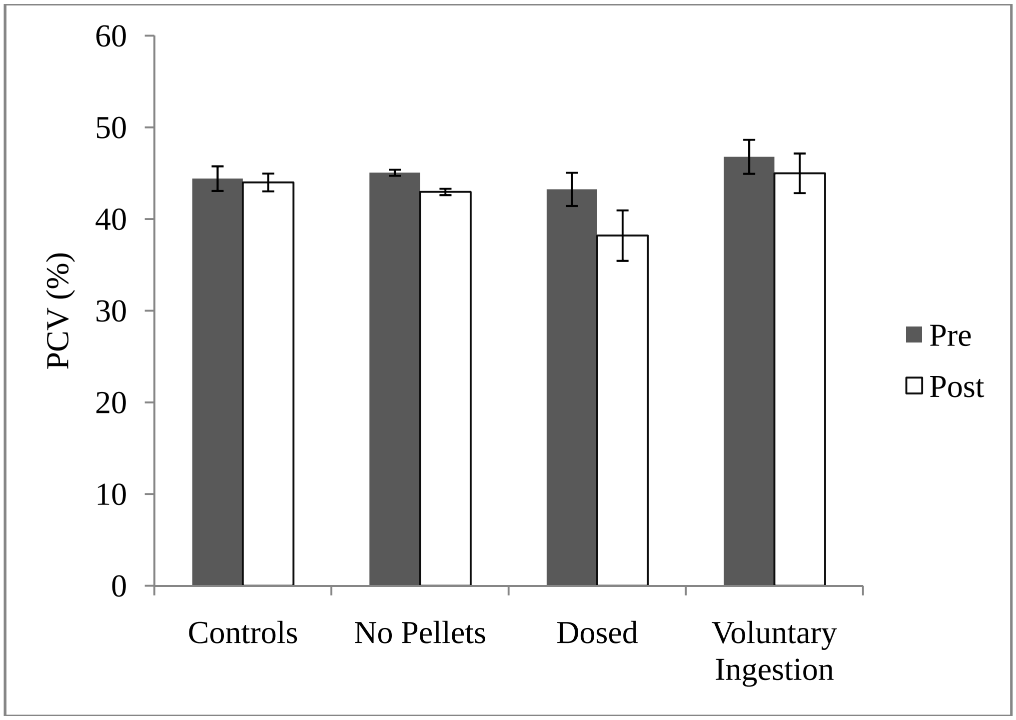
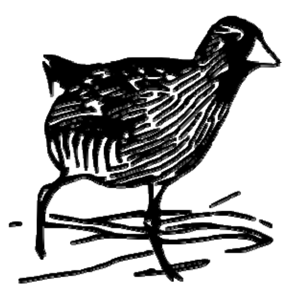


Figure 3. Packed cell volumes (PCV; mean ± SE) pre- and post-treatment of wild mourning doves held in captivity in a lead shot ingestion study in 2008 during Carbondale, IL, USA.



White-winged Doves

USING GIS, STABLE ISOTOPES, AND GENETIC ANALYSIS TO DIFFERENTIATE POPULATIONS OF WHITE-WINGED DOVE THAT BREED IN THE UNITED STATES: DELINEATING HABITAT USE, POST-BREEDING DISPERSAL, AND WINTERING GROUND DISTRIBUTION

SCOTT A. CARLETON, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82072 (scarlet@uwyo.edu)
CARLOS MARTINEZ DEL RIO, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82072 (cmdelrio@uwyo.edu)

Graduate Student: Scott Carleton (Ph.D.); **Final Report**

Introduction
Across their range, white-winged dove populations have exhibited large increases and declines. These fluctuations have been caused, to a large extent, by anthropogenic changes on the landscape. The sources of anthropogenic change on the breeding grounds and their effects on white-winged dove populations have been well documented and addressed. However, our understanding of factors effecting white-winged doves on the wintering grounds are less understood. To investigate white-winged doves on the wintering grounds we identified two objectives that must first be met. *1) We need to better understand the distribution of eastern and western populations on the breeding grounds and 2) we need to determine if the eastern and western populations of white-winged doves can be differentiated from one another.*

Two new analytical methods, stable isotope and genetic marker analysis, have emerged as powerful tools to differentiate populations of birds and describe their movements. During molt, the carbon ($\delta^{13}C$) and hydrogen ($\delta^{2}H$ henceforth referred to as δD) isotopic signatures of the food and water birds consume are incorporated into their tissues. This signature, once incorporated into feather tissue, becomes inert and remains as a record of the breeding ground until the feather is again molted. This is important because hydrogen isotopic composition (δD) of precipitation forms a gradient across North America due roughly to differences in temperature, humidity, evaporation, topography and patterns of rainfall. Because of this gradient, feathers grown in one geographic location are discernible from feathers grown in another geographic location. In addition, genetic markers, such as microsatellite DNA and amplified fragment length polymorphisms (AFLP), are a powerful tool to differentiate populations of closely related species. We wanted to combine these two methods with GIS spatial analysis to differentiate the two populations of white-winged doves that breed in North America and then determine their distribution on the wintering grounds in Southern Mexico.

Typical Sonoran desert habitat south of Gila Bend, Arizona, *photo by S. Carleton*

Progress to date
With the help of Texas Parks and Wildlife, New Mexico Game and Fish, California Game and Fish, and Arizona Game and Fish biologists we began collecting wings from hunters in the fall of 2004, 2005, 2007, and 2008. We pulled the earliest molted flight feather, as this would have been grown on or near the breeding grounds. Deuterium, δD, isotope analysis of feathers reveals clear differentiation among dove populations across Arizona, New Mexico, and Texas. Discriminant analysis indicates that,

isotopically, New Mexico and Texas birds have similar isotopic values and could not be differentiated from one another. However, discriminant analysis differentiated New Mexico and Texas doves from Arizona populations of doves. Furthermore, in Arizona doves inhabiting Sonoran Desert habitats could be differentiated from doves inhabiting agricultural habitats. Figure 1 shows feather δD values across the landscape using a GIS interpolation model. You can clearly see that white-winged dove isotope values show little differentiation from east to west until you reach southern Arizona. The use of saguaro cacti in the Sonoran Desert causes an increase in feather δD values and the influence of flood irrigation utilizing Colorado River water causes a decrease in feather δD values creating a mosaic of values that are revealed using GIS spatial analysis. Not only can we differentiate eastern and western populations, we can differentiate desert from agricultural doves in Arizona. Determining the distribution of white-winged doves on the wintering grounds relied on our ability to differentiate the two populations from one another. We are currently applying a GIS probability surface model developed by Dr. Michael Wunder at the University of Colorado-Denver to determine the breeding ground origins for birds collected in southern Mexico. The results of this data will help determine the location and distribution of eastern and western populations in Southern Mexico during the winter and are almost complete.

We are awaiting final analysis of the AFLP data, and plan to compare data collected in two other studies utilizing mitochondrial and microsatellite DNA to investigate subspecies classification for *Zenaida asiatica asiatica* and *Z. a. mearnsii*. The final results of this study, including all GIS spatial analysis using isotope data and genetic analysis are almost complete and are being written up for publication.

Future work

We have been analyzing stable isotope values from mourning doves and white-winged doves between desert and agricultural sites. Our initial analyses show that doves in agricultural complexes have identical isotope signatures whereas doves in desert habitats have contrasting isotope signatures revealing differences in resource use and availability to two different desert consumers. We are currently finishing the analysis of native seeds and will be writing this up for publication.

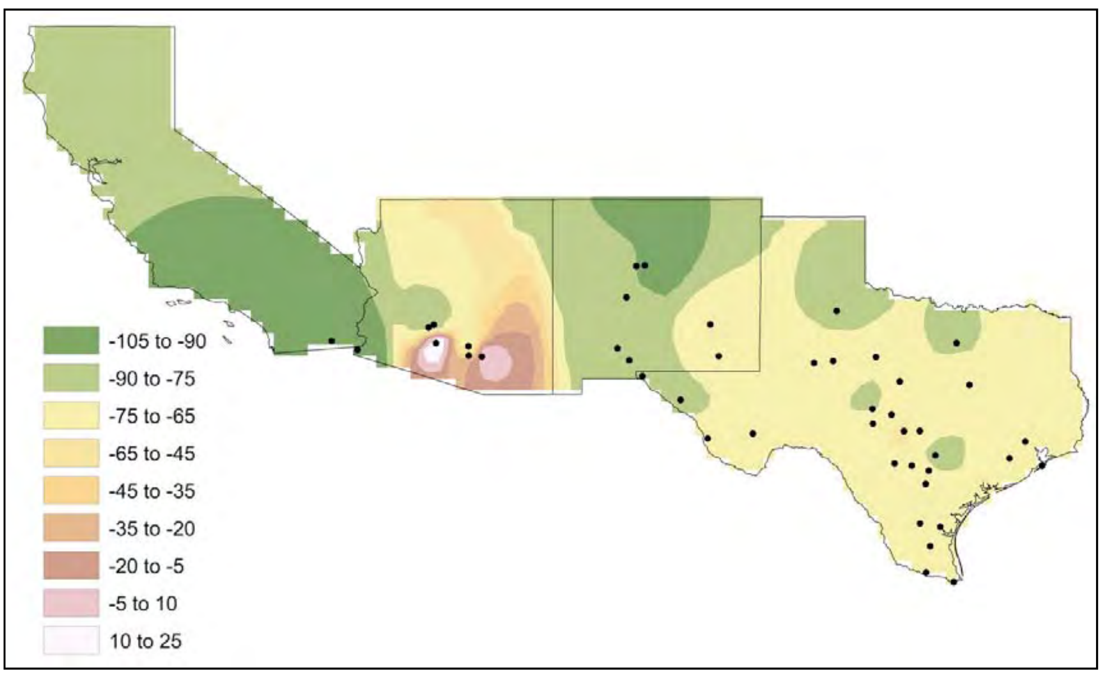


Figure 1. Feather δD values can be used to create 'Isoscapes' across the breeding range. Interpolated surface of feather δD isotope values reveals little differentiation across NM and TX. In AZ habitat use drives localized feather δD values. Points are collection sites.

Band-tailed Pigeons

BAND-TAILED PIGEON USE OF SUPPLEMENTAL SODIUM AND CALCIUM

TODD A. SANDERS, Population Ecologist, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, 911 NE 11th Avenue, Portland, OR 97232, USA (todd_sanders@fws.gov)

Expected Completion: 2010

Introduction and Objectives

In the Pacific Northwest, band-tailed pigeons have a strong affinity for and use mineral sites (mineral laden water or soil) during the nesting season. The principal attractant at these sites appears to be sodium ions, but the birds may also seek calcium ions. Pigeons in the U.S. Interior and southern Pacific Coast regions generally do not exhibit this behavior. These birds should have the same physiology and therefore similar mineral needs throughout their range. Band-tailed pigeons are thought to have an increased need for sodium, and possibly calcium, during the nesting season for egg and crop milk production. Specific information about the mineral needs and intake for breeding pigeons are unknown. However the timing and region of mineral site use is associated with the availability of berries of red elderberry, cascara, and blue elderberry, which are known to be primary food items consumed by band-tailed pigeons when available. The properties of these berries most likely to cause pigeons to seek supplemental minerals when consuming them are high potassium content, low sodium and calcium content, high moisture content, high acidity, and secondary plant compounds such as alkaloids and tannins known to occur in red elderberry and cascara. Another plausible explanation for band-tailed pigeon use of mineral sites during the nesting season in the Pacific Northwest is that these birds simply do not have regular access to mineralized grit or alkaline soils as do birds in the Interior region and elsewhere. The band-tailed pigeon need for supplemental sodium and calcium during reproduction or in association with a berry diet has not been tested experimentally. Furthermore, band-tailed pigeons are counted annually at select mineral sites by wildlife agencies in British Columbia, Washington, Oregon, and California to index abundance without a clear understanding of what factors may cause these counts to vary in time and space other than population abundance and precipitation.

My goal is to test the hypothesis that the band-tailed pigeon needs supplemental sodium and calcium during reproduction and in association with a berry diet. Specific objectives are to: (1) determine which supplemental minerals are sought by band-tailed pigeons in the Pacific Northwest, (2) determine if supplemental mineral use is associated with reproduction and or a berry diet, and (3) determine if grit selected by band-tailed pigeons throughout the Interior and Pacific Coast regions represents a differential source for supplemental minerals. Essential components of the study necessary to accomplish these objectives include: (1) a feeding trial to experimentally test which food items are associated with mineral site use, the specific minerals sought, and consequences of limited access; (2) evaluation of ionic content of mineral sites known to be used by band-tailed pigeons; (3) assessment of the apparent attraction to, and consumption of, alternative minerals provided free living band-tailed pigeons; (4) determination of mineral content of primary food items consumed by band-tailed pigeons throughout their range in the Interior and Pacific Coast regions; (5) evaluation of the mineral content of crop milk from band-tailed pigeons in the Interior and Pacific Coast regions; and (6) assessment of mineral content of grit removed from the gizzards of hunter-shot band-tailed pigeons throughout their range during summer and fall.

This study is expected to provide results with application throughout the species range where little is known about supplemental mineral use, and to contribute to the priority research needs for this species where the population status is largely either unknown or thought to be less abundant than in the past. Specifically, this research provides information toward developing reliable population monitoring techniques for use throughout the range of the species, describing seasonal habitats essential for maintaining pigeon populations, and understanding the effects of land management practices on food (and associated supplemental mineral) availability and abundance needed to maintain breeding populations. Furthermore, used mineral sites appear to be scarce in the western U.S., and are seemingly essential resources for this species, at least in this part of their range. Mineral sites may be the scarcest resource required for reproduction by band-tailed pigeons in the Pacific Northwest. Also, eighty-six percent of known currently-used mineral sites are privately owned and subject to possible alteration from land-use practices. Potentially, minerals sites could be enhanced or created if the physiological need for mineral is known.

Progress to Date

I completed the first year of a 2-year study as planned including: (1) conducting a feeding trial, (2) sampling mineral content of sites known to be used by band-tailed pigeons, (3) creation of a mineral site used by free living band-tailed pigeons, (4) sampling mineral content of natural food items, (5) sampling mineral content of crop milk, and (6) sampling mineral content of grit used by band-tailed pigeons.

Mineralized water and salt deposits on rock outcropping at Jarbo Gap mineral site along the Feather River in northern California, *Photo by Todd Sanders.*

I conducted a feeding trial on 24 pairs of wild caught band-tailed pigeons during July through September. Each pair was kept individually in an outdoor flight cage made of 14 gauge 2.5 × 2.5 cm galvanized welded wire mesh measuring 81.3 cm wide, 152.4 cm tall, and 121.9 cm deep. The gender of each bird was determined by plumage examination and using Polymerase Chain Reaction to analyze the DNA from the sex chromosomes of each bird. Each bird was randomly assigned to a cage with the constraint that each cage contained a pair. Each cage had a wire mesh loft and plastic nest bowl with pad, perch pole made of 2.5 cm outside diameter PVC pipe across the width of the cage, and 3 spill proof plastic dishes: 1 for feed, 1 for fresh water, and 1 for mineral solution depending on treatment. Each pair was assigned to 1 of 4 treatment groups (n = 6 per treatment): water, NaCl solution at 3,500 ppm Na, CaCl solution at 1,500 ppm Ca, and NaCl and CaCl solution at 3,500 ppm Na and 1,500 ppm Ca. Sodium and calcium solutions were similar in concentration to the mean of mineral springs used by band-tailed pigeons in Oregon. Birds were offered an unlimited amount of feed, water, and mineral solution and checked daily. Each feeding trial consisted of 4 to 5 consecutive weeks of feeding a single food item, either red elderberry or cascara. Red elderberry was fed 5 weeks, cascara 4 weeks, and red elderberry again for 4 more weeks. I intended to feed blue elderberry during the last 4 weeks, but unexpectedly there was little available for collection due to variation in seasonal availability. Berries were wild picked, frozen, and thawed prior to feeding. Berries were kept frozen no longer than 3 months. Feeding trials were consecutive and the birds were feed cracked corn during the 2 weeks prior to the start of feeding trials in which birds adjusted to captivity. Cages were cleaned weekly. Evaporation was measured in 4 additional spill proof plastic dishes placed adjacent to the cages and protected from animal access. Evaporation and fluid consumption was measured weekly and body mass was measured at the beginning and end of each feeding trial to the nearest 100th gram. A fecal sample was collected from each cage during the last week of each feeding trial for assessment of mineral excretion. Fecal samples were submitted to Oregon State University's Central Analytical Laboratory for analysis by induction-coupled plasma (ICP) spectrometer scan to measure cation composition. Initial results from this first year of the feeding trial indicate that none of the pairs initiated a nest in captivity and there was no difference in apparent condition or body mass among treatment groups. Apparently non-breeding band-tailed pigeons are able to maintain health when feeding exclusively on a berry diet regardless of access to supplemental minerals for at least 13 weeks. Pigeons consumed little to no free water when fed berries.

I sampled ionic content at about 40 mineral licks known to be currently used by band-tailed pigeons throughout Washington, Oregon, and California. This sample represents most all of the sites were pigeons are counted by state agencies and the primary sites know to be used by these birds. Samples were submitted to Oregon State University's Central Analytical Laboratory for analysis by ICP spectrometer scan to measure cation composition. Preliminary results are consistent with earlier published results from Oregon in that mineral licks currently used by band-tailed pigeons are consistently high in sodium content and are highly variable in calcium content with many licks having little to no calcium.

I created a mineral station within the breeding range of band-tailed pigeons and maintained the site during late May to early September. The mineral station consisted of a wood platform with 2 shallow pans that each held about 11 liters of water surrounded by a 182.9 cm high chicken wire fence. One pan contained a NaCl solution at 3,500 ppm Na and the other contained CaCl solution at 1,500 ppm Ca. Fluid consumption was measured daily and the position of pans were cleaned and rotated weekly. Evaporation was measured daily in a third pan surrounded by 2.5 x 2.5 cm mesh welded wire. Band-tailed pigeons found the site and drank daily. During late May through July (62 days), band-tailed pigeons consumed 73.5 liters of NaCl (about 1.2 liters per day) and 56.5 Liters of CaCl (about 0.9 liters per day). The birds appeared to favor NaCl, but possibly drank CaCl as a water source given the low concentration of Ca. During August and early September (36 days), both pans were filled with NaCl solution and band-tailed pigeons continued to visit the station and consumed 48.5 liters of NaCl (about 1.3 liters per day). Also, an additional station was established within 300 meters. Trays were filled with soil from the area mixed 5 parts soil to 1 part NaCl or CaCl. Band-tailed pigeons consumed 406.9 grams of NaCl and dirt mixture vs. 60.4 grams of CaCl and dirt mixture per week while continuing to use the NaCl solution 300 meters away. Birds appeared to have a strong craving for sodium before elderberry fruits where available and during an unusual year of especially abundant wild cherries, and this craving persisted throughout the nesting seasons regardless of apparent availability of elderberry, cascara, and other food items in the vicinity.

I collected about 25 samples food items consumed by band-tailed pigeons throughout their range. Samples were submitted to Forage Testing Laboratory, Dairy One, Inc for analysis by ICP spectrometer scan to measure cation composition. In general, red elderberry, cascara, and blue elderberry from the Pacific Northwest appeared similar in mineral content to food items used by band-tailed pigeons throughout the Pacific Coast and Interior regions, except that elderberry and cascara appeared to have slightly higher moisture and potassium content. Food items consumed by band-tailed pigeons appear slightly deficient in calcium and highly deficient in sodium in comparison to the nutritional requirements for growing domestic birds, which range from 0.4 to 1.2% calcium and 0.30 to 0.70% potassium, and are almost invariably 0.15% sodium in the dry diet.

I collected crop milk from 11 harvested pigeons during September 2009 in Oregon and Washington and 1 from Colorado. Crop milk was submitted to Forage Testing Laboratory, Dairy One, Inc for analysis by ICP spectrometer scan to measure cation composition. Values from the Colorado sample were intermediate to the range of values from Oregon and Washington so sample results were combined. Crop milk contained 0.15% sodium (SE=0.01), 0.78% calcium (0.04), and 0.52% potassium (0.02). These values are consistent with the nutrient requirements for growing poultry, and may represent the nutrient requirement of growing band-tailed pigeons.

I collected gastroliths and determined food items consumed in 341 hunter shot band-tailed pigeons during the 2008 and 2009 hunting seasons. I determined the number, mass, volume, and angularity class of gastroliths for each bird. The primary food items selected by birds in the Pacific Northwest was elderberry and cascara, with some cherry and dogwood. The gastroliths from 60 birds, 30 from each of the Interior and Pacific Coast regions, were submitted to GeoAnalytical Lab at Washington State University for mineral composition determination via ThermoARL Advant'XP+ sequential X-ray fluorescence (XRF) spectrometer analysis. Samples were ground to a fine powder, weighed with di-lithium tetraborate flux (2:1 flux:rock), fused at 1000°C in a muffle oven, and cooled; the bead was then reground, refused and polished on diamond laps to provide a smooth flat analysis surface. Analysis included the assessment of the 10 major and minor elements of most rocks, plus 19 trace elements. Results indicate that birds from the Interior and Pacific Coast regions generally select similar material for gastroliths. Gastroliths from the Pacific Coast and Interior regions were primarily silicon; 79.5% (SE=2.8, 95% CI=74.0 to 85.0) and 89.2% (SE=2.4, 95% CI=84.6 to 93.9), respectively. Gastroliths contained 3.3% (SE=0.7, 95% CI=1.9 to 4.8) and 3.0% (SE=2.3, 95% CI=0.0 to 7.6) calcium and 2.1% (SE=0.2, 95% CI=1.7 to 2.6) and 0.8% (SE=0.1, 95% CI=0.5 to 1.1) sodium. I also submitted 6 gastrolith samples from the Interior region and 12 samples from the Pacific Coast region to Vancouver Petrographics, Ltd. in British Columbia, Canada for mounting and slicing into polished thin sections. These thin sections will be used for determination of apparent materials selected for gastroliths by band-tailed pigeons.

Future Work

Preliminary research results to date indicate that band-tailed pigeons in the Pacific Northwest seek supplemental sodium and possibly calcium during the nesting season. This need seems to be associated with production of crop milk during reproduction. Food items throughout the species range appear to provide little calcium and especially little sodium. Possibly band-tailed pigeons in the Pacific Northwest compared to elsewhere are more challenged in retaining sodium because of the high moisture and potassium content of their almost exclusive berry diet. These birds are able to find supplemental sodium and calcium at certain natural seeps and springs in the Pacific Northwest. It is not apparent if band-tailed pigeons regularly seek supplemental minerals in other parts of the species range. But if they do, the grit selected by these birds does not appear to be a source of supplemental sodium or calcium.

Work planed for 2010 includes repeating the feeding trial on nesting band-tailed pigeons. It will be imperative to have captive band-tailed pigeons nest to determine if supplemental mineral use is associated with reproduction. Presently it is unclear whether band-tailed pigeon will nest in captivity. Also, I plan to continue to sample any remaining mineral sites and food items not already sampled in 2009, and to maintain the mineral site created in 2009. Gastrolith thin sections will be examined under an electron scanning microprobe at Oregon State University to determine parent material of gastroliths used by band-tailed pigeons. A final report on the research is expected to be completed in December 2010.

These results represent the first year of a 2-year study funded primarily by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service).

Salt deposits on rock outcropping at Jarbo Gap mineral site along the Feather River in northern California. *Photo by Todd Sanders*

BREEDING DISTRIBUTION AND MIGRATION ROUTES OF PACIFIC COAST BAND-TAILED PIGEONS

MICHAEL L. CASAZZA and CORY T. OVERTON, US Geological Survey, Western Ecological Research Center, 6924 Tremont Road, Dixon, CA 95620 (Mike_Casazza@usgs.gov, coverton@usgs.gov)

Expected Completion: June 2010

Beginning in 2006, we radio marked band-tailed pigeons with solar powered satellite (PTT) transmitters. The PTT's allowed for year around tracking of this highly migratory species and provided valuable data regarding migration patterns and timing, site fidelity to breeding or wintering areas, and distribution of pigeons relative to hunting seasons. We radio-marked pigeons during the breeding season (July-August) although a small subset of the birds was marked in California during the winter period of 2006 and 2007.

We marked fourteen band-tailed pigeons in 2007 at six locations in California, Oregon, Washington, and Nevada (near CA border at Lake Tahoe). Four additional birds were radio-marked in British Columbia, one bird in Washington and two birds in California during the breeding season of 2008 (July/August). This provided a total of twenty one birds marked in 2007-2008 (Figure 1).

Migration – Timing

Spring migration started on May 23 in 2006 (n=2), April 25 in 2007 (n=2) and April 16 in 2008 (n=7). The duration of the Spring migration period ranged from 15 to 36 days with an overall mean of 19 days (Figure 2). Most of our data on Fall migration was obtained in 2007 and 2008 with an average start date of September 23, and an average end date of November 7th for a duration averaging 45 days (n=22) (Figure 2).

Migration – Distance

Radio-marked pigeons had a high fidelity to their breeding areas. The average distance between the center of their breeding season home ranges was only 7 km (n=12) while the average distance between the center of winter season home ranges was 109 km (n=22). The overall average distance traveled between winter and breeding season use areas was about 747 km (n=54).

Mineral Sites

Virtually all birds were located within 35 km of a mineral site during the breeding season. The only exceptions were California marked birds, including the bird marked in Carson City, NV and the two birds marked near Morgan Hill, CA in 2008. The distribution of known mineral sites in California does not include these areas, suggesting unknown mineral sites may be present.

Hunting Season

Several of the solar powered transmitters continued to function into 2009. During 2007, no bird had left the state where it resided during the breeding season by the end of the September hunting season (Figure 3). However, in 2008 several of the pigeons had moved out of their breeding areas (Figure 3). The 3 remaining operable PTT transmitters in 2009 remained in the vicinity of their breeding season locations during the hunting season (Figure 3). Future analysis will explore the timing of movement in relation to annual weather patterns.

The pattern (distribution and abundance) of bird locations indicated that in 2007, one Washington bird still exhibited nesting behavior (highly localized movements) during the September hunting season. Two birds breeding in Oregon (one from McMinnville, the other marked near Sacramento, CA) initiated migration during the hunting season but remained in Oregon throughout. None of the California breeding birds (including the bird marked in Carson City, NV) exhibited any large movements during the early California hunting season.

Locations of birds during the hunting season were often found near mineral sites. Of the 14 birds with adequate hunting season locations (excluding one bird from Sequim, WA and the bird marked at the Dutch Canyon, OR mineral site), 9 birds were located at least once within 10 km of a known mineral site. One additional bird was located once 16 km from a mineral site and an additional bird location 27 km. The three birds marked in California were all located >60 km from a known mineral site. The McMinnville bird that initiated fall migration during the hunting season was found within 15 km of three separate mineral sites during the 9 day hunting season.

Conclusion

The 2009 band-tailed pigeon satellite telemetry season provided additional information on Pacific Coast band-tailed pigeon migration patterns due to the long-life of a few of the solar powered transmitters. The four additional transmitters purchased by the US Fish and Wildlife Service and deployed in British Columbia provided insight into the movement patterns from our northern most area (Figure 3).

Although sample size is often limited in studies using PTT's due to the high cost of the transmitter and data retrieval, the longevity of these solar powered transmitters increased our ability to examine seasonal and yearly differences in movement patterns, timing and migration paths.

During spring of 2010 we will complete our final analyses. Results will be incorporated into a final report and several peer reviewed journal articles. Results from this project can be viewed on our website: http://www.werc.usgs.gov/dixon/pigeon/.

Primary support for this three-year project has been provided through a grant from the Webless Migratory Game Bird Research Program administered by the US Fish and Wildlife Service. Partners include the California, Oregon, and Washington state wildlife agencies, and the Canadian Wildlife Service.

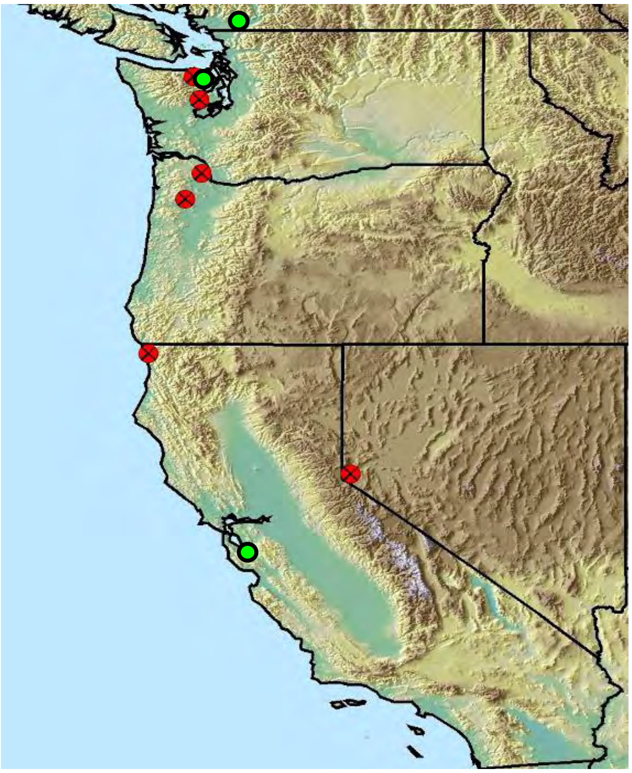


Figure 1. Pacific Coast band-tailed pigeons were captured and fitted with 12 gram back-pack mounted satellite transmitters at six locations in August 2007 (red) and 3 locations in 2008 (green).

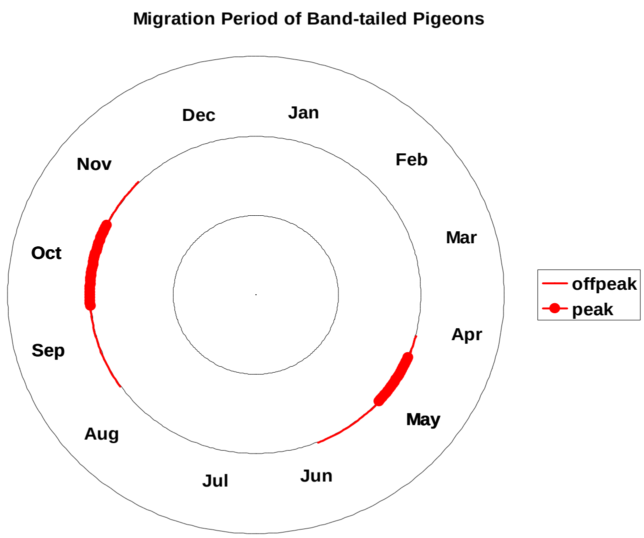


Figure 2. Migration timing of Pacific Coast band-tailed pigeons

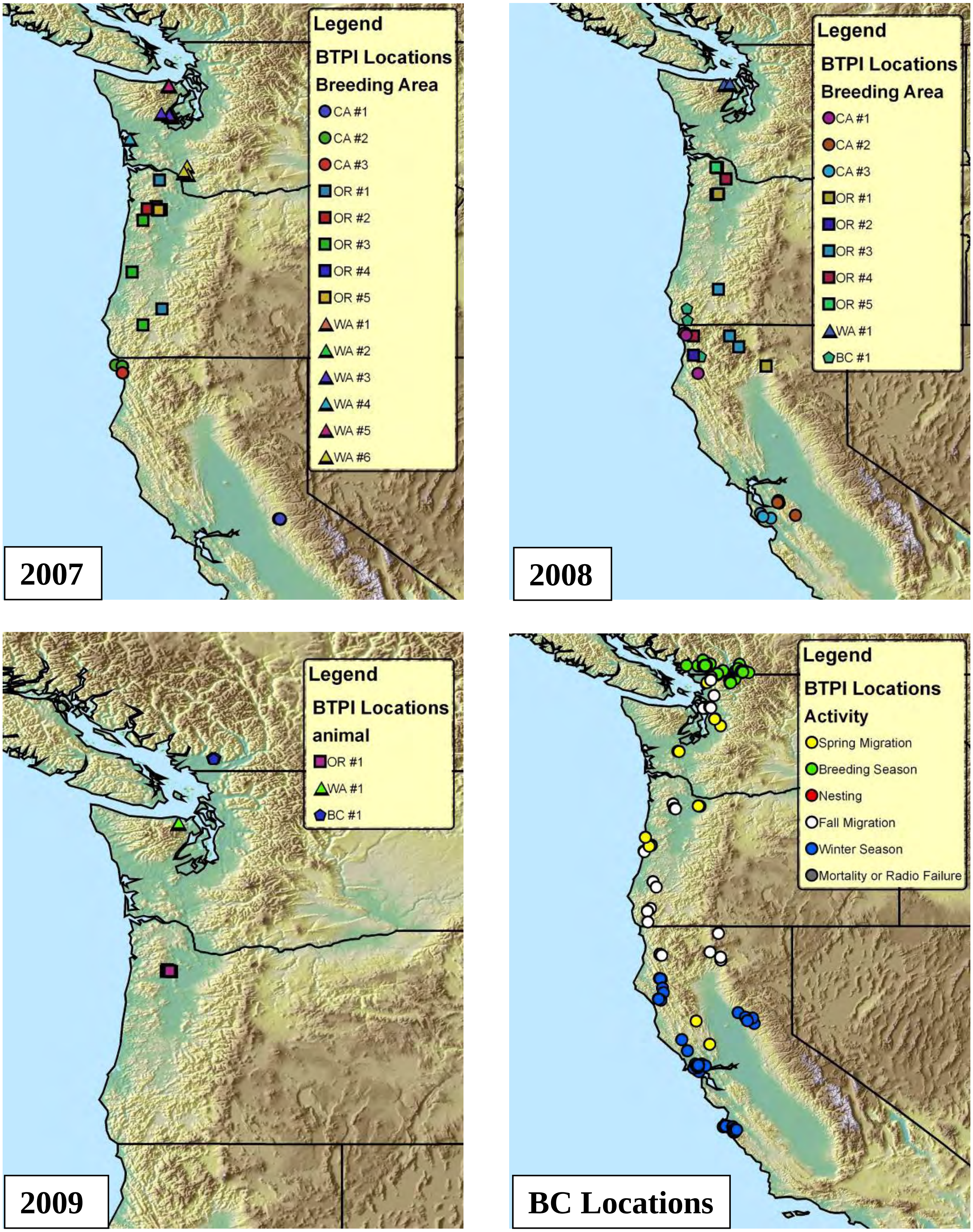


Figure 3. Band-tailed pigeon locations during the September 2007, 2008, and 2009 hunting seasons and locations of band-tailed pigeons radio-marked in British Columbia, Canada.

Sandhill Cranes

ECOLOGY OF SANDHILL CRANES (*GRUS CANADENSIS TABIDA*) BREEDING IN NORTHEAST NEVADA

CRAIG MORTIMORE, Nevada Department of Wildlife, 1100 Valley Road, Reno, Nevada 89512, USA (cmort@ndow.org)
CHRISTOPHER NICOLAI, Department of Natural Resources and Environmental Science, University of Nevada Reno, 1000 Valley Road, Reno, Nevada 89512, USA (nicolai@unr.nevada.edu)
JEFF MACKAY, United States Fish & Wildlife Service, Ruby Lake National Wildlife Refuge. HC 60, Box 860, Ruby Valley, Nevada 89833, USA (Jeff_Mackay@fws.gov)
PETER BRADLEY, Nevada Department of Wildlife, 60 Youth Center Road, Elko, Nevada 89801, USA (pradley@ndow.org)
JAMES SEDINGER, Department of Natural Resources and Environmental Science, University of Nevada Reno, 1000 Valley Road, Reno, Nevada 89512, USA (jsedinger@cabnr.unr.edu)

Graduate Student: Chad W. August (M.S.); **Expected Completion:** May 2011

Introduction and Objectives

Greater sandhill cranes (*Grus canadensis tabida*) nesting primarily in northeastern Nevada, south-central and southwestern Idaho, and extreme northwestern Utah are assigned to the Lower Colorado River Valley (LCRV) population because they winter along the lower Colorado and Gila Rivers in Arizona, the Imperial Valley, California, and in Baja California Norte and Sonora, Mexico. This population is the smallest of the migratory populations of sandhill cranes and has one of the lowest reported recruitment rates (4.8%) of any crane population in North America (Drewien et al. 1995).

In 2008, the Fish and Wildlife Service determined that a small allowable hunt would occur if the most recent, reliable 3-year LCRV population average for which there is available data was greater than 2,500 birds (Kruse 2009). The 3-year average for 2006, 2007, and 2009 was 2,981 cranes, which was greater than the population objective. An experimental 3-year hunt has been proposed for this population on the wintering areas in Arizona. Thus far, no studies exist that have estimated important demographic parameters of the LCRV population of sandhill cranes. Accurate assessment of survival rates, productivity, and other parameters are imperative to properly manage this population.

The objectives of this study are to 1) estimate nest success for cranes nesting in northeastern Nevada, 2) estimate proportion of colts that survive from hatch to fledging, 3) estimate proportion of pairs that attempt to nest and 4) estimate adult annual survival. These demographic parameters will be used to develop a population projection matrix model (Caswell 2001). This matrix model will allow evaluation of the sensitivity of the population's growth rate to certain vital rates, which can help inform future management decisions.

Progress

Meadows and riparian areas in northeast Nevada were surveyed for nesting cranes beginning in April 2009 (Figure 1). A majority of the nest searching was done by searching on foot, but in addition we searched for nesting cranes with a variety of techniques including scanning using spotting scope and binoculars for nesting cranes, helicopter and airplane surveys, monitoring cranes for changing of incubation responsibilities, and ATV searching. A total of 61 nests were discovered in Northeast Nevada during summer 2009. Eleven of the nests found were already inactive (previously hatched or failed). Fifty active nests were monitored, of which 17 produced at least one colt (34% Apparent Nest Success).

To determine colt survival, a 5-gram VHF radio transmitter was attached to the back of 51 colts using prong-and-suture. Colts were monitored approximately twice weekly. When colts reached three weeks of age, radio transmitters were removed and attached to auxiliary markers to be placed above the left tibiotarsus and a federal aluminum band was added above the right tibiotarsus.. Thirty colts were banded with auxiliary markers and federal aluminum bands. Of colts for which we determined fate, 12 colts survived to fledging and 15 colts succumbed to mortality (n=27).

During fall pre-migration staging in August and September, adult cranes were banded on Ruby Lake NWR by rocket netting over a rye field baited with corn. During four shots, we were successful in capturing nine adult cranes. Eight of the cranes were banded using a USFWS aluminum band and a PVC auxiliary marker with a two-digit blue alpha-numeric code (one of the cranes was previously banded).

Attachment of a radio transmitter to a young colt using prong-and-suture. *Photo courtesy of University of Nevada Reno*

Future Work

Upon arrival of cranes to Nevada in spring 2010, we will attempt to capture cranes for banding using corn laced with alpha-chloralose via protocol modified from Hayes et al. (2003) in addition to employing standard rocket-netting procedures. In 2010, we will continue searching for and monitoring nests and colts to determine fate. Additional airplane flights will be added to increase nest sample sizes, as this was one of the more efficacious methods used in the first year of the project. We will survey breeding areas in Northeast Nevada to determine proportion of pairs that are attempting to nest. We will use modern maximum likelihood approaches to estimate nest and colt survival following the second field season.

This summary is for the first year of a two-year project funded by the USFWS Webless Migratory Game Bird Research and Management Program, Nevada Department of Wildlife, Ruby Lake National Wildlife Refuge, and the University of Nevada Reno. The study will go towards fulfillment of an M.S. for graduate student Chad August from the University of Nevada Reno under the advisement of Dr. James S. Sedinger. Final reports are expected by May of 2011.

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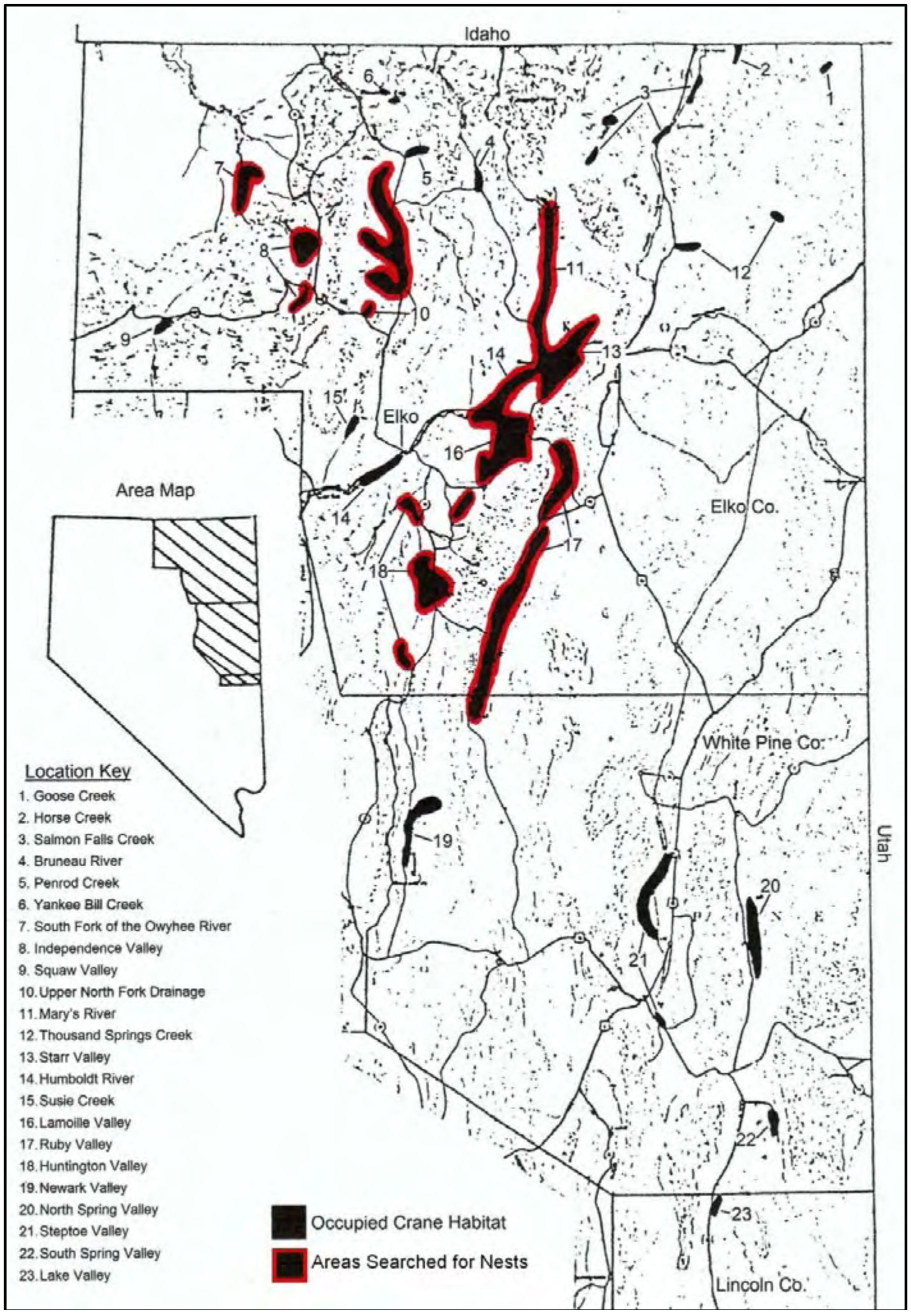

Figure 1. Occupied breeding habitat for greater sandhill cranes in northeast Nevada and areas regularly searched for nests during the 2009 field season. (Modified from Rawlings et al. 1987)

MOVEMENT PATTERNS OF SANDHILL CRANES (*GRUS CANADENSIS TABIDA)* WINTERING ALONG THE LOWER COLORADO RIVER OF ARIZONA

Michael Ingraldi and Vincent Frary, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix AZ 85086 (mingraldi@azfd.gov)

Expected Completion: October 2010

The Greater Sandhill Crane (*Grus canadensis tabida*) wintering population along the lower Colorado and Gila Rivers of Arizona are unique due to their short migration pathway; nesting primarily in scattered intermountain wetlands of northeastern Nevada, and southwestern Idaho and wintering in Arizona and California (Figure 1). This local population of Greater Sandhill Cranes, designated the Lower Colorado River Valley (LCRV) population, is the smallest of the five management populations recognized in the United States (Drewin and Lewis 1987, Meine and Archibald 1996). In a recent environmental assessment of proposed hunting regulations for LCRV cranes within the Pacific Flyway the issue was raised regarding the discrepancy between the breeding and wintering population numbers. Specifically, there appear to be more birds in the LCRV wintering population than can be accounted for on the breeding grounds (e.g., only approximately 30% of the wintering population has been located within the Nevada summer range). This discrepancy suggests one or more of the following possibilities: 1) the summer range includes a larger area than currently identified (i.e., not all the birds are being counted), 2) the summer ranges of the LCRV population and/or the Rocky Mountain and Central Valley populations are not mutually exclusive, 3) there is only one population of western Greater Sandhill Cranes with subpopulations utilizing distinct wintering areas and/or, 4) summer ranges are distinct with some 'mixing' of populations occurring during migration and on winter ranges.

The objective of this study is to monitor seasonal movements of LCRV cranes using satellite transmitters and re-sighting of visual identification (VID) bands in order to clarify the dilemma described above. Attempts at trapping cranes for this project began in November 2008, and are currently ongoing. All trapping has been conducted at Cibola National Wildlife Refuge (CNWR) in Cibola, Arizona (Figure 2). We have tested three crane capture methods including cannon netting over baited sites, cannon netting using crane decoys as an attractant, and spotlight/hand-capturing cranes after dark.

Thus far, we have trapped 3 LCRV cranes during a single successful cannon-net capture over a baited site. At the time when cranes were trapped, we had not yet received satellite transmitters from the manufacturer. Trapped cranes were banded with a VID band and a United States Geological Survey (USGS) aluminum band. All band information was reported to the U.S. Department of the Interior Bird Banding Laboratory.

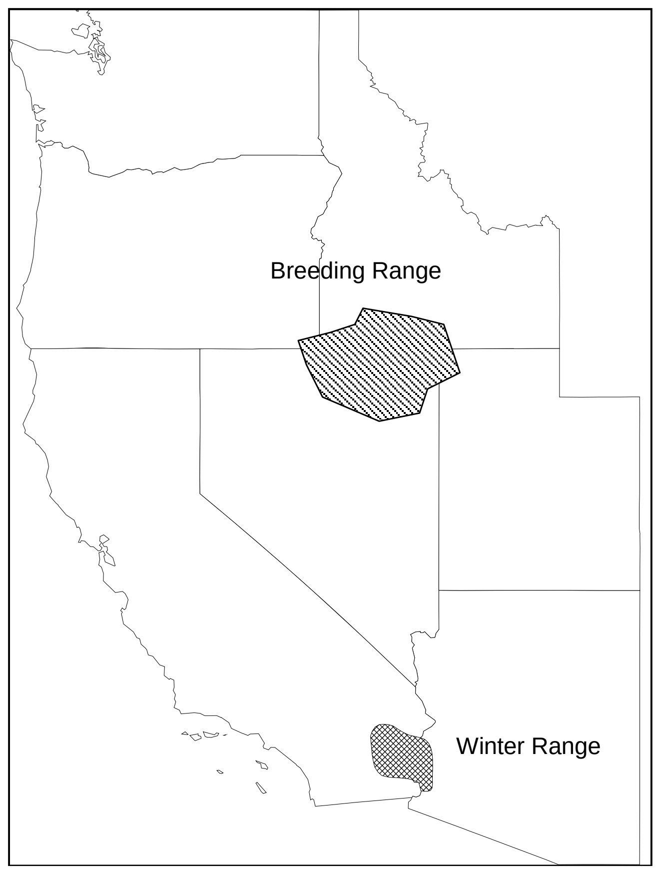

Figure 1. Approximate breeding and wintering distribution of the Lower Colorado River Valley Population of Sandhill Cranes. Only an estimated 30% of the wintering population can be accounted for on breeding grounds in Nevada and Idaho.

Figure 2. Sandhill crane trap site at Cibola National Wildlife Refuge in Cibola, Arizona. Cranes are attracted to trap sites using corn, millet, and/or barley and trapped using cannon nets.

We are currently pre-baiting trap cites as CNWR, and anticipate resuming trapping beginning in December 2009. We will attempt to deploy all six satellite transmitters currently on-hand in addition to banding individuals. We are also planning to travel to Nevada during the crane breeding season in order to search for VID bands and to observe nesting locations of any satellite-transmittered LCRV cranes.

These are results thus far from an ongoing single-year study funded through the USFWS Webless Migratory Game Bird Research Program and the Arizona Game and Fish Department.

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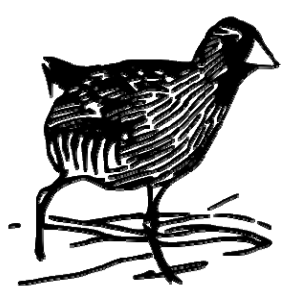

AN EVALUATION OF FACTORS INFLUENCING THE RELIABILITY OF THE ANNUAL SPRING SURVEY OF THE MIDCONTINENT POPULATION OF SANDHILL CRANES

AARON T. PEARSE, USGS Northern Prairie Wildlife Research Center, 8711 37th Street Southeast, Jamestown, ND, 58401 USA (apearse@usgs.gov)
GARY L. KRAPU, USGS Northern Prairie Wildlife Research Center, 8711 37th Street Southeast, Jamestown, ND, 58401 USA

Expected Completion: October 2011

Introduction and Objectives

The midcontinent population (MCP) of sandhill cranes (*Grus canadensis*) is among the most widely dispersed game bird population in the world. Opportunities to conduct an annual survey of the MCP are limited to spring when cranes stage for several weeks in the central and North Platte River Valleys of Nebraska. The U.S. Fish and Wildlife Service conducts a coordinated annual survey in this region on the fourth Tuesday of March each year beginning in 1970. The USFWS relies on this photo-corrected survey to estimate size of the MCP and uses survey estimates to guide decisions concerning population management. Large annual fluctuations in abundance estimates over the past 25 years have cast doubt as to the reliability of the survey. Inability to account for annual variation poses a major concern for managers because sandhill cranes have the lowest annual recruitment rate among game birds (Drewien et al. 1995), limiting the acceptable margin of error in estimates of population size when setting hunting seasons. As a result, gaining reliable annual estimates of MCP size has been identified as a key information need for webless game bird research.

Variation in estimates of MCP abundance from the annual March survey may be due to numerous factors including sampling error, annual variation in observation bias, availability of cranes in the sampled area, and true abundance of MCP cranes. Of these factors, availability of cranes to be sampled has the greatest potential to influence variation in estimates because of fluctuations in migratory patterns of cranes among years. To address missing cranes, searches are conducted in selected Central Flyway states in coordination with the crane survey, but a lack of detailed information on where cranes might be located has hampered efforts to effectively survey these areas. Also, on the Nebraska survey area, waste corn has become less available over the past 2 decades (Krapu et al. 2004), potentially causing cranes to fly farther from the river to feed than in the past and raising concerns that a significant part of the population may move beyond the surveyed area to locate food during some years. Without knowledge of the origins of cranes missed during surveys, potential exists for cranes to decline significantly before surveys detect a negative trend. Weather and river flows vary among years on survey dates but little information exists on how these differences affect reliability of surveys, emphasizing the need for greater insight of their potential effects on crane migration schedules as it relates to reliability of information gained from surveys. Therefore our objectives were to 1) determine distribution of sandhill cranes to assess their availability to be counted during the annual March population survey and locations of cranes not in the survey area; 2) explain variation in timing of crane arrival to and departure from the CPRV and percentage of the MCP present during survey dates with respect to weather and roosting-habitat conditions; 3) quantify distribution and flock sizes of cranes within and adjacent to the survey area and evaluate how variation in these values influence survey estimates; and 4) develop an objective protocol to evaluate the reliability of annual surveys and integrate that assessment tool into the monitoring program of the MCP of sandhill cranes.

Progress to Date

We established 8 transects within the central Platte River Valley to estimate distances cranes flew from the river and temporal use of the region by cranes. We conducted surveys each week on Tuesdays beginning the third week of February and continuing through the second week of April 1998–2002. During spring 2009, we resumed transect surveys during mid- and late March (3 surveys) to supplement existing survey data. We determined spatial distribution of cranes using South Dakota during spring migration to identify likely spring-staging areas. We used this information to devise a ground-based survey protocol, where we visited sections of land and enumerated cranes present. We also noted any observations of cranes in the general survey area when traveling between locations by counting birds and recorded geographic locations.

Future Work

We are in the final stages of completing a data set that identifies arrival and departure information from VHF- and PTT-tagged cranes. We will explain variation in these variables with a set of weather and roosting-habitat covariates. Temperature, prevailing winds, and river flows likely influence migration schedules of cranes, and we will use general linear models to determine if and what magnitude relationships exist between these and other potential covariates. During springs 2010-2011, we will continue transect surveys in Nebraska during mid- and late March and, after completion, analyze data collected for 1998–2002 and 2009–2011. We also will continue South Dakota surveys during the spring survey during March 2010 and 2011 to determine if relative numbers of cranes using this area varies among years. These are results from the first year of a 3-year study funded by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service).

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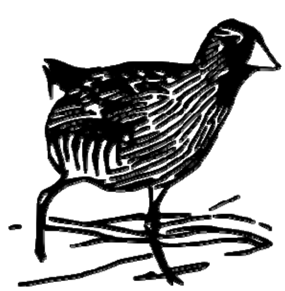

THE USE OF SATELLITE TELEMETRY TO EVALUATE MIGRATION CHRONOLOGY AND BREEDING, MIGRATORY, AND WINTERING DISTRIBUTION OF EASTERN POPULATION SANDHILL CRANES

DAVID L. FRONCZAK, U.S. Fish and Wildlife Service , Migratory Bird Management, Bishop Henry Whipple Building, 1 Federal Drive, Room 501, Fort Snelling, Minnesota, USA (dave_fronczak@fws.gov)
DAVID E. ANDERSEN, U.S. Geological Survey (USGS), Minnesota Cooperative Fish and Wildlife Research Unit, 200 Hodson Hall, 1980 Folwell Ave, St. Paul, Minnesota, USA (dea@umn.edu)

Graduate Student: David L. Fronczak (M.S.); **Expected Completion:** 2012

Introduction

The Mississippi and Atlantic Flyway Councils have recently developed a management plan for the Eastern Population (EP) of sandhill cranes (*Grus canadensis tabida*) and are expecting an endorsement for the plan by their councils in March 2010. The plan's stated goal is to manage EP cranes in the Mississippi and Atlantic Flyways at a sustainable population level that is consistent with habitat and societal values (Ad Hoc Eastern Population Sandhill Crane Committee 2010). The main objectives of the plan include:

1. Maintain the population index between 30,000-60,000 cranes as measured by the U.S. Fish and Wildlife Service (USFWS) Coordinated Fall Survey.
2. Reduce agricultural damage and conflicts due to EP cranes.
3. Provide non-consumptive opportunities
4. Provide consumptive opportunities.

Objective One of the management plan states that the population status will be monitored by the fall sandhill crane survey coordinated by the USFWS. The fall survey is a long term annual survey, established in 1979. It consists of efforts by volunteers and state/federal agencies from the Atlantic and Mississippi Flyways (Wisconsin, Michigan, Indiana, Tennessee, Georgia, and Florida). The main goal of the survey is to count EP cranes that concentrate in Indiana, Michigan, and Wisconsin. The survey is also timed to count birds migrating from the Manitoulin Island staging area in northern Lake Huron, Ontario (EP management plan 2010). The results of the 2009 fall survey indicated that the population index is approaching 60,000 with a five-year average (2005-2009) of 39,000-40,000 (Fig. 1).

Early observation records indicate that EP cranes breed across the Great Lakes region (Michigan, Ontario, and Wisconsin) and winter in Florida and southern Georgia (Walkinshaw 1960). However, the extent of the breeding range in Ontario is unclear. Observation records also indicate that EP cranes migrate southward from their breeding grounds through an east-central corridor that includes Illinois, Indiana, Ohio, Kentucky, Tennessee, and Alabama, enroute to wintering grounds in southern Georgia and central Florida (Walkinshaw 1973, Lewis 1977, Tacha et al. 1992, Meine and Archibald 1996).

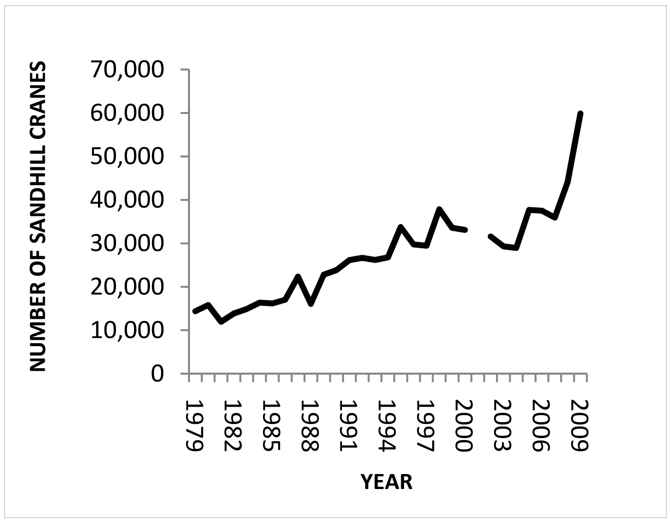

Figure 1. Number of Eastern Population sandhill cranes counted on fall surveys. Survey was not conducted in 2001. U.S. Fish and Wildlife Service data.

EP cranes appear to be expanding their traditional breeding range and migration routes. A 1977-1979 cooperative inventory of sandhill cranes in Minnesota observed breeding pairs, young, and non-breeding sandhill cranes in northwest and east-central counties during the months of May through August. Those cranes observed in east-central Minnesota were considered a part of the EP (Henderson 1979). Since the late 1970s, the breeding range has expanded to the south and now includes northern Iowa, Illinois, Indiana, and Ohio (Tacha et al. 1992; David Sherman, Ohio Department of Natural Resources personal communication).

Recent advancements in technology allow a better examination of sandhill crane movements than was previously possible. For example, in 2007, platform transmitter terminal (ptt) satellite transmitters were placed on 6 sandhill cranes in north-central and southwest Louisiana (Sammy King, U.S. Geological Survey [USGS] Louisiana Cooperative Fish and Wildlife Research Unit 2007). Two of the 6 marked birds migrated east of the Mississippi River into the EP range. The remainder migrated west of the Mississippi River into the Mid-Continent Population (MCP) range, suggesting mixing between the EP and MCP in Louisiana. Of the two birds that migrated east of the Mississippi River, 1 migrated through a less traditional route of west Tennessee through Illinois and into Wisconsin. That same year, Long Point Waterfowl – Bird Studies, Canada placed 4 ptt satellite transmitters on EP sandhill cranes on the north shore of Lake Ontario, Canada and described cranes using traditional migration routes and breeding and wintering areas (Long Point Waterfowl - Bird Studies Canada 2009**).**

In 2009, the Association of Fish and Wildlife Agencies' Migratory Game Bird (MGB) Support Task Force composed of U. S. and Canadian academic, state/provincial, and federal agency experts met to identify priority information needs for the 6 migratory populations of sandhill cranes. These priority needs focused on initiating or enhancing monitoring efforts and estimating vital rates during the annual cycle of sandhill cranes (D. J. Case and Associates 2009). Reviewing the main objectives of the EP management plan and available EP crane studies, the MGB Task Force identified 2 primary information needs for EP cranes:

1. Describe the geographic extents of the breeding and wintering range. Document the spatial and temporal aspects of migration and make appropriate suggestions towards improving the design of the USFWS coordinated survey that will reflect current distribution and migration patterns.

2. Conduct a critical review of the current USFWS coordinated survey and evaluate its effectiveness to monitor the population, recommend improvements for the survey, and develop a standard survey protocol.

The objectives of our study are to address the first information priority need for EP cranes identified by the MGB Task Force. We will describe the EP breeding and wintering range and migration by trapping sandhill cranes with rocket nets on major staging grounds and placing solar GPS satellite transmitters on 40 EP sandhill cranes. We will trap EP sandhill cranes at the Hiawassee Wildlife Refuge, Tennessee during the months of December and January and then at the Goose Ponds Fish & Wildlife Area (FWA) and Jasper-Pulaski FWA, Indiana during the month of March, 2009-2011.

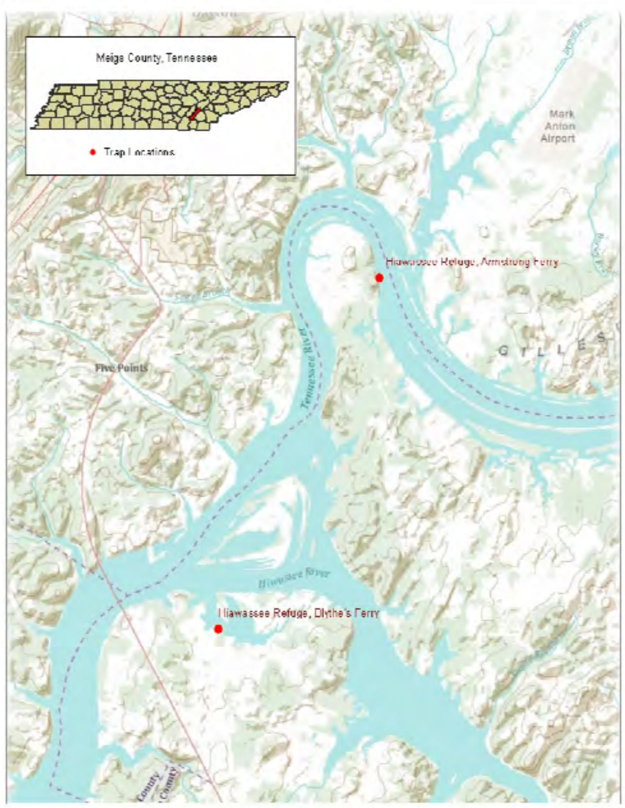

Figure 2. Eastern Population sandhill crane trapping locations at Hiawassee Wildlife Refuge, Meigs County, Tennessee.

Study Area

We trapped EP sandhill cranes (EP) using rocket nets at the Hiawassee Wildlife Refuge, Armstrong and Blythe's Ferry Units, Meigs County, Tennessee (Fig. 2) during the months of December 2009 and January 2010. Hiawassee Wildlife Refuge is located in eastern Tennessee within the Southern Ridge and Valley Physiographic System 13 (Partners In Flight: Physiographic Area Plan 2010) and the tablelands of the Southern Cumberland Plateau. The most abundant land-cover types are oak-hickory or oak-pine mesophytic forest, with scattered agricultural fields comprising a low proportion of the total landscape.

The Hiwassee Wildlife Refuge encompasses approximately 2,428 ha (1,112 ha land and 1,416 ha water) located on Chickamauga Lake at the confluence of the Hiwassee and Tennessee Rivers. Included are 162 ha of the Hiwassee Island. Land use is approximately 30% agricultural land that is cropped and 70% is a wooded mix, mainly of pine and hardwood forest. Crops produced for wildlife consumption include corn, winter wheat, soybeans, milo, varieties of millet, and buckwheat (Tennessee Ornithological Society 2006). Adjacent sand bars and low water levels on Chickamauga Lake create ideal roosting habitat for waterfowl and sandhill cranes during the fall and winter months. The refuge is managed to provide habitat for wildlife, specifically wintering waterfowl. Observations during the 2003-2010 Midwinter Waterfowl Survey for Chickamauga Lake indicate increased utilization by sandhill cranes going from 10,000 cranes in 2003 to over 40,000 in 2010.

Methods

In December 2009 and January 2010, we trapped EP sandhill cranes within the Hiawassee Wildlife Refuge, initially in the Armstrong Ferry Unit and then in the Blythe's Ferry Unit. We identified daytime loafing sites by observing crane movements, and baited loafing sites with approximately 23-34 kg of whole corn in a 2.6-3.3 m wide pile. We used a protocol for identifying potential trapping sites developed for MCP cranes (Dave Brandt, USGS Northern Prairie Wildlife Research Center, personal communication), giving priority to loafing sites with >20 cranes present in pasture or other open land-cover types. When cranes responded to bait for 2 consecutive days, we used a rocket net set up as described by Wheeler and Lewis (1972) and Dave Brandt (USGS Northern Prairie Wildlife Research Center, personal communication).

We conducted trapping primarily in the morning because cranes consistently returned to these sites after leaving evening roosts. We detonated charges when ≤8 cranes were at the bait pile and were feeding. Following capture, we isolated a single crane and placed it in a canvas handling bag to receive a satellite transmitter. The remainder of the cranes were removed from the net and banded. We desired to affix transmitters on adult female sandhill cranes observed in family groups or as members of a male-female pair. We identified adult females based on red skin on the crown of the head, smaller body size, and social behavior among birds (Dave Brandt, USGS Northern Prairie Wildlife Research Center and Ann Lacy, International Crane Foundation, personal communications). If family groups were not available, we isolated a smaller bodied, adult crane.

We collected morphological measurements on the crane to which we attached transmitters as described by Dzubin and Cooch (1992), drew blood and placed collected blood in a Lysis buffer anticoagulant solution to determine sex of the bird at a later time (Jones 2005), and affixed a NorthStar Science and Technology solar GPS satellite transmitter to the upper tarsus (Dave Brandt, USGS Northern Prairie Wildlife Research Center, personal communication). We banded all birds captured with a USGS, Bird Banding Laboratory (BBL) size 8, 1-800, aluminum, butt-end band and released all birds captured in a single trapping episode (i.e., all birds captured in a single rocket net) together.

In addition to using rocket nets, we captured 1 bird with modified Victor #3 softcatch leghold trap as described by King and Paulson (1998). The captured crane was fitted with a USGS, BBL 1-800 band and released.

Data:--We receive satellite data by email every 2 days from CLS America, Inc. Data are translated by software developed by NorthStar Science and Technology, viewed using ESRI ArcGIS software (2009), and maintained in a database of location and sensor data in SAS v9.1 (2008).

Timeline:--In March 2010 we will continue to rocket-net trap and affix 6 more transmitters on sandhill cranes at Goose Ponds FWA and Jasper-Pulaski FWA, Indiana. During December 2010 and January 2011, we plan to trap birds at Hiawassee Wildlife Refuge, Tennessee and complete trapping cranes in Indiana during March 2011.

First Field Season Results

During the months of December 2009 and January 2010, we captured 45 EP sandhill cranes on the Armstrong and Blythe's Ferry Units, Hiawassee

Wildlife Refuge, Tennessee. We captured 44 cranes using rocket nets and 1 crane using a softcatch leghold trap. We fitted 6 cranes with solar GPS satellite transmitters and banded all captured birds with a USGS, BBL 1-800 aluminum band. We drew blood and made morphological measurements from satellite transmitter-fitted cranes.

Four of the 6 birds we captured on the Hiawasse Wildlife Refuge roost and feed within a 24-km radius of the refuge. One marked crane started a southern migration on 28 December 2009, stopped over a short time in Gordon and Macon Counties, Georgia, and currently is located in Crisp County, Georgia. Another crane started its northern migration on 27 January 2010 and has currently settled in Barren County, Kentucky.

Future work

An additional 24 transmitters will be placed on cranes during 2010-2011. Bird will be tracked over the next 2 years to delineate migratory pathways, staging areas, breeding/wintering areas, and to determine migration chronology.

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American Woodcock

FACTORS AFFECTING DETECTION OF AMERICAN WOODCOCK ON SINGING-GROUND SURVEYS

STEFANIE M. BERGH, Natural Resources Science and Management Graduate Program, Minnesota Cooperative Fish and Wildlife Research Unit, 200 Hodson Hall, 1980 Folwell Ave, St. Paul, Minnesota, USA (bergh072@umn.edu)

DAVID E. ANDERSEN, U.S. Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit, 200 Hodson Hall, 1980 Folwell Ave, St. Paul, Minnesota, USA (dea@umn.edu)

Graduate student: Stefanie Bergh (M.S.); **Expected Completion:** December 2010

Introduction and Objectives

Woodcock populations are monitored via the Singing-ground Survey (SGS), coordinated by the U. S. Fish and Wildlife Service and the Canadian Wildlife Service. This survey has been conducted throughout the primary woodcock breeding range since 1968 and is used as an index of abundance and population trend. The SGS consists of approximately 1,500 routes, which are surveyed during courtship in the spring. Observers initiate surveys shortly after sunset and record the number of woodcock heard peenting (a vocalization made during courtship displays by male woodcock) at each of 10 listening points on a survey route during a 2-minute listening period. From 1968 to 2008, the numbers of singing male American woodcock counted on the SGS declined in both the Eastern and Central Management Regions.

However, without knowledge about the relationship between counts and population size, and whether this relationship is constant among years, interpreting results of the SGS is complicated. Spatial and temporal variation in detection probability introduces potentially significant noise into counts of woodcock, and there are many factors that can influence detection probability of displaying male woodcock in the SGS including weather conditions, observer error, woodcock behavior, woodcock density, change in singing-ground sites, and the distance from and orientation of a peenting woodcock relative to the listening point. Also, the effective area surveyed at a listening stop is not known, and may vary as a function of landscape type (e.g., forest, agriculture, urban, etc.), environmental conditions under which surveys are conducted, abilities of observers, and other factors.

Our specific research objectives are to estimate the detection probability of woodcock on the SGS and factors that might influence their detection, and to estimate the effective distance surveyed from SGS points.

Releasing a male woodcock at its singing ground. *Photo by Stefanie Bergh*

Progress to Date

In April and May 2009 we surveyed 4 established SGS routes (routes 77, 80, 86, and 91 in Pine County, Minnesota) and 4 randomly selected reference routes following the protocol for conducting surveys as part of the SGS. We detected a total of 128 woodcock at 60 of 80 sites on our 8 routes. We developed models of woodcock detection probability and occupancy (the proportion of sites occupied by displaying male woodcock) and evaluated these models in an Information-Theoretic framework. The intercept-only model with constant detection and occupancy probabilities and no covariates had an overall detection probability of 0.46 (SE ± 0.0127) while the best-supported model included detection probability as a function of observer and wind speed. We also captured and radio-marked 5 male woodcock for a pilot study to determine the feasibility of capturing and monitoring male woodcock on their singing grounds. Finally, to estimate the farthest distance at which we could detect a peenting woodcock, we used a recording of a woodcock peent broadcast through speakers, and estimated detection probability as a function of distance in both forested and open landscapes.

Future Work

In 2010 we will again survey Singing-ground Survey routes (as in 2009) and conduct additional detection-distance surveys. Data from both years will be compared and analysis will be completed during the summer of 2010, with a final project report (SMB M.S. thesis) completed by December of 2010.

This is a summary of the second year of a 3- year study funded by U.S. Fish and Wildlife Service and the Minnesota Cooperative Fish and Wildlife Research Unit (U.S. Geological Survey and the University of Minnesota).

American woodcock (*Scolopax minor*) with a transmitter. *Photo by Stefanie Bergh*

AMERICAN WOODCOCK SINGING-GROUND SURVEYS IN THE WESTERN GREAT LAKES REGION: ASSESSMENT OF TRENDS IN WOODCOCK COUNTS, FOREST COVER TYPES ALONG SURVEY ROUTES, AND LANDSCAPE COVER TYPE COMPOSITION

DAVID E. ANDERSEN, U.S. Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (dea@umn.edu)

MATTHEW. NELSON, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108 (nels5558@umn.edu)

JAMES R. KELLEY, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, BH Whipple Federal Building, 1 Federal Drive, Fort Snelling, MN 55111-4056. (James_R_Kelley@fws.gov)

Graduate student: Matthew Nelson (M.S.); **Expected Completion:** 2010

Introduction and Objectives

Declines in the number of American woodcock (*Scolopax minor*) detected on the annual Singing-ground Survey have lead to reductions in hunting bag limit and season length, delaying season framework opening dates, and development of a management plan to increase woodcock abundance. However, trends in counts of woodcock along survey routes are difficult to interpret without an understanding of forest cover type composition along survey routes, and how well cover type along routes represents cover type composition in the larger landscape. Woodcock use early successional cover types in forested landscapes for courtship and breeding, and declines in counts on the Singing-ground Survey may reflect changes in extent and distribution of cover types along survey routes. Because the location of survey routes does not change, and because survey routes are generally located along secondary roads that existed at the time the survey was developed (1968), it is not known whether survey routes are currently representative of the landscapes in which they occur. The relationship between cover type characteristics along existing survey routes and cover type characteristics of the larger landscapes in which routes occur has been assessed in only a few locations. In the Central Management Region, only in Michigan has an assessment been completed comparing landscapes covered by Singing-ground Survey routes and land-cover across the state, with few and small differences noted.

In the Central Management Region, changes in extent of cover types used by woodcock are thought to have influenced woodcock abundance. Since the mid-1960s, the total area of aspen (*Populus* spp.), an important component of woodcock habitat, decreased by 21% in Michigan, Minnesota, and Wisconsin. However, although the percentage of aspen-dominated cover types in the landscape has decreased throughout the western Great Lakes region, the extent of hardwood seedling-sapling cover types increased 23% in Minnesota from 1962-1990 and 3% in Wisconsin from 1968-1996. During this same period, the number of singing woodcock detected on routes declined 29% in Minnesota and 44% in Wisconsin. Thus, the cause of apparent population declines may vary across the breeding range of woodcock. Similarly, the relationship between extent and distribution of cover types used by woodcock along survey routes and their extent and distribution in the larger landscape may also vary across regions.

Determining the relationship between extent and distribution of cover types used by woodcock along survey routes and their extent and distribution in the larger landscape is a priority for management of woodcock. Furthermore, how changes in extent and distribution of cover types along survey routes are related to changes in apparent woodcock abundance can be different in different landscapes, and as indicated above, reasons for changes in apparent abundance in Minnesota and Wisconsin are not currently evident. Change across the breeding range from early successional forest types and old fields to a more mature landscape is widely regarded as the reason for apparent woodcock population declines, and woodcock abundance appears to be negatively correlated with an increase in the extent of urban-industrial land uses in the northeast U.S. It is not evident whether these same factors are operating in the Central Management Region.

To address these issues in the Central Management

Region, our overall project objective is to better understand the relationship(s) between changes in counts of woodcock on Singing-ground Surveys in Minnesota and Wisconsin and forest land-cover. We propose to (1) assess patterns in annual counts of woodcock along existing survey routes, (2) assess changes in land-cover types along these routes over time, (3) relate temporal changes in woodcock counts to changes in land-cover composition, and (4) compare current cover type composition along routes to current landscape cover type composition. If possible, we will also compare past cover type composition along survey routes to landscape cover composition.

Preliminary Findings

To better understand the long-term trends in Singing-ground Survey counts, we created two sets of models and compared land-cover along routes to the broader landscape. The first set of models identify which land-cover classes best explain Singing-ground Survey count data. Due to the different time periods of available land-cover data, we ran the set of models independently for Wisconsin and Minnesota. In Wisconsin, these models indicated that regenerating forest, wetlands, and open space were the land-cover types that best explained woodcock counts (Table 1). In Minnesota, mature forest and water best explained woodcock counts (Table 1).

The second set of models assessed how change in land-cover from 1992 to 2005 related to the change in woodcock counts in Wisconsin (we were only able to compile data for this analysis for Wisconsin) over the same time period. Almost 25% of the land-cover along survey routes in Wisconsin changed between 1992 and 2005. Nearly half of this change was accounted for by land cover changing from regenerating forest to mature forest (~5%) and land cover changing from mature forest to regenerating forest (~7%). Change to and from regenerating forest and mature forest best explained changes in woodcock counts (Table 2).

Future Work

Final model assessment and comparison of land-cover composition along survey routes versus the larger landscape are currently being completed. We anticipate completion of this project in early 2010, with a final report (M.S. thesis) completed by June 2010.

This is a summary of the third year of a 3-year study funded by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service), the Minnesota Department of Natural Resources, the Wisconsin Department of Natural Resources, Woodcock Minnesota, and the Minnesota Cooperative Fish and Wildlife Research Unit (U.S. Geological Survey and the University of Minnesota).

Table 1. Number of parameters (*K*), Akaike's Information Criterion (AIC), and model weights (*wi*) for best-supported models of woodcock counts by land-cover type.

Model[ab]	k	AIC value	ΔAIC	w_i
Wisconsin				
(.),R	2	459.21	0	0.29
(.),P^2,R	3	460.85	1.64	0.13
(.),P^2,L,R	4	462.57	3.36	0.05
(.),P^2,R,P^2*R	4	462.76	3.55	0.05
(.),U,F, U*F	4	463.46	4.25	0.03
(.),P^2,L,R,P^2*L*R	5	464.47	5.26	0.02
(.),U,F	3	465.03	5.82	0.02
Minnesota				
(.),W	2	537.18	0	0.27
(.),F	2	538.6	1.42	0.13
(.),P2,L,R	4	539.08	1.9	0.11
(.),U,P2,F,W,L,R	7	539.41	2.23	0.09
(.),P2,L,R,P2*L*R	5	539.42	2.24	0.09
(.),U,F	3	539.99	2.81	0.07
(.),R	2	540	2.82	0.07
(.),U,F, U*F	4	541.54	4.36	0.03
(.)	1	541.61	4.43	0.03

[a] U=developed, P=open space, F=forest, R=regenerating forest, W=water, L=wetland, (.)=random Intercept

[b] 3 year average of SGS count data

Table 2. Number of parameters (*K*), Akaike's Information Criterion (AIC), and model weights (*wi*) for models of woodcock counts by land-cover change in Wisconsin from 1992-2005.

Model[a]	k	AIC value	ΔAIC	w_i
(.)R-F	2	282.66	0	0.14
(.)R-L	2	284.32	1.66	0.06
(.)F-R	2	284.36	1.7	0.06
(.)	1	284.74	2.08	0.05

[a] U=developed, P=open space, F=forest, R=regenerating forest, W=water, L=wetland, (.)=random Intercept

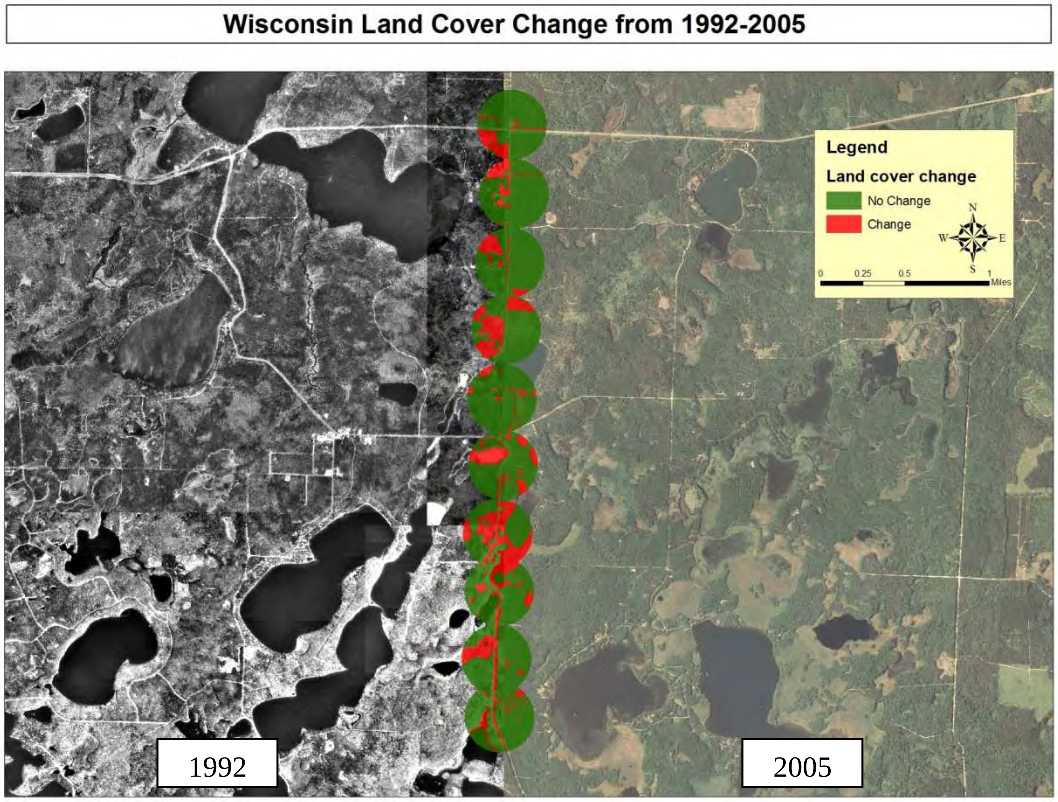
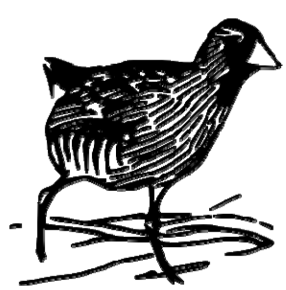


Figure 1. Map of Singing-ground Survey route no. 12 in Wisconsin. Areas depicted in red indicate a change in land-cover over time.



INVESTIGATE COMMUNICATION STRATEGIES TO SUPPORT IMPLEMENTATION OF THE NORTH AMERICAN WOODCOCK CONSERVATION PLAN

SCOT J. WILLIAMSON, Wildlife Management Institute, 69 Clinton Avenue, St. Johnsbury, VT 05819 (wmisw@together.net)
DAVID J. CASE, D.J. Case & Associates, 317 E. Jefferson Boulevard, Mishawaka, IN 46545 (dave@djcase.com)
REBECCA CHRISTOFFEL, D.J. Case & Associates, 317 E. Jefferson Boulevard, Mishawaka, IN 46545 (rebecca@djcase.com)
PHIL T. SENG, D.J. Case & Associates, 317 E. Jefferson Boulevard, Mishawaka, IN 46545 (phil@djcase.com)

Final Report

Introduction and Objectives

The draft *American Woodcock Conservation Plan* has established a goal of producing an additional 3.2 million acres of early successional habitat (ESH) to existing ESH levels in Bird Conservation Region (BCR) 14 to advance full recovery of woodcock populations to 1970 levels. In BCR 28, the Appalachian Mountain Region, the recovery goal demands 3.0 million acres of ESH. To achieve these goals, management on private lands to increase ESH habitat is critical.

The goal of this project was to "Investigate communication strategies to integrate private landowner habitat management interests and capacities into programs designed to implement the *American Woodcock Conservation Plan* through identification of critical audiences, testing of key messages and documentation of optimal delivery mechanisms."

The work described here is focused specifically on owners of small (10- to 100-acre) woodlands in the 10 states that are part of BCRs 14 and 28 (ME, CT, VT, NH, NY, PA, OH, MD, VA, and WV). This project was not designed to address communication needs of large landowners, industrial landowners, or public lands. However, the work is designed to provide foundational insights, approaches and communications strategies that may be applicable in other areas as well.

Methods

A communications team of six individuals was formed in June 2008. The team included Judy Stokes, Chief of Public Affairs, NH Fish & Game Department; Terri Edwards, Office of External Affairs, US FWS; Carl Graybill, Jr., retired (formerly of PA Game Commission); Scot Williamson, Vice President, Wildlife Management Institute; Dave Case, President, D.J. Case & Associates; and Rebecca Christoffel, Project Manager and Human Dimensions Specialist, D.J. Case & Associates. In June 2009, Rebecca Christoffel changed employment and was replaced on the team by Phil Seng, Vice President, D.J. Case & Associates. A group workspace was constructed for team communications about the project. Updates and queries were posted periodically by team members and files were uploaded to the site for team members' review, comments and collaboration.

The Team used the following approach to develop a communications strategy:

1. **Literature Review** (*Annotated Bibliography for the Investigating Communication Strategies to Support Implementation of the North American Woodcock Conservation Plan Project*) – the Team collected and reviewed pertinent literature regarding private, non-industrial woodland owners and management of their forested lands.

2. **Interviews** (*Summary of Semi-Structured Interviews with Natural Resource Professionals*) – the Team identified and spoke with 30 key natural resource professionals who engage in early successional habitat management and outreach on private lands, to learn about their efforts, messages, audiences, and assessment of such efforts.

3. **Focus Groups**
   a. Phase I (*Summary of Focus Group Meetings with Private Landowners*) – the Team conducted four focus groups (one in NH, one in NY, and two in PA) with private, non-industrial woodland owners to determine the fundamental reasons why they might choose

to either actively manage their land for early successional forest habitat or not, and to test the appeal of potential messages that might be used in a communications and outreach campaign aimed at increasing the acreage of private lands being managed for early successional forest habitat.

b. Phase II (*Message Testing Focus Group Meetings with Private Landowners (Phase II)*) – the Team conducted an additional set of three focus groups (two in NY and one in PA) to test communication vehicles (images, messages, tag lines, and print ads) that might be used to encourage private landowner participation in early successional habitat management, and to compare and contrast the characteristics of Phase I focus group participants with those of this Phase II focus group work.

4. **NWOS Survey Analysis** (*Analysis of National Woodland Owner Survey Data for Bird Conservation Regions 14 and 28*) – the Team reviewed results of the *National Woodland Owner Survey* for small woodland owners in BCRs 14 and 28, to determine understanding of and attitudes toward forest ownership and management, and other conservation issues. They also compared demographics of and results from survey participants with participants in Phase II Focus Groups, to determine to what degree focus group participants were "representative" of the broader woodland owner population, and whether results and insights obtained in focus groups could be applied to the broader population.

Based on results from the above research, the Team identified the top five target audiences and objectives for each audience (broad strategies for achieving these objectives are contained in the communication strategy).

1. Private, non-industrial woodland owners of 10-100 acres in BCRs 14 and 28 **-** These are the "end users"–people who must implement young forest habitat management on their lands.
   Objective: Create and maintain early successional habitat on their lands.

2. Conservation professionals with direct landowner contact **–** people who have direct contact with small parcel owners as part of their normal operations/activities.
   Objective: Help woodland owners create and maintain young forest habitat.

3. Other conservation professionals **–** people who have potential contact with end users, and/or whose agencies/organizations have programs or efforts that encourage young forest management.
   Objective: Allow and help woodland owners (both public and private) create and maintain young forest habitat.

4. Residents of forested communities **–** people who live in or near communities that have significant forested acreages (or lands that could be managed as young forest habitat).
   Objective: Allow creation and maintenance of early successional habitat on public and private lands.

5. Hunters, especially woodcock and grouse hunters **–** people with a vested interest in young forest habitat because of the positive impacts such habitat has on the species they like to pursue.
   Objective: Advocate for and support creation and maintenance of early successional habitat on public and private lands.

Recommended Actions
The Team proposes the following actions for achieving the above objectives and encouraging small parcel landowners to implement young forest management on their lands in BCRs 14 and 28.

1. <u>Comprehensive Web Site</u>
   Design and develop a comprehensive Web site that provides the information and resources needed by each of the target audiences. Segment the site so the various sections can be customized very specifically to each of the target audiences. Early successional management is a complex topic, and a well-built Web site affords the opportunity to tell the full story in nested fashion, so people can access as much or as little information as they need.

   - Research existing Web sites that already deliver various pieces of this information, and build the site to complement and leverage these efforts.

- Create section(s) of the site that encourage and sustain two-way communications with the target audiences. Create an on-line community for the effort.

- Build relationships between and among the target audiences.

2. Develop "Five-County Pilot Areas"
   Create detailed pilot communications campaigns to increase young forest habitat management on private lands in one or more limited areas (five counties within one state, perhaps). There is far too much variability (habitat, programs, social norms, etc.) across the area of interest to effectively implement a single communications campaign. Each of these pilot areas should be large enough to show impacts, but small enough so a reasonable amount of communications can be delivered and so impacts can be assessed in a meaningful manner. These campaigns should be customized to the local landowners, ecology, assistance programs and wood markets. If these pilot campaigns show positive results, expand them to encompass broader areas. Managers should consider incorporating the following elements into the pilot campaigns:

- Design/develop/conduct a series of workshops/presentations with natural resource professionals in the treatment areas to convince them of the need for young forest management (as necessary) and to share the key messages and communication techniques they should use with private woodland owners.

- Develop a Powerpoint presentation that natural resources professionals can use with landowners (one-on-one or small groups) to encourage participation in young forest management.

- Develop a series of printed informational materials that natural resources professionals can leave behind with woodland owners to encourage participation in young forest management. Identify and include information on all currently available funding/cost-share programs. All materials should be designed to share a "family look" with the design of the Web site.

- Create a network or registry of small woodland owners who are engaged in young forest management. Be sure they understand the key messages so they can advocate for young forest management with other landowners who may contact them.

- Include evaluation metrics in all actions so they can be assessed for effects on increases in acreage of young forest habitat on private lands, improved knowledge/attitudes among target audiences, and utility of specific techniques and methods used in the campaign.

3. Large-Scale Partnerships
   Broad-scale communication efforts to landowners across large geographical regions to support young forest habitat for woodcock conservation is not strategically justifiable. That is, there probably are not enough landowners interested in woodcock conservation to make such a strategy succeed. (That approach probably is not economically feasible, either). However, there are other organizations and partners that are also interested in young forest management, though not necessarily interested in woodcock conservation. Deer, grouse, turkeys, and a wide array of other wildlife and plants are dependent on young forests, just like woodcock. A wider array of species of interest will bring a much larger support base to bear on the issue. Messages that all such groups hold in common include:

- Young forest habitat is important for healthy ecosystems
- Timber harvest and other forest management, when done responsibly, is good for many types of plants and wildlife.

Recognize that not all early successional management efforts will benefit woodcock. For instance, no amount of young forest on arid, upland sites will attract or hold woodcock. But partnerships can create synergy of effort for all partners, and help create informed consent for young forest management with the broader public.

These are final results from a 2-year study funded by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service).

IMPLEMENTATION OF THE AMERICAN WOODCOCK CONSERVATION PLAN IN THE UPPER GREAT LAKES

SCOT J. WILLIAMSON, Wildlife Management Institute, 4426 VT Route 215N, Cabot, VT 05647, USA (wmisw@together.net)
PAT RUBLE, Wildlife Management Institute, 12748 West Bank Drive, Millersport, OH 43046, USA (patrublewmi@columbus.rr.com)

Final Report

Introduction and Objectives

The American woodcock (*Scolopax minor*) is a popular game bird throughout eastern North America and is managed on the basis of two populations: eastern and central. Both populations have experienced significant declines since surveys were first implemented in the mid-1960s. Loss and degradation of early successional forest habitat is believed to be the primary factor responsible for these declines (Kelley and Williamson et al., 2008).

Modeling by Thogmartin et al. (2007) shows the United States' portions of BCR's 12 and 23 to be among the most productive for woodcock, based on the singing ground surveys administered by the U.S. Fish and Wildlife Service. The *American Woodcock Conservation Plan (Plan)* has established a goal of adding 3.5 and 1.5 million acres of early successional habitat (ESH) to existing ESH levels in Bird Conservation Regions (BCR) 12 and 23 respectively, to advance full recovery of woodcock populations to 1970 levels in these areas.

The Wildlife Management Institute (WMI) proposed to create and implement a woodcock habitat initiative in BCR 12 and 23. Objectives of the project were to: (1) Create multiple, high profile, on-the-ground woodcock habitat management projects that serve as demonstration or model projects that may be replicated in other places. (2) Integrate priorities for woodcock habitat management with other land-use or natural resource planning efforts at the local, state and federal level. (3) Leverage additional funding from various incentive and grant programs.

Progress to Date

Two contract service providers were hired with individual responsibilities for the U.S. portions of BCR 12 and BCR 23 to work with partners to develop woodcock habitat demonstration areas and to establish surveys to monitor the response of woodcock to habitat management. During the project period (9/15/2008-9/30/2009), a set of Woodcock/Young Forest Habitat Best Management Practices (BMPs) for the Upper Great Lakes region was drafted with input from the US Geological Survey, US Fish and Wildlife Service, US Forest Service, Michigan, Minnesota and Wisconsin Departments of Natural Resources, Ruffed Grouse Society, Golden-Winged Warbler Working Group and WMI among others. The BMPs are available online at www.timberdoodle.org. Forty-five meetings/presentations were held with potential partners to advance the objectives of the initiative; 22 properties were assessed as potential demonstration areas; 12,538 acres were identified for future management activity; 4 sites had management activities initiated; and, survey routes were established and run at 8 sites to document baseline population levels prior to management activities.

In addition, WMI was successful in securing a grant from the National Fish and Wildlife Foundation which will help underwrite implementation of the *Plan* for the next several years.

These are results of a one-year management project funded by the Webless Migratory Game Bird Program (US Fish and Wildlife Service).

Future Work

Due to the substantial population and habitat objectives outlined in the *Plan* relative to the limited funding available to address them, partners in the effort for BCR 12 and 23 recognized the importance of targeting resources to areas that provide the highest potential for population response to management activities. To that end, the Science Team of the Upper Mississippi River/Great Lakes Joint Venture, in cooperation the US Fish and Wildlife Service, US Forest Service, Michigan, Minnesota and Wisconsin Departments of Natural Resources, National Wild Turkey Federation and WMI, is in the process of identifying high priority management zones within each of the three states (Figure 1). High priority management areas will be identified based on six criteria: predicted woodcock relative abundance, an index of potential habitat, singing ground survey data, proportion of landscape in aspen, land ownership patterns, and local knowledge. Once these areas are identified, partners will meet with federal, state and local agency land managers along with federal and state agencies that provide technical assistance and funding for management on private lands to devise a plan of implementation within each of the zones.

The partners recognize and agree that it will be critical to evaluate the effectiveness of this approach. Hence, an evaluation component will be part of the effort. This evaluation aspect will likely drive timing of priority zone identification as it will be desirable to collect baseline population information during the spring of 2010, prior to application of management prescriptions within the zones.

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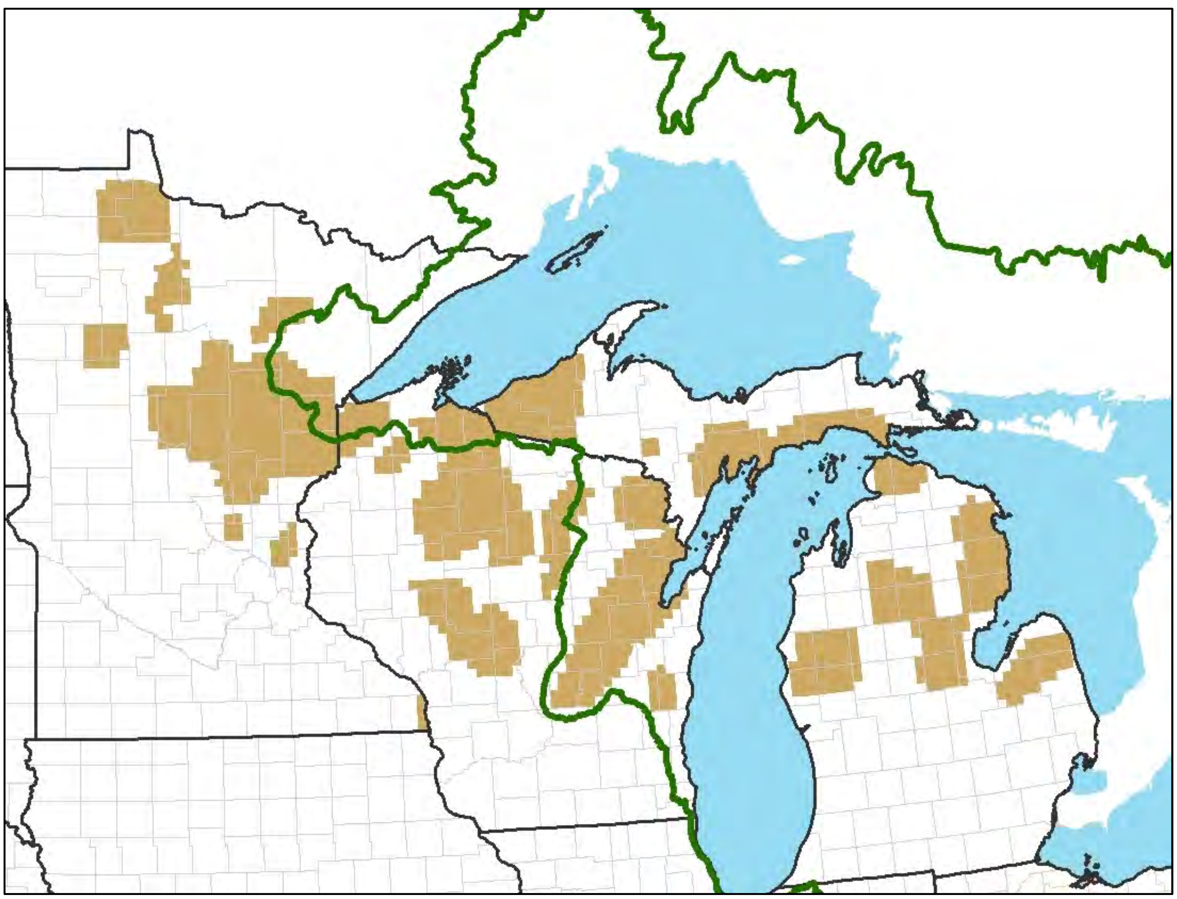

Figure 1. Preliminary high-priority management areas identified for Minnesota, Wisconsin, and Michigan based on habitat modeling completed by the Upper Mississippi River and Great Lakes Region Joint Venture Science Office and local knowledge.

AGRICULTURAL WINTERING HABITAT AS A LIMITING FACTOR FOR WOODCOCK IN THE SOUTHEAST: THIRTY YEARS OF AGROECOSYSTEM CHANGE

EMILY B. BLACKMAN, DR. CHRISTOPHER S. DEPERNO, DR. M. NILS PETERSON, AND DR. CHRISTOPHER E. MOORMAN., NC State University Dept. of Forestry and Environmental Resources, Fisheries and Wildlife Sciences, Turner House, Box 7646, Raleigh, NC 27695 (csdepern@ncsu.edu)

Graduate Student: Emily B. Blackman (M.S.); **Expected Completion:** fall 2010

Introduction and Objectives

American woodcock populations have declined in North Carolina and across the Southeast, and woodcock have declined range-wide by 1.0% per year between 1966 and 2000 and 6.8% per year between 1980 and 2003. As a result, woodcock are listed as a Species of High Concern by the U.S. Shorebird Conservation Plan, a Game Bird Below Desired Condition by the U.S. Fish and Wildlife Service, and a "yellow list" species in slow decline and of national conservation concern by the National Audubon Society.

Woodcock population declines most likely have occurred because of habitat loss and alteration. Research by North Carolina State University faculty and graduate students in the 1970s and early 1980s showed that woodcock primarily used conventionally tilled soybean fields with a ridge and furrow system. Soybean fields were richer in organic matter and nitrogen than other field types and therefore provided higher quality habitat for earthworms. Additionally, woodcock found shelter from weather and predators in the crop furrows. Since those research studies, changes in agricultural practices, such as reductions in tillage and narrower row spacing, altered nocturnal foraging habitat and likely the prey base. During December-February 2008-2009 and 2009-2010, we studied wintering woodcock at the same locations and compared woodcock habitat use and diet with results from 30 years prior. During the 2008-2009 field season, the field types included no-till soybean (n=35), winter wheat (n=14), disked corn (n=9), corn with standing stalks (n=6), conventionally tilled soybean (n=3), and cotton (n=3). Our study was conducted in eastern North Carolina south of Lake Mattamuskeet National Wildlife Refuge along Highway 264.

Our objectives were to:

1. Determine woodcock nocturnal habitat use in a landscape dominated by agriculture.
2. Compare current use of no-till systems with historical use of bed and furrow agro-ecosystems in the same location.
3. Determine how field type, soil health, and earthworm abundance affect selection of nocturnal foraging sites.

Additional objectives during the 2009-2010 season were to:

1. Use radio telemetry to collect more detailed information about nocturnal habitat use and identify diurnal habitat use.
2. Conduct landowner interviews to assess the impact of hunting on the American woodcock population in eastern North Carolina.

Progress to Date

We surveyed 70 agricultural fields twice from mid-December until the end of January (2008-09) by looking for woodcock eye shine using halogen bulb headlamps. We conducted all surveys between dusk and midnight. Two observers each walked 0.40 km transects in each field and recorded the total number of birds seen, their GPS location, the field type, and the distance from the observer to where the bird was spotted. Also, we recorded weather and moon phase for each night, as woodcock presence in fields is often influenced by weather conditions.

We collected soil and earthworm samples from five fields of each type. In each field, we took six soil and earthworm samples on a diagonal; sampling points were spaced ~15 meters apart and the diagonal assured the soil came from different rows. We collected samples between rows when present, because woodcock were generally observed roosting and feeding between rows. We collected 0.25 liters of soil using hand-held shovels and gathered data on soil moisture content and temperature using a moisture probe and a soil thermometer, respectively. The probe reported soil water content as a percentage by volume. The samples were tested for pH level, percent organic matter, and nitrate content. Also, we collected all earthworms within a 1-m^2 area at the six soil sampling points. We preserved earthworms in jars of 70% ethanol and sent them to a lab (Dr. John W. Reynolds' Oligochaetology Laboratory, Ontario) to be identified to species. Soil and earthworm sampling was done to a depth of about 3 inches, the approximate maximum distance that a woodcock can probe into soil. We collected samples from dusk until midnight to mimic woodcock feeding habits.

Figure 1. No-till soybean field in eastern North Carolina, 2008 - 2009. *Photo courtesy of North Carolina State University*

During 2008-09, nocturnal use of fields by woodcock varied by field type ($F = 3.126$, $df = 3$, $P = 0.032$); no-till soybeans (Figure 1) were used more than wheat ($P = 0.034$) and row corn (Figure 2) was used more than disked corn ($P = 0.034$) and wheat ($P = 0.016$). Earthworm presence varied by field type ($F < 0.001$); more earthworms were detected in no-till soybean than conventionally tilled soybeans, corn with standing stalks, cotton, wheat, and disked corn ($P < 0.001$). Also, more earthworms were detected in conventionally tilled soybeans than cotton ($P = 0.005$) and disked corn ($P = 0.011$) (Figure 3). Woodcock may use corn fields with standing stalks for cover from weather and predators and no-till soybean fields because of the relatively high abundance of earthworms (Figure 3).

Figure 2. Corn field with standing stalks in eastern North Carolina, 2008 - 2009. *Photo courtesy of North Carolina State University*

We collected 342 earthworms during the 2008-09 season. Species were *Aporrectodea trapezoides* (n=210), *Diplocardia caroliniana* (n=84), *Amynthas diffringens* (n=32), *Bimastos parvus* (n=12), *Aporrectodea rosea* (n=2), *Amynthas hupeiensis* (n=1), and *Bimastos tumidus* (n=1).

Ongoing Work

December 2009 to March 2010, we will repeat surveys of woodcock and soil and earthworm sampling. The crop types surveyed in 2009-2010 will include disked corn (n= 30), no-till soybean (n= 30), corn with standing stalks (n=4), and winter wheat (n= 4). There were significantly fewer winter wheat fields planted in the fall of 2009. In addition, we will capture approximately 30 woodcock for banding, avian influenza testing, and radio-transmitter attachment (Figure 4). We will collect diurnal and nocturnal locations for each bird every 24 hours to assess local movements.

This summary describes the first year of a two year project funded by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service) and North Carolina State University.

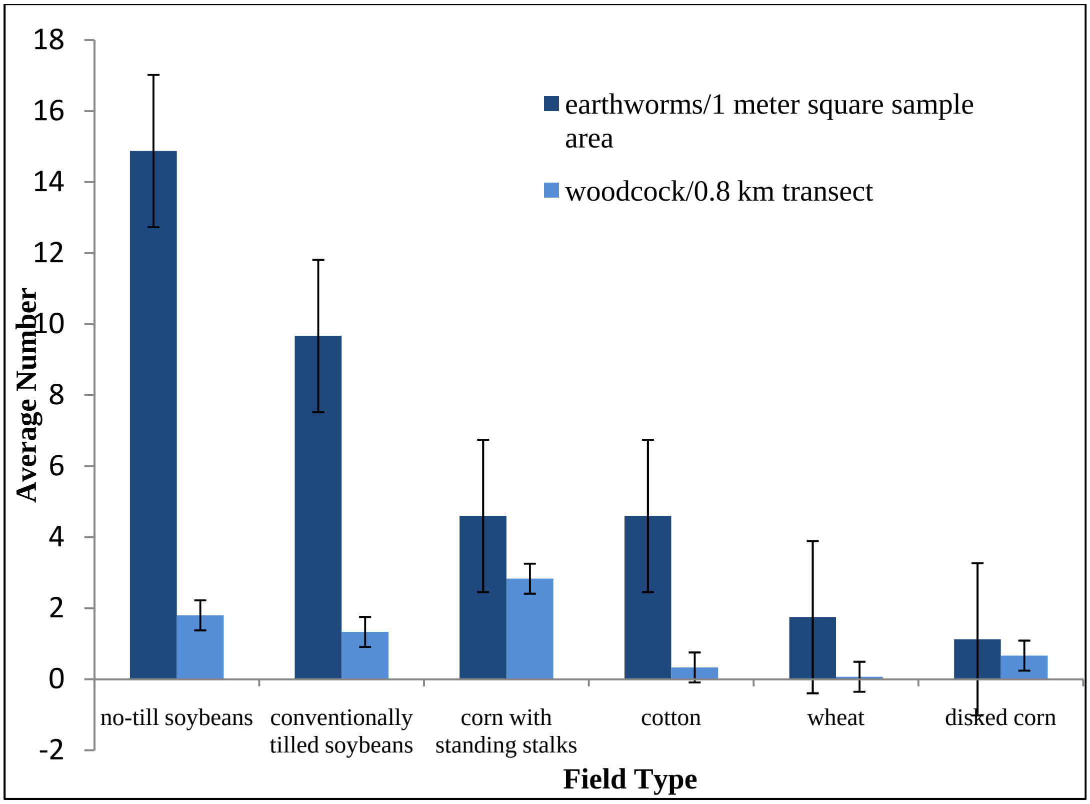

Figure 3. Mean (+/- SE) number of American woodcock and earthworms per 0.8km transect and 1-m^2 sample area, respectively, by field in eastern North Carolina, 2008 - 2009.

Figure 4. Graduate student Emily Blackman (middle) and technicians attach a radio-transmitter to an American woodcock in eastern North Carolina, 2008 - 2009. *Photo courtesy of North Carolina State University*

Secretive Marsh Birds

ASSESSING AN EXPERT-BASED LANDSCAPE APPROACH TO PREDICT KING RAIL DISTRIBUTIONS IN THE UPPER MISSISSIPPI RIVER AND GREAT LAKES REGION JOINT VENTURE

JASON R. BOLENBAUGH, University of Arkansas, Department of Biological Sciences, WAAX 203, University of Arkansas, Fayetteville, AR 72701 (jbolenba@uark.edu)
DAVID G. KREMENTZ, USGS Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, WAAX 203, University of Arkansas, Fayetteville, AR 72701 (krementz@uark.edu)

Graduate student: Jason R. Bolenbaugh (M.S.); **Expected Completion:** 2010

Introduction

Recent advances in geographic information systems (GIS) and remote sensing technologies enable researchers to use sampling strategies that result in inferences over large landscapes (Naugle et al. 2001). When combined with Landscape Suitability Index (LSI) models, predictive models that provide researchers with a tool to evaluate wildlife habitat quality across large landscapes (Dijak et al. 2006), researchers can examine how marsh bird occupancy relates to habitat variability across the landscape (Naugle et al. 2001).

In this study, we are validating a LSI model designed to identify wetland habitats of varying suitability for king rail (*Rallus elegans*) use (i.e. survival, reproduction, brood rearing). We also want to determine the distribution of king rails in the study region; identify areas of high king rail abundance; and provide recommendations that will assist managers in creating a more reliable LSI model for future king rail management.

In 2008, we used the king rail LSI model combined with the National Land Cover Dataset (NLCD) and GIS to randomly select 100 wetlands each for high, moderate, and low habitat suitability. Habitat suitability scores ranged from high (>80 – 100), moderate (≥30 - <80), to low (<30) (Table 1). After we selected the wetlands for each suitability class, we found low suitability sites greatly outnumbered those of high and moderate suitability sites (Fig. 1). Additionally, high and moderate suitability wetlands had a tendency to be grouped together within a wetland complex (Fig. 2). Although we were concerned with the closeness of high and moderate suitability sites, we were satisfied with the overall distribution of those sites across the study region.

Once the field season began we encountered above average rainfall resulting in many of our high and moderate suitability sites being inundated along the Mississippi River corridor. In many cases, we could not survey the site(s) due to safety or complete inundation of emergent vegetation.

Another area of concern we wanted to improve on in 2009 was the overall distribution of survey sites across the study region. Much of our distribution in 2008 was a result of weather events that persisted throughout the field season and logistical difficulties associated with the vastness of the study area.

In 2009, we decided to use the National Wetlands Inventory (NWI) spatial database rather than the NLCD used in 2008. We felt the NWI would: 1) be more spatially accurate and better suited at identifying wetland types than the NLCD; 2) reduce the cluster of high and moderate suitability sites within the same wetland complex (Brad Potter, U.S. Fish & Wildlife Service, personal communication); and 3) allow us to attain a better distribution of survey sites across the study region by increasing the number of high and moderate suitability sites.

Methods

Our study area was located in the Upper Mississippi River/Great Lakes Joint Venture, hereafter referred to as the JV. The JV encompasses all or portions of 10 mid-western states (IA, IL, IN, KS, MI, MN, MO, NE, OH, and WI) and is comprised of federal and state agencies, private organizations and tribal groups whose goal is to protect or increase habitat for wildlife species that are associated with wetland habitats. This region is unique in that a portion of the wetlands are directly associated with the Great Lakes (Lake Erie, Lake Huron, and Lake Michigan) and large river systems such as the Illinois, Mississippi, Missouri, and Ohio. Of the 10 states that comprise the JV, 6 have lost >50% of their original wetlands, while the other 4 have lost between 25 and 50%. Additionally, the king rail is considered endangered in 7 states (IA, IL, IN, MI, MN, MO, and OH), a Species of Special Concern in Wisconsin, and a species with no state status in Kansas and Nebraska (Cooper 2007).

Once we decided to use the NWI as our spatial database, we elected to restrict wetland size from which survey sites would be randomly selected to only those wetlands ≥5ha. We did this because we felt: 1) a disadvantage of the NWI is it is outdated and an estimated 20% of the wetlands may no longer exist due to drainage for other land uses (Brad Potter, U.S. Fish & Wildlife Service, personal communication); and 2) wetlands ≥5ha are more likely to be occupied by marsh birds. Brown and Dinsmore (1986) found the frequency of occurrence of the American bittern (*Botaurus letiginosus*), American coot (*Fulica americana*), least bittern (*Ixobrychus exillis*), pied-billed grebe (*Podilymbus podiceps*), sora (*Porzana carolina*), and Virginia rail (*Rallus limicola*) was higher in wetlands >5ha versus those wetlands that were <1ha. They also found the frequency of occurrence was higher for the American bittern, American coot, least bittern, and pied-billed grebe in wetlands >5ha versus those wetlands 1 – 4.9ha. Frequency of occurrence for the sora and Virginia rail were the same for wetlands >5ha and wetlands 1 - 4.9ha.

We used ArcGIS 9.2 and the Hawth's Tools application to select 399 wetland sites based on corresponding LSI values of high, moderate, and low suitability; 133 sites in each group (Table 1). A site was defined as a coordinate (i.e. point) located within a wetland of a designated LSI value. Like 2008, we excluded Michigan from the other states when we conducted the sampling procedure due to the large number of wetlands found in Michigan. Instead, we sampled 45 wetland sites for Michigan alone, 15 from each habitat suitability category. We omitted Wisconsin from the survey because the Wisconsin Department of Natural Resources is continuing an independent survey of king rails and other marsh birds. Once the sites were selected, one team of 2 surveyed Missouri beginning in Kansas City and continued east into southern Illinois, southern Indiana, and central Ohio. The other team began surveys in Nebraska and traveled east to survey Iowa, Minnesota, northern Illinois, and northern Indiana. Both teams surveyed northern Ohio and Michigan together.

Table 1. Landscape Suitability Index scores for wetland types used by breeding King Rails. Scores closer to 100 represent a greater suitability for King Rails. The resulting output values were averaged within 5 km × 5 km blocks for enhanced regional display.

Output options	*LSI score*
Palustrine emergent wetlands >20 ha and <20 km from current King Rail breeding locations	*100*
Palustrine emergent wetlands <20 ha and <20 km from current King Rail breeding locations	*80*
Palustrine emergent, scrub/shrub, and forested wetlands >20 ha and <20 km from current King Rail breeding locations	*50*
Palustrine emergent, scrub/shrub, and forested wetlands <20 ha and <20 km from current King Rail breeding locations	*30*
Other sites without breeding history but within species traditional breeding range (see below)[a]	*0-100*

[a]Emergent wetlands >20 ha and <40 km from major river systems (Mississippi, Missouri, Ohio, Scioto, Wabash, Illinois, and Wisconsin) or >20 ha and <20 km from the southern shores of Lake Michigan and Lake Erie were given initial scores of 100; emergent wetlands <20 ha within the same regions were given scores of 80. Woody wetlands >20 ha and <40 km from major river systems or >20 ha and <20km from the southern shores of Lake Michigan and Lake Erie were given initial scores of 50; woody wetlands in the same regions were given scores of 30. All scores for these sites were then weighted by latitude; southern-most locations multiplied by 1.0 to northern latitudes outside the species range which were multiplied by 0.0 (Brad Potter, U.S. Fish & Wildlife Service).

Call-playback surveys were conducted during 3 separate occasions from 4 May to 9 July, 2009, following the protocol of Conway (2008). Each survey period was no longer than 21 days apart. We conducted surveys from 30 minutes before sunrise until ~3 hours after, and from 2 hours before sunset until ½ hour after. Each survey consisted of a 5 minute passive listening period followed by 9 minutes of recorded calls. For each species, 30 seconds of its calls were broadcast, followed by 30 seconds of silence. Nine species were broadcast: least bittern, yellow rail (*Coturnicops noveboracensis*), sora, Virginia rail, king rail, American bittern, common moorhen (*Gallinula chloropus*), American coot, and pied-billed grebe. During each survey, we recorded the segment each individual was detected, and the estimated distance (m) to the calling bird.

We collected the following habitat data within a 30m radius, centered at the point in which we were standing: 1) percent open water, short emergent vegetation (<1m tall), tall emergent vegetation (>1m tall), percent woody vegetation, and 2) percent coverage for each plant species.

Results

Precipitation for the 2009 breeding season was relatively normal to below normal. May water levels at Carlos Avery WMA in Anoka County, Minnesota were similar to their normal July levels (Dan Rhode, Minnesota Department of Natural Resources, personal communication). However, we could not survey areas in the Illinois River watershed, the Wabash and White Rivers in southern Indiana, and southeastern Kansas (Marais des Cygnes Wildlife Area) and southwestern Missouri (Four Rivers CA) because of flooding. Fortunately, the model using the NWI worked as we had hoped. We not only reduced the clustering of high and moderate suitability sites, but we also increased the amount of moderate suitability sites across the JV, and limited the loss of habitat in flood prone regions to only moderate suitability sites. We surveyed 264 sites in 2009 (Fig. 1), 103 high sites, 67 moderate sites, and 94 low sites (Table 2). We surveyed 51 sites in Michigan, 43 in Minnesota, 43 in Missouri, 43 in Ohio, 28 in Illinois, 27 in Indiana, 22 in Iowa, and 7 in Nebraska. We did not survey any sites in Kansas due to flooding and lack of accessible habitat (Table 2).

Figure 1. Distribution of 2009 survey sites in the Upper Mississippi River/Great Lakes Joint Venture.

We detected more marsh birds in 2009 (n = 924) than in 2008 (n = 705). We also detected more marsh birds per round of surveys in 2009 (Rd.1 = 400, Rd.2 = 359, Rd.3 = 165) than in 2008 (Rd.1 = 368, Rd.2 = 200, Rd.3 = 137) with both years experiencing a similar decline in detection as the season progressed (Table 3).

Species Detections

We detected 5 king rails at 4 sites (Avg. = 1.25, SE = 0.25, Median = 1.0, Mode = 1.0) in 2009, a decrease from 2008 (Table 2). We detected 3 king rails at Goose Pond Fish and Wildlife Area in Linton, IN. We detected 2 at Goose Pond 14 (GP14) and the other at Goose Pond 05 (GP05). We detected 2 king rails at B.K. Leach Conservation Area (Bittern Basin Unit) in Elsberry, MO. The Goose Pond sites were low suitability sites, and the B.K. Leach sites were moderate suitability sites. We did not detect any king rails in high suitability sites in either year. During the 5 surveys when a king rail was detected; only 2 surveys had other marsh birds detected. GP05 had a king rail, common moorhen, and pied-billed grebe detected during the second survey, and GP14 had a king rail and pied-billed grebe detected during the second survey.

Two habitat variables that persisted across the four sites were open water (Range = 8 – 55%) and short emergent vegetation (Range = 15 – 90%). The B.K. Leach sites were dominated by short emergent vegetation (BK03 = 90%, BK06 = 45%) such as common spike rush (*Eleocharis palustris*) and smartweed (*Polygonum sp.*), with little or no tall emergent vegetation (BK03 and BK06 = 0%) or woody vegetation (BK03 = 2%, BK06 = 0%). The Goose Pond sites were dominated by tall emergent vegetation (GP05 = 40%, GP14 = 50%) and open water (GP05 = 35%, GP14 = 30%), followed by short emergent vegetation (GP05 = 20%, GP14 = 15%) and woody vegetation (GP05 and GP14 = 5%). Hybrid cattail (*Typha xglauca*) was the dominant species of tall emergent vegetation, with various species of rush (*Juncus sp.*) and sedge (*Carex sp.*) (short emergent vegetation) surrounding the cattail. A common attribute at all sites with king rails was the close proximity to small upland habitats located within the wetland. At BK03 the water levels were low enough that the king rail was detected on a natural island that provided maximum cover during early plant growth. At BK06 the king rail was detected in common spike rush, and later moved to an adjacent upland peninsula. At Goose Pond the king rails were detected in ridge-and-swale habitats in which a ridge of upland habitat was created by the spoil dug from the adjacent swale. The swale serves as deep water habitat from which the tall emergent vegetation has emerged. The remains of crayfish, a common king rail food were found at all 4 sites.

The most common marsh bird detected for the second straight season was the pied-billed grebe. We detected 327 pied-billed grebes at 102 sites (Avg. = 3.2, SE = 0.27, Median = 2.0, Mode = 1.0) in 2009, a decrease from 2008. Fifty-five sites had at least one pied-billed grebe detected during multiple surveys. The most pied-billed grebes detected during a single survey were 7. Detections were highest during round 2 (146), followed by 113 in round 1, and 68 in round 3 (Table 3). Twenty-one sites had only the pied-billed grebe detected at them. During the 175 surveys that were conducted in which a pied-billed grebe was detected, 54 American coot, 33 common moorhens, 28 American bitterns, 19 least bitterns, 14 Virginia rails, 13 sora, and 2 king rails were also detected.

We detected 168 American coot at 71 sites (Avg. = 2.36, SE = 0.21, Median = 2.0, Mode = 1.0) in 2009, an increase from 2008. Eighteen sites had at least one American coot detected during multiple surveys. The most American coot detected during a single survey was 6 (twice). Detections were highest during round 1 (70), followed by 66 in round 2, and 32 in round 3. During the 93 surveys in which an American coot was detected, 54 pied-billed grebes, 19 American bitterns, 17 sora, 15 Virginia rails, 14 least bitterns, and 13 common moorhens were also detected.

We detected 115 sora at 59 sites (Avg. = 1.94, SE = 0.17, Median = 1.0, Mode = 1.0) in 2009, an increase from 2008. Seven sites had at least one sora detected during multiple surveys. The most sora detected during a single survey was 7. Detections were highest in round 1 (99), followed by 11 in round 2, and 5 in round 3. During the 66 surveys in which a sora was detected, 18 Virginia rails, 17 American coot, 17 pied-billed grebes, 10 American bitterns, 6 least bitterns, and 4 common moorhens were also detected.

We detected 96 Virginia rails at 52 sites (Avg. = 1.85, SE = 0.19, Median = 1.0, Mode = 1.0) in 2009, an increase from 2008. Thirteen sites had at least one Virginia rail detected during multiple surveys. The most Virginia rails detected during a single survey were 5. Detections were highest in round 1 (48), followed by 31 in round 2, and 17 in round 3. During the 66 surveys in which a Virginia rail was detected, 18 sora, 16 American coot, 14 pied-billed grebes, 13 American bitterns, 5 common moorhens, and 4 least bitterns were also detected.

We detected 81 American bitterns at 46 sites (Avg. = 1.76, SE = 0.13, Median = 2.0, Mode = 1.0) in 2009, an increase from 2008. Fifteen sites had at least one American bittern detected during multiple surveys. The most American bitterns detected during a single survey were 3 (four times). Detections were greatest in round 1 (44), followed by 32 in round 2, and 5 in round 3. During the 61 surveys in which an American bittern was detected, 32 pied-billed grebes, 20 American coot, 13 Virginia rails, 10 sora, 9 common moorhen, and 5 least bitterns were also detected.

We detected 69 common moorhens at 35 sites (Avg. = 1.97, SE = 0.23, Median = 1.0, Mode = 1.0) in 2009, a decrease from 2008. Nine sites had at least one common moorhen detected during multiple surveys. The most common moorhens detected during a single survey were 4. Detections were highest in round 2 (36), followed by 21 in round 3, and 12 in round 1. During the 45 surveys in which a common moorhen was detected, 32 pied-billed grebes, 13 American coot, 9 American bitterns, 5 least bitterns, 5 Virginia rails, and 4 sora were also detected.

We detected 63 least bitterns at 39 sites (Avg. = 1.62, SE = 0.17, Median = 1.0, Mode = 1.0) in 2009, an increase from 2008. Seven sites had at least one least bittern detected during multiple surveys. The most least bitterns detected during a single survey were 3 (twice). Detections were highest in round 2 (33), followed by 17 in round 3, and 13 in round 1. During the 48 surveys in which a least bittern was detected, 20 pied-billed grebes, 13 American coot, 5 American bitterns, 5 common moorhens, 4 sora, and 4 Virginia rails were also detected. We did not detect any yellow rails for a second straight field season.

Although we only detected king rails at moderate and low habitat suitability sites, there was one king rail detected in a high suitability site on the southern portion of Winous Point Duck Club in Ottawa County, OH (Karen Willard, The Ohio State University, personal communication). Karen Willard is a graduate teaching associate at The Ohio State University who is conducting similar marsh bird call-playback surveys throughout the state of Ohio. We did not survey the southern portion of Winous Point Duck Club because our randomly selected sites were located in the northern portion.

Future Plans

With only 5 king rail detections, estimating occupancy rates will not be possible. We will report on the king rail results qualitatively. Without sufficient numbers of king rail detections we do not envision a means of validating the LSI model or a means of improving the LSI. Our results further indicate the dire situation that the migratory cohort of the king rail population in the Mississippi Flyway is in. We will investigate whether we have sufficient information to conduct a population viability analysis on this king rail population. To take advantage of the other collected data, we will evaluate marsh bird guild habitat use. We envision three guilds: 1) king rail, Virginia rail and sora, and 2) least bittern and American bittern, and 3) pied-billed grebe, common moorhen, and American coot. We will use program MARK and other avian community analysis approaches to evaluate habitat use.

Acknowledgements

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Table 2. Number of sites surveyed for each habitat suitability in each state of the Upper Mississippi River/Great Lakes Joint Venture for the 2008 and 2009 breeding seasons.

	High Suitability		Moderate Suitability		Low Suitability		Total Sites	
	2008	2009	2008	2009	2008	2009	2008	2009
Illinois	1	12	3	11	16	5	20	28
Indiana	0	0	0	8	19	26	19	34
Iowa	6	9	4	5	8	1	18	15
Kansas	0	0	0	0	0	0	0	0
Michigan	11	34	0	1	33	16	44	51
Minnesota	0	0	0	0	26	43	26	43
Missouri	19	7	22	36	49	0	90	43
Nebraska	0	0	0	5	0	2	0	7
Ohio	47	41	0	1	0	1	47	43
Total	84	103	29	67	151	94	264	264

Table 3. Number of detections per round of surveys and total for each marsh bird species in 2008 and 2009.

	Round 1		Round 2		Round 3		Total	
	2008	2009	2008	2009	2008	2009	2008	2009
Pied-billed Grebe	157	113	100	146	86	68	343	327
American Coot	20	70	13	66	0	32	33	168
Sora	46	99	10	11	6	5	62	115
Virginia Rail	4	48	15	31	18	17	37	96
American Bittern	60	44	17	32	8	5	85	81
Common Moorhen	61	12	25	36	12	21	98	69
Least Bittern	17	13	15	33	6	17	38	63
King Rail	2	1	5	4	1	0	8	5
Yellow Rail	0	0	0	0	0	0	0	0
Total	368	400	200	359	137	165	706	924

IMPLEMENTATION OF A NATIONAL MARSHBIRD MONITORING PROGRAM: USING WISCONSIN AS A TEST OF PROGRAM STUDY DESIGN

ANDY PAULIOS, Wisconsin Bird Conservation Initiative, Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI 53707-7921 (Andy.Paulios@wi.gov)
RYAN BRADY, Wisconsin Bird Conservation Initiative, Wisconsin Department of Natural Resources, 2501 Golf Course Rd., Ashland, WI 54806 (ryan.brady@wisconsin.gov)

Expected Completion: January 2011

Background and Objectives

Largely because of their secretive behavior and difficult-to-access habitats, marshbirds such as rails, bitterns, coots, and grebes are among the most poorly monitored bird groups in North America. Yet many species are of high conservation concern (e.g. American Bittern, King Rail, Yellow Rail), some are harvested (e.g. Sora, Virginia Rail, Wilson's Snipe), and all are thought to be excellent indicators of wetland ecosystem quality (Conway 2009). Hence more information on their population status, trends, and habitat associations is greatly needed.

Marshbird monitoring has received greater attention in the past decade but most work has focused on standardization of survey protocols, often in the context of national wildlife refuges or other localized management units (Conway 2009). However, the U.S. Fish & Wildlife Service's Division of Migratory Bird Management in Patuxent, Maryland, recently initiated a surge toward a national marshbird monitoring program, with hopes of establishing a study design and sampling framework that can be used on state, regional, and national scales. The primary objectives of the national program are to: (1) estimate population trends for conservation planning; (2) provide status data, especially for harvested species; and (3) collect ancillary habitat data to inform habitat management decisions at multiple scales.

In 2008, Wisconsin became the first state to pilot implementation of the national marshbird monitoring program through coordination efforts of the Wisconsin Bird Conservation Initiative (http://www.wisconsinbirds.org/) and Wisconsin Department of Natural Resources. The goals of the pilot study are to: (1) shape study design of the national program (e.g. provide estimates of detection probability and occupancy, determine number of survey sites required for desired power, and assess utility of WWI/NWI maps for site selection); (2) inform coordination/implementation efforts (e.g. state and regional coordination needs, how surveyors and volunteers are recruited, operating costs, and reliability of volunteer bird surveyors); (3) provide baseline data on detectability, occupancy, abundance, and habitats of Wisconsin's marshbirds; and (4) assess feasibility of design for monitoring rare species, such as King and Yellow Rails.

Methods

Study design. Details of the general sampling design framework can be found in Johnson et al. (2009). In Wisconsin, the sampling frame was defined as all wetlands in the state that could potentially have marshbirds. These were selected from the digital layers of the Wisconsin Wetland Inventory (WWI; http://dnr.wi.gov/wetlands/inventory.html) using the following classes: (1) aquatic bed, (2) emergent/wet meadow, and (3) shrub/scrub ONLY when interspersed with emergent/wet meadow. Survey sites were selected statewide within defined wetlands using two-stage cluster sampling via a Generalized Random Tessellation Stratified procedure (GRTS), which clustered survey points (Secondary Sampling Units, or SSUs) within larger Primary Sample Units (PSUs) for logistical efficiency.

PSUs and SSUs were then analyzed (in the order selected) remotely using aerial photographs and ground-truthed in the field to assess their suitability for the survey. Selected SSUs were excluded if they had inappropriate habitat (i.e. no longer a wetland, succeeded to shrub/scrub, too dry, etc.) or were too difficult to access (i.e. bordered by impenetrable habitat and/or greater than ~400 meters from any road/trail access). Selected PSUs were excluded if they had less than five suitable SSUs to be surveyed. This process resulted in a "route" of five to ten suitable SSUs occurring randomly within each 40-km^2 PSU.

Target species. Primary target species in this survey were Yellow, Sora, Virginia, and King Rails, Least and American Bitterns, American Coot, Common Moorhen, Pied-billed Grebe, and Wilson's Snipe (2009 only). Secondary target species were Red-necked Grebe, Black and Forster's Terns, Marsh and Sedge Wrens (the latter in 2009 only), Swamp and Le Conte's Sparrows, Yellow-headed Blackbird, and Sandhill Crane (2009 only). These secondary species were selected because they also occupy the wetland habitats to be surveyed, may be poorly monitored by existing surveys, and/or are of conservation interest on state or regional levels. Surveyors did not record data on non-target species.

Survey protocol. Surveys were conducted at each SSU using the standardized protocol outlined by Conway (2009). The broadcast sequence in this study included six species: Least Bittern, Yellow Rail, Sora, Virginia Rail, King Rail (southern WI only), and American Bittern. Two to three replicate surveys were conducted between May 1 and June 15 in southern Wisconsin and between May 15 and June 30 in northern Wisconsin. Observers included a combination of hired field technicians, biologists, and volunteers who were trained via workshops and online resources. See Brady (2009) for more details.

Preliminary Results and Discussion

Year One – 2008

In 2008, three field techs and 25 volunteers surveyed 326 SSUs (points) at 53 PSUs (routes) statewide. See Table 1 for total detections by survey period. Some patterns included:

- Detections and occupancy rates were lower than expected, probably because we were conservative in groundtruthing and included too much "marginal" marshbird habitat (i.e. wetlands that were too dry, too shrubby, a monoculture of reed canary grass, etc.).
- Detections for "hemi-marsh" species – such as Pied-billed Grebe, Least Bittern, gallinules, and Yellow-headed Blackbird – were especially low. The sampling design, either through WWI or the groundtruthing process, may not be picking up this habitat.
- King Rails were expectedly scarce and mainly in southeast Wisconsin. Yellow Rails were also rarely detected – a nocturnal survey may be needed to adequately monitor this species.
- This survey may be able to monitor population trends of Wilson's Snipe – a harvested species – at the state level.
- Occupancy by Sora, American Bittern, and Virginia Rail was positively related to wetland size and percentage of wetland surrounding the survey point and significantly higher in permanently inundated wetlands. Hence water level is likely a strong predictor of marshbird occupancy and should be measured as a covariate (though this is challenging on a state-level scale).
- Detection probability decreased through the survey period for most species. The survey ultimately may require only two replicate surveys to meet monitoring objectives.

Table 1. Numbers of individuals of target species detected during the 2008 Wisconsin Marshbird Survey.

Species	Period 1	Period 2	Period 3	Total
American Bittern	48	18	0	66
American Coot	5	2	0	7
Common Moorhen	0	3	1	4
King Rail	2	2	0	4
Least Bittern	2	4	0	6
Pied-billed Grebe	13	6	1	20
Sora	74	55	4	133
Virginia Rail	31	29	9	69
Yellow Rail	2	0	0	2
Black Tern	8	39	0	47
Forster's Tern	2	6	0	8
Le Conte's Sparrow	4	4	2	10
Marsh Wren	115	97	8	220
Red-necked Grebe	0	0	0	0
Swamp Sparrow	374	384	97	855
Wilson's Snipe	23	24	4	51
Yellow-headed Blackbird	0	3	0	3
Points Surveyed	*326*	*307*	*63*	*326*

Year Two – 2009

In 2009, two field techs and 25 volunteers surveyed 311 SSUs at 42 PSUs statewide. We applied more stringent ground-truthing criteria and thus eliminated some points that were in "marginal" habitat. These were replaced by new, randomly-selected points in more appropriate habitat. This efficiency, coupled with timelier implementation of surveys (early May in 2009 vs. mid-May in 2008), at least in part led to substantially higher detection rates for most species (Table 2). Sora, American Bittern, and Virginia Rail were again most common. Detections of hemi-marsh species were higher than 2008 but still low. Eleven King Rails were detected but ten of these came over replicate surveys at three survey points within one state wildlife area. Detections decreased through each survey period for most primary species, and drastically so for Sora (Table 2). Results of occupancy modeling for 2009 data were not available at time of this report.

Table 2. Numbers of individuals of target species detected during the 2009 Wisconsin Marshbird Survey.

Species	Period 1	Period 2	Period 3	Total
American Bittern	93	62	48	203
American Coot	39	12	4	55
Common Moorhen	14	2	1	17
King Rail	2	5	4	11
Least Bittern	6	5	4	15
Pied-billed Grebe	28	21	11	60
Sora	262	113	22	397
Virginia Rail	56	46	30	132
Wilson's Snipe	31	17	12	60
Yellow Rail	2	1	1	4
Black Tern	6	5	29	40
Forster's Tern	27	4	0	31
Le Conte's Sparrow	8	7	5	20
Marsh Wren	113	155	136	404
Red-necked Grebe	0	0	0	0
Sandhill Crane	262	211	207	680
Sedge Wren	175	240	231	646
Swamp Sparrow	549	634	613	1796
Yellow-headed Blackbird	1	1	1	3
Routes Surveyed	*38*	*37*	*37*	*42*
Points Surveyed	*270*	*266*	*265*	*311*

Comments on Study Design and Implementation

- The Wisconsin Wetland Inventory accurately identified wetlands in most cases. Limitations included old data, some counties not yet digitized, and exclusion of restored wetlands.
- The two-stage cluster sampling using GRTS was effective in producing "routes" of survey points in appropriate habitat while maintaining randomization and spatial balance.
- Ground-truthing – both remotely and in the field – represented the greatest investment of time and resources but was an essential part of implementing this design, especially with volunteer surveyors.
- Volunteers were reliable and performed well, with retention high across years. Training was critical as the protocol is more complex than other surveys and required use of audio equipment and GPS receivers. We found it essential to explain the study design to volunteers so they understood why they were visiting random wetland locations instead of favored sites of interest. Their understanding, passion, and proficiency suggest this survey could be mostly or entirely citizen-based in the long-term, at least here in Wisconsin.
- Proper coordination and implementation required a statewide survey coordinator. This was facilitated by WBCI's Wisconsin Marshbird Survey website (http://wiatri.net/projects/birdroutes/marshbirds.htm).
- Conway's protocol (2009) appeared to be effective and was readily implemented by trained surveyors.
- Standardized equipment, including mp3 players, portable folding speakers, and GPS receivers, were provided to all surveyors. GPS was required because it was not reasonable to permanently mark all survey points statewide.
- Measuring habitat variables at survey sites is a significant concern given the large scale of this survey and heavy reliance on volunteers. What variables to measure and how to measure them proved difficult but see an example from this pilot study at http://wiatri.net/projects/birdroutes/Docs/SampleHabitatSheet.pdf. Measuring water levels, an important predictor of marshbird occupancy, could be especially challenging.
- Availability of a centralized database and statistician through the Patuxent Wildlife Research Center fulfilled important state-level needs after surveys were completed.

Future Work

The first two years of this pilot study have set the stage for an annual, long-term marshbird monitoring program in Wisconsin.

- In 2010, we will focus on surveying more private lands. We surveyed mostly public lands in the first two years for ease of implementation.
- In 2011, we hope to add wetland restorations to complete the sampling framework and compare marshbird population parameters there to non-restored wetlands from the WWI.
- In 2011, we plan to conduct intensive habitat analyses to characterize marshbird habitat associations and determine which variables to measure over long-term and how to measure them.
- The survey may require adaptations to better monitor uncommon or rare species. How we handle this will depend on state priorities and if other states in the region join the national survey effort.
- We will continue to conduct analyses of occupancy, detectability, power, abundance, etc. to inform survey design and conservation planning for target species.

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Funding and Completion

Estimated completion date is January 2011. For information and future updates see http://wiatri.net/projects/birdroutes/marshbirds.htm.

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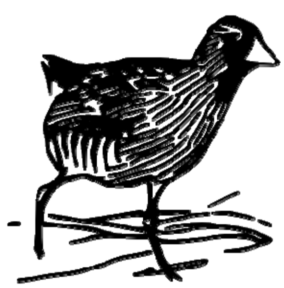


DEVELOPING OPTIMAL SURVEY TECHNIQUES FOR MONITORING POPULATION STATUS OF RAILS, SNIPE, COOTS, AND GALLINULES

DR. COURTNEY J. CONWAY, Assistant Unit Leader, USGS Arizona Cooperative Fish & Wildlife Research Unit, 325 Biological Sciences East, University of Arizona, Tucson, AZ 85721 (cconway@ag.arizona.edu)

DR. MARK WOODREY, Research Coordinator, Grand Bay National Estuarine Research Reserve, Mississippi State University, 6005 Bayou Heron Road, Moss Point, MS 39562

CHRISTOPHER NADEAU, Wildlife Biologist, Arizona Cooperative Fish and Wildlife Research Unit, 122 Biological Sciences East, University of Arizona, Tucson, Arizona 85721

MEAGHAN CONWAY, Wildlife Biologist, Arizona Cooperative Fish and Wildlife Research Unit, 104 Biological Sciences East, University of Arizona, Tucson, Arizona 85721

The acreage of emergent wetlands in North America has declined sharply during the past century. Populations of many species of webless migratory game birds that are dependent on emergent wetlands may be adversely affected. For these reasons, a need for more accurate information on population status and trends has been identified as a top research need for 15 years. Standardized survey protocols are now available, however, numerous methodological questions related to optimal survey methods were raised at a recent marsh bird symposium and in recently published papers, including: (1) the optimal annual timing for conducting surveys in each region of the country, (2) the optimal tide stage for conducting surveys in tidal wetlands, and (3) the effect of broadcasting non-local dialects on detection probability. We are working closely with the National Estuarine Research Reserve (NERR) program to address these questions.

Each NERR in the United States has tidal monitoring equipment that will be invaluable to the study. We surveyed marsh birds at 113 survey points on 3 NERRs in 2009: Apalachicola in Florida, Weeks Bay in Mississippi, and Grand Bay in Louisiana. We also surveyed marsh birds at 271 survey points on 4 National Wildlife Refuges in Florida in 2009. We surveyed a subset of routes at each location every two weeks from 15 February to 1 August. We will use data from these routes to determine the seasonal peak in number of birds detected for each focal species. Preliminary results from FL suggest that the peak varied among species and among locations. These results suggest that the 1.5 month survey window for south Florida may not be adequate to capture the optimal survey dates for all species. Furthermore, the peak in number of birds detected seems to be correlated with rises in water depth caused by late-spring rains in south Florida.

We also surveyed a subset of survey routes on mornings or evenings when the tide was high, mid, or low to determine how tidal stage affects response rates of each species. Lastly, we surveyed a subset of routes using call-broadcast tracks of least bittern and clapper rail recorded in Florida and California. We surveyed each route on consecutive days using a broadcast track from one location on day 1 and a broadcast track from the other location on day 2. We randomly selected which broadcast track we used on day 1 and we only varied the dialect of one species (either clapper rail or least bittern) during each set of two surveys. We will use the results of these surveys to determine the affect of broadcasting different dialects of the same species on the response to call-broadcast.

We will continue to survey for marsh birds at NERRs in 2009, including new survey points at Ace Basin NERR and Ace Basin NWR in South Carolina and possibly 3 other NERRs on the east coast. These results are a preliminary summary of the first year of a 2-year study that was funded by the USFWS Webless Migratory Game Bird Research and Management Program and the USGS Research Partnership Program.

ESTIMATING POPULATION TRENDS, RELATIVE ABUNDANCE, AND EFFECTS OF MANAGEMENT ACTIONS ON 7 SPECIES OF WEBLESS MIGRATORY GAME BIRDS.

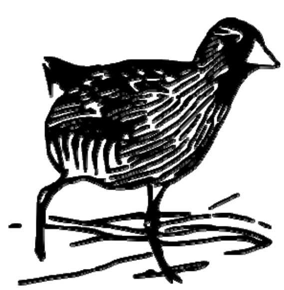
DR. COURTNEY J. CONWAY, Assistant Unit Leader, USGS Arizona Cooperative Fish & Wildlife Research Unit, 325 Biological Sciences East, University of Arizona, Tucson, AZ 85721 (cconway@ag.arizona.edu)
CHRISTOPHER NADEAU, Wildlife Biologist, Arizona Cooperative Fish and Wildlife Research Unit, 122 Biological Sciences East, University of Arizona, Tucson, Arizona 85721
MEAGHAN CONWAY, Wildlife Biologist, Arizona Cooperative Fish and Wildlife Research Unit, 104 Biological Sciences East, University of Arizona, Tucson, Arizona 85721

Populations of many species of webless migratory game birds that inhabit marshes (rails, American coots, common moorhens, purple gallinules, Wilson's snipe) are thought to be declining in North America. Furthermore, emergent wetlands are being eradicated and degraded at an alarming rate and yet we know little about the effects of wetland alterations on marsh birds. In 1999, work began to develop a marsh bird monitoring protocol for conducting standardized surveys for marsh birds across North America. Over 150 participants have voluntarily used the protocol to survey marsh birds since 1999 and participants contributed their data to a pooled dataset. The objectives of this project were to: (1) maintain and expand the development of the National Marsh Bird Monitoring Protocol for two more years, and (2) use data collected using the protocol to (a) estimate population trends and relative abundance for seven focal species (American coot, common moorhen, purple gallinule, clapper rail, king rail, Virginia rail, and sora) of management concern, (b) determine the effectiveness of call-broadcast for monitoring Wilson's snipe, and (c) determine the effect of various management practices and environmental factors on occupancy and abundance of each of the seven focal species.

Since 2008, we have worked extensively to maintain and expand the program. We worked with over 25 new participants to help establish local marsh bird survey efforts across the United States. We also worked with many previous participants of the program to improve survey design in their region. We hosted 3-day training workshops in both 2008 and 2009 where we taught 57 participants from 10 states and 2 Canadian provinces how to collect data using the National Marsh Bird Monitoring Protocol and how to identify all of the vocalizations for each of the focal species. We worked closely with USFWS to revise to standardized protocol based on comments from FWS employees. We greatly expanded our marsh bird website to help provide guidance for implementing the protocol (http://ag.arizona.edu/research/azfwru/NationalMarshBird/). Lastly, we worked with Patuxent Wildlife Research Center to migrate the pooled dataset to an online database and to create an online data entry platform that performs quality control for the pooled dataset.

In addition to maintaining and improving the continental monitoring program, we worked with the pooled dataset to address objectives a, b, and c listed above. We estimated local, regional, and national abundance of each focal marsh bird species using data from 73 National Wildlife Refuges. The relative abundance of most species of secretive marsh birds was low; mean number detected was <0.3 birds per point at >75% of the 73 refuges for all species except clapper rails, pied-billed grebes, common moorhens, and American coots. Relative abundance varied among U.S Fish and Wildlife Service regions for most species; American bitterns were most abundant in Regions 1, 3, 4, and 8; American coots were most abundant in Regions 1 and 2; black rails and Virginia rails were most abundant in Region 2; clapper rails were most abundant in Regions 4 and 8; king rails were most abundant in Regions 2 and 4; and common moorhens, least bitterns, and pied-billed grebes were most abundant in Regions 2 and 8. We are currently working to produce abundance maps based on these results and to estimate population trends of each species. We also evaluated the effectiveness of call-broadcast for monitoring Wilson's snipe. We compared the frequency of Wilson's snipe responses in one-minute of passive listening to the frequency of responses in one minute of call-broadcast. Although Wilson's snipe responded more often during the call-broadcast period ($\chi 2$ = 29.1, df = 9, P = 0.001), the effect size was moderate; the use of call-broadcast increased the number of Wilson's snipe detected by 18% compared to an equivalent one-minute passive listening period. We are currently conducting analyses to evaluate the effects of management actions, water depth, and water quality on each focal marsh bird species. We are working with over 30 National Wildlife Refuges to determine the historic management actions that have occurred near survey points, install staff gauges in some management units, and measure salinity and pH at some marsh bird survey points.

These results are a preliminary summary of the first 1.75 years of a 2-year study that was funded by the Webless Migratory Game Bird Research and Management Program with additional funding from the USFWS Biological Monitoring Team (BMT) for marsh birds.



NESTING, BROOD REARING, AND WINTER HABITAT SELECTION OF KING RAILS AND CLAPPER RAILS WITHIN THE ACE BASIN, SC

WILLIAM E. MILLS and ERNIE P. WIGGERS, Nemours Wildlife Foundation, Yemassee, SC 29945, USA (emills@nemourswildlife.org)
CATHERINE E. RICKETTS and SARA H. SCHWEITZER, University of Georgia, Athens, GA 30602, USA

Graduate Student: Catherine E. Ricketts (M.S.); **Expected Completion:** May 2011

Introduction and Objectives

Population numbers of two marsh game bird species, the king rail (*Rallus longirostris)* and clapper rail (*Rallus longirostris*), have suffered declines due to loss of wetland and tidal marsh habitats. Three clapper rail subspecies in the western U.S. are both state and federally endangered and populations of the 5 subspecies west of the Mississippi River may be stable or declining. In Canada, the king rail is federally endangered and the U.S. Fish & Wildlife Service (USFWS) has named it a "Bird of Management Concern," a "Game Bird Below Desired Condition," and a focal species within its "Focal Species Strategy for Migratory Birds." South Carolina, along with 29 other states, considers the king rail a "Species of Greatest Conservation Need."

Wetland loss is often mitigated by creating man–made wetlands, including marshes, yet it is unclear if these habitats are capable of sustaining marsh obligate species. Managed coastal impoundments may supplement rail habitat, if they meet rails' habitat needs. Because of habitat loss, actual and perceived declining numbers, and hunting pressure, we need data on king and clapper rail population sizes, demographic parameters, and habitat requirements to make informed management decisions to conserve the species. The natural histories of these species are well documented for the Carolinas and Georgia, but there are few estimates of either population numbers or basic demographic parameters, e.g., survival, using modern quantitative methods because historical data are lacking

These birds are secretive, reluctant to fly, and inhabit emergent marshes with thick vegetation, thus they are more often heard than seen. Their behavior, combined with the challenges in accessing their habitat, makes capturing these birds in sufficient sample sizes for scientific study difficult. Our study will try to gather information on a sample of king and clapper rails that will address knowledge gaps. The objectives of our study are to: 1) evaluate the effectiveness of 2 capture techniques for king rails and clapper rails for the purpose of attaching radio transmitters; 2) use radio telemetry to examine winter habitat selection, home range, nest site selection, and survival of king rails and clapper rails using impoundments and tidal marshes in the ACE Basin region of South Carolina.

Progress to Date

The first 6 months of the project focused on developing effective rail capture and transmitter attachment techniques. During spring and summer of 2008 we used cloverleaf traps with drift fences with periodic call broadcasts of rail vocalizations (Kearns et al. 1998) to capture 15 clapper rails and 2 Virginia rails over a 3 month period that included approximately 310 trap nights. We were unsuccessful on 4 attempts at using a john boat on night time high tide events to catch rails with spotlights and dip nets. No rails were located or captured using this technique. This was due mainly to the inability to move through the marsh vegetation with a prop driven boat even at high tide.

We floated eggs found in nests with unknown initiation dates to determine incubation stage. *Photo by C. Ricketts*

Our most successful capture technique developed to date involves the use of a thermal imaging camera from an airboat at high tide. The thermal imaging camera enabled us to locate rails in thick vegetation that were undetectable with spotlights alone. The airboat provided access to portions of the marsh that were inaccessible using other methods. Once a rail was located with the thermal imaging camera, the driver would maneuver the airboat alongside and the rail would be then be captured with a dip net. This method produced a rate of 19 clapper rail captures per hour, far exceeding the other methods we used. This will become our primary technique in future capture efforts.

We evaluated the effectiveness of both necklace and backpack style transmitters on a sample of 24 clapper rails. In a previous study we had found the backpack transmitter attached using the leg loop harness (Haramis and Kearns 2000) to be difficult to attach properly. We elected to try necklace style attachment which would be easier to attach and potentially reduce stress on the birds. However, after increased experience with the leg loop harness and the lower retention rate for the necklaces, we will use the backpack transmitters exclusively as we go forward with the study.

From February to August 2009, we captured 44 clapper (February, n=24; March, n=13; April, n=5; June, n=2) and 3 king rails (March, n=1; April, n=2). The king rails were all located within the Combahee Fields Unit of the Ernest F. Hollings ACE Basin National Wildlife Refuge while the clapper rails were located downstream along the Combahee River and Wimbee Creek. At the time of capture we recorded standard morphometric measurements and collected 2-3 outer retrices for genetic determination of sex. We banded and outfitted each bird with a radio–transmitter attached as a backpack.

We obtained ≥17 locations (range 17- 80), spanning different time periods and all tidal ranges, for 31 clapper rails through the end of July, 2009. For the 2 king rails captured in April we have >40 locations for each bird. We recorded over 1100 locations for these 31 clapper rails and 2 king rails. From April through the end of July, 2009, we found and monitored 54 clapper rail nests to assess reproductive success. Chicks hatched from 18 nests, 30 nests failed, and for 6 nests we could not determine fate. Nests failed either because of depredation (at least 12) or high tide flooding (at least 8). We found no king rail nests. We measured vegetation characteristics at three different scales: study area (60 points dispersed throughout ~2200 ha); home range (10 points along line transect(s) per bird); and nest site (66 points representing 33 nests paired with a random site within 50 meters) for a total of 456 points. We collected data on vegetation height, species present, horizontal cover (stem density and percent cover), and distance to nearest flowing water. For nest sites we also measured nest characteristics such as nest height, canopy height, nest depth, and nest width. To date, clapper rails generally do not use impoundments but king rails do.

A clapper rail defends its nest. *Photo by C. Ricketts*

A king rail with transmitter just before we released it back into ACE Basin NWR. *Photo by C. Ricketts*

Future Work

During February to August 2010, we will attempt to radio-mark 50 birds (approximately 25 king rails and 25 clapper rails). We will locate rails 2 to 3 times per week. During breeding season 2010, we will search for and monitor nests. The addition of a color band should assist in determining if a radio-marked rail is associated with a nest. We will measure vegetation characteristics again in 2010. Additional variables such as patch size and amount of edge will be calculated in a GIS Sex determination via genetic analyses for rails captured in 2009 is almost complete and we plan to collect feathers from 2010 captured rails for the same purpose. The data from 2009 and 2010 will allow us to estimate home ranges, examine wintering, nesting, and brood rearing habitat selection, and estimate survival of king and clapper rails in managed impoundments and tidal wetlands in the ACE Basin region of South Carolina. This summary is for the first 1.5 years of a 2.5 year study funded by the USFWS's Webless Migratory Game Bird Research Program and the Nemours Wildlife Foundation. The study will go towards fulfillment of an MS for graduate student Cathy Ricketts from the University of Georgia under the advisement of Dr. Sara H. Schweitzer. Final reports are expected by May of 2011.

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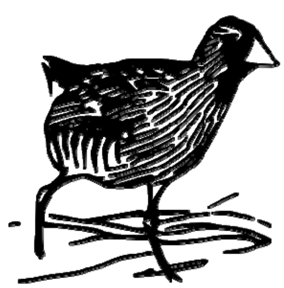


THE EFFECT OF WATERFOWL IMPOUNDMENTS ON SORA AND VIRGINIA RAIL POPULATIONS

BRIAN J. OLSEN and ELLEN P. ROBERTSON, School of Biology and Ecology, 5751 Murray Hall, University of Maine, Orono, ME 04469 (Brian_Olsen@umit.maine.edu)

Graduate Student: Ellen Robertson (M.S.); **Expected Completion:** May 2012

Project Description and Objectives

A common management technique to offset wetland habitat loss and provide habitat for migratory birds is the impoundment of aquatic areas. The hydrologic characteristics of impoundments, however, may be dramatically different from the seasonally flooded wetlands that many impoundments replace. This technique has proven effective for many waterfowl and shorebird species, but its effects remain untested for rails which breed in these altered landscapes. The more stable water levels of impoundments could benefit rails by increasing foraging success and decreasing nest predation, but impoundments may harm rail populations by increasing nest flooding and methyl-mercury exposure, or by decreasing the diversity of prey and vegetation. Assessing the effects of impoundments on breeding rails is difficult, however, due to the current limitations of broadcast survey methods. Further research into the influences of rail reproductive stage on vocalization probability is needed. The impacts of wetland impoundment may be multiple and complex, and a controlled study is required to assess this management practice. The objectives of this project are to: 1) establish the probability of rail nest predation or flooding, 2) measure the risk of adult and juvenile rails to methyl-mercury exposure, 3) compare the above measures between different types of impounded wetlands, and 4) develop an individual-based model of vocal detection probability relative to reproductive stage to predict rail population trends more accurately using established broadcast survey methods.

Progress to Date

One pilot field season was completed during the summer of 2009 by Ellen Robertson (an M.S. candidate) with funding from the University of Maine. This included surveying 58 wetlands for Virginia rails and soras in central and eastern Maine to assist with initial site selection. Surveyed wetlands possessed varying degrees of impoundment, and those with high rail densities were subsequently selected for trapping and nest searching efforts. Thirty-three eggless nests and 10 nests with eggs were found and monitored every 3-5 days until success or failure. We also recorded parental calls/behavior around the nest. Rails used a variety of vegetation types for nest construction and nest cover and (anecdotally) seemed to prefer transitional edges between vegetation patches.

A Virginia rail captured with a baitfish cast net at Field's Pond, Orrington, ME. *Photo courtesy of University of Maine*

The summer was an unusually rainy one for Maine and half of the monitored nests flooded (in wetlands with all different degrees of impoundment, N = 5). Additionally, two were depredated, leading to very low apparent nest success. We will calculate daily cause-specific failure probabilities with this and all future nest data. Several trapping methods were attempted this summer. Four methods each captured a single adult Virginia rail: a cloverleaf trap (30-40 meters of fencing with funnels leading into cages: Kearns et. al 1998), noose mats, and drift fences with funnels and wire cage traps. The most successful method (4 rails captured), however, was a baitfish cast nest used on incubating adults. No adults abandoned the nest after they were captured in this manner. We captured chicks successfully by hand while drying on or near the nest ($N = 4$). Samples for Hg analysis were taken from both the adult (blood and feathers) and chicks (blood only). We also weighed, photographed, banded, and gathered standard morphometric data on all captured adults.

We recorded the adult response to broadcast calls during the different nesting stages for each of the ten known nesting pairs. Broadcast surveys were conducted using digital recordings of territorial calls to illicit adult response as many as four times for each territorial pair during the breeding season (during territory establishment, nest building, incubation, and brooding). Each survey occurred within three hours of sunrise or sunset and surveyors recorded adult vocalization response, time to respond, and distance from the call-back speaker. This data will assist us in determining the optimal rail reproductive stages at which to conduct broadcast surveys. Given the limited sample size and variance from this pilot season, we will wait to report initial results until further field work has been conducted.

Our two subsequent field seasons are funded by the Webless Migratory Game Bird Research Program and will be conducted by E.P. Robertson and 2-3 additional field technicians (the pilot season was largely conducted by E.P.R. alone). We will concentrate work during this period on wetlands with differing degrees of hydrologic impoundment that were identified during the pilot year as sites with relatively high rail densities for the region. Project completion and final reports are expected in May 2012.

These are the results from the first 6 months of a 3-year study funded/supported by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service), Moosehorn National Wildlife Refuge, a University of Maine Faculty Research Grant, the Biodiversity Research Institute, and the Maine Department of Inland Fisheries and Wildlife.

A Virginia rail nest with four eggs in Orrington, ME. *Photo courtesy of University of Maine*

LINKING SITE OCCUPANCY, REPRODUCTIVE SUCCESS, AND MANAGEMENT OUTCOMES FOR STRATEGIC HABITAT CONSERVATION OF KING RAIL (*RALLUS ELEGANS*)

JAIME A. COLLAZO, North Carolina Cooperative Fish and Wildlife Research Unit, Campus Box 7617, North Carolina State University, Raleigh, North Carolina 27695 (jaime_collazo@ncsu.edu)
C. ASHTON DREW, Biodiversity and Spatial Information Center, Department of Biology, Campus Box 7617, North Carolina State University, Raleigh, North Carolina 27695 (ashton_drew@ncsu.edu)

Graduate Student: Samantha Rogers (M.S.); **Expected Completion:** 2011

Introduction and Objectives

For the past three years, we have been involved in developing and validating expert-based Bayesian Belief Network models of King Rail occupancy of marshes in eastern North Carolina and Southeastern Virginia. This Science Support Partnership (SSP) funded initiative was in response to the U.S. Fish and Wildlife Service's Strategic Habitat Conservation (SHC) need to develop robust, science-based procedures to step-down population and habitat objectives from national planning documents to local (refuge scale) levels for species from diverse taxa (Drew et al 2006). As a secretive species that locally has been neither actively managed nor monitored, the King Rail provided an excellent focal species to evaluate the ability of expert-knowledge models to bridge the gap between paucity of data and conservation needs, and provide a rigorous foundation to guide future adaptive management and monitoring efforts. Field validation of our models using call-back surveys and occupancy modeling allowed us to explore the strengths, weaknesses, and biases in expert knowledge (Drew and Collazo, in prep). We have found that expert-based Bayesian Belief Networks perform well for predicting King Rail occupancy patterns, with 83% of field measured occupancy rates falling within one standard deviation of the model's predicted occupancy values. Furthermore, all King Rail detections occurred at sites ranked High or Moderate probability of occupancy by King Rail, and no King Rail were detected at sites ranked Low (Drew and Collazo, in prep).

Achieving high predictive ability for mapping occupancy at the ecosystem and refuge scales is an exciting achievement, however, such distribution models only provide part of the information necessary for effective *long-term* conservation planning in dynamic systems. As is the case for many species, the national objectives are not only to protect the existing population, but also to grow the population. For King Rail, the Southeast Region Waterbird plan recommendations the Southeast Coast Plain BCR King Rail population increase from an estimated 830 pairs to 6000 pairs. Data on population vital rates (immigration, emigration, births, and deaths) is essential to distinguish source versus sink habitat or the presence of density dependent effects that may affect population growth rates. Furthermore, if the objective is to increase a population and achieve long-term population viability, it is essential to know how strongly management actions affect these vital rates to best manage habitat once it is protected. To this end, we proposed to complement our occupancy models and field validation with a parallel study on nest success in relation to both the occupancy model's landscape predictor variables and the use of prescribed fire as a management tool. Ultimately, this WMGBR funded project will allow us to integrate reproductive activity (nest success) and management impacts (year since burn) into our distribution model. The research objectives of our project are to:

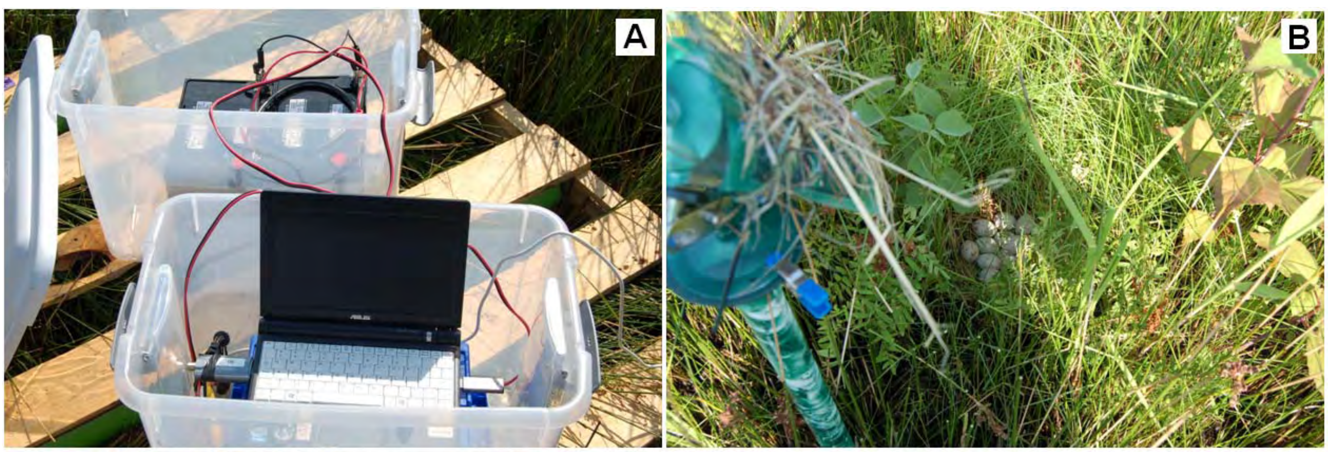
(1) Quantify the effects of marsh management history (year-since-burn) on probability of site occupancy, probability of reproductive activity, and reproductive output (chicks fledged) of King Rail.
(2) Evaluate the relative value of landscape and microhabitat characteristics as predictors of reproductive output.
(3) Identify causes of nest failure.

(4) Integrate data on reproduction and management outcomes into existing occupancy models to create dynamic model to simulate future populations.

Progress to Date

From March 24 to July 2, a USGS funded crew performed secretive marsh bird call-back surveys (Conway 2005) for model validation and a WMGBR funded crew performed nest searches and nest monitoring. The call-back surveys were conducted on public and private lands, including Back Bay National Wildlife Refuge (VA), False Cape State Park (VA), MacKay Island National Wildlife Refuge (NC), North Landing River Preserve (VA), Northwest River State Natural Area Preserve (VA), and Northwest River Marsh State Game Land (NC). The nest searches were restricted to the refuges, state park, and the intervening private lands, as daily maintenance of the nest video monitoring systems required a smaller study area. Locations for nest searches were selected based on landscape characteristics and management history (year-since-burn).

When a nest was located, we documented the geographic coordinates along with nest characteristics, such as number of eggs, nest height, water depth below nest, and associated vegetation. Then a video surveillance camera was mounted within 1 m of the nest to document all nest activity for the duration of nest occupancy. These systems (Figure 1) included an infrared security video camera attached to an analog to digital data converter, a mini-pc, and a thumb drive set in a plastic bin and connected to two 12-volt marine deep cycle batteries set in a second plastic bin (Drew et al., in prep). The plastic bins were kept approximately 20 m from the nest site, to reduce disturbance effects while changing recording media and batteries. These camera systems provided continuous recording and thereby allowed us to capture night and daytime activity, including parental behaviors, species interactions, and predatory events.



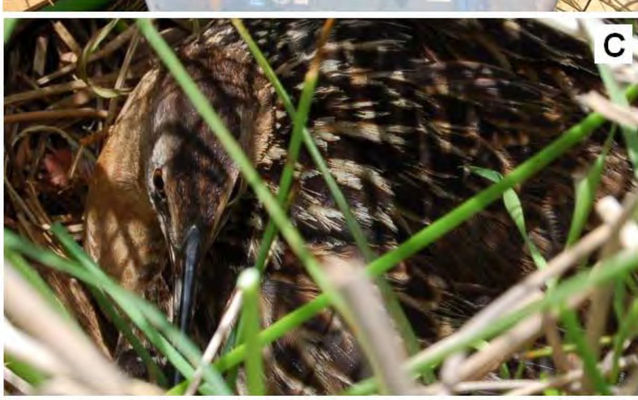


Figure 1. (A) Nest video recording equipment including two batteries connected to a mini-PC, analog to digital data converter, and a 16 GB data stick, all set within plastic bins on a floating wood pallet and covered by a camoflauged shade canopy (not shown). (B) Nest monitoring video camera mounted above an active King Rail nest at Mackay Island National Wildlife Refuge, NC. This nest successfully hatched 10 of 12 eggs (two eggs were infertile). This site had been burned approximately two months prior to this photograph. (C) A King Rail on its nest at Back Bay National Wildlife Refuge, VA. This nest successfully hatched 6 of 11 eggs (five were infertile).

Seven King Rail nests were located and monitored for a total of 118 video days (Figure 2) between 4 May and 17 June 2009. In addition, we found six Least Bittern nests in the same habitat, so we opportunistically monitored this species (147 video days between 7 May and 2 July), which is a priority species for our State partners (Figure 2). Most active nest sites were found in the interior of the marsh landscape (>150 m walk from nearest roadside or shoreline access point). We recorded 2374 hours (612.2 GB data) at King Rail nests and 2670 hours (700.4 GB data) at Least Bittern nests. Documented behaviors included brooding, egg laying, egg turning, nest construction, nest defense, hatching, feeding, and predation by snakes and raccoons. Nest success, or cause of nest failure, was clearly documented in all cases (Figure 1). For King Rail full clutches (five of seven nests) averaged 10.6 eggs. Of 60 King Rail eggs laid, 35 (58%) hatched, 7 (17%) were infertile, and 18 (30%) were predated. For Least Bittern, all six nests produced complete clutches, which averaged 4.3 eggs. Of 26 Least Bittern eggs laid, 18 (69%) hatched successfully, zero (0%) were infertile, and 8 (31%) were predated. Unexpectedly, most nests were found in areas that had been burned just previous to the field season (5 of 7 King Rail nests, 4 of 6 Least Bittern nests). Despite significant search effort, no nests were found in areas where greater than two years had passed since prescribed burning. Pictures of all nests and eggs are available on our project website, as is a poster presentation of hypotheses and preliminary results by Samantha Rogers (http://www.basic.ncsu.edu/proj/SSP.html).

The above information represents preliminary results from one year of a two year study of nest success, with funding from the USFWS Webless Migratory Game Bird Research Program, the US Geological Survey, and North Carolina State University. The final results will be published in 2011.

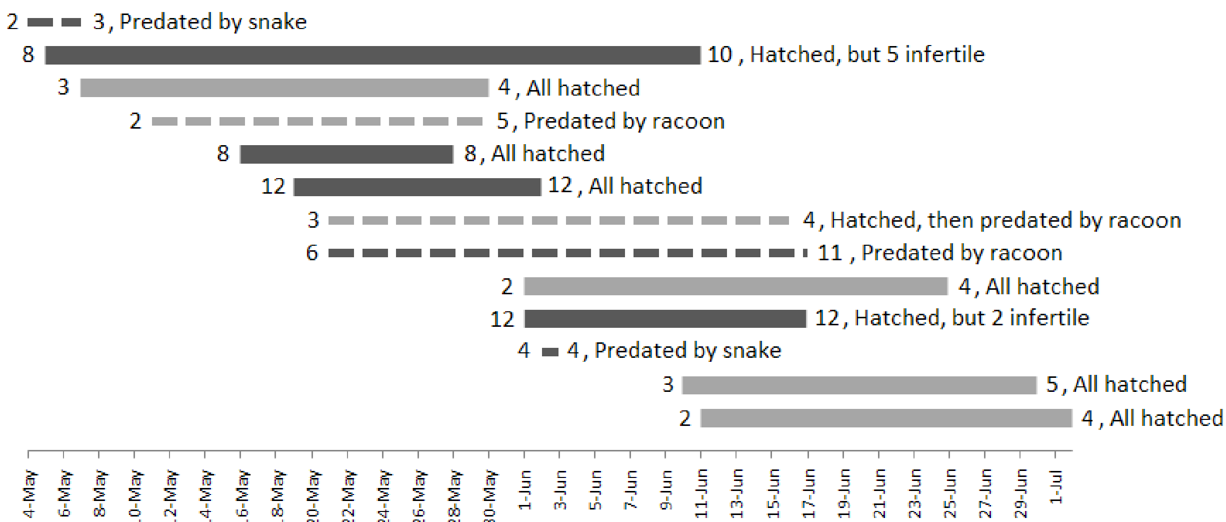


Figure 2. Preliminary nest monitoring data for King Rail ■ and Least Bittern ■ in eastern North Carolina and southeastern Virginia in 2009. At least one, 1-hour nest search was conducted daily from March 25 to June 25, the period when King Rail were actively calling in the marshes. Monitoring dates for successful nests are shown with wide solid lines, while predated nests are shown with thin dashed lines. The numbers indicate the eggs present when the nest was first located (left) and either hatched or predated (right).

Future Work

Several work-study students, volunteers, and Samantha are currently watching the King Rail nest video. We are documenting: (1) parental time spent on versus off the nest, (2) frequency of parental departure from the nest, (3) predation events and their outcome, (4) non-predatory interspecific interactions at the nest site, (5) non-predatory conspecific interactions at the nest site, (6) number of chicks hatching and departing the nest, and (7) number of days from egg laying to hatching in cases where video is installed prior to laying of complete clutch. The Least Bittern data has been sent to Nick Bartok (University of Western Ontario) for viewing and publishing the associated results.

Given the success of our first field season and the potential value of our data, the USGS has provided money from their Quick Response program to perform a second field season. Some of our observations, such as ground nests on dry soil near trees and the selection of year zero burn areas, were unexpected and unusual given current knowledge of King Rail ecology, so this second field season will also allow us to explore whether such habitat selection is consistent across years.

As originally planned, but with the additional year's data, we will use a multi-state modeling approach (Mackenzie et al 2006) to estimate the probability that a site will be occupied (Psi) and the probability of detecting reproductive activity, given that the site is occupied using program PRESENCE (Hines 2006). With these estimates, we will quantify occupancy, probability of detecting reproductive activity and reproductive success in relation to management history, in addition to microhabitat and landscape site characteristics. We can then integrate this knowledge of reproductive success into our existing Bayesian Belief Network occupancy model, so that the model not only identifies sites predicted to have high occupancy and abundance of King Rail, but also indicates which among these sites offers the highest reproductive potential given landscape characteristics. Furthermore, we will integrate the management effects knowledge, to allow managers to simulate the predicted population outcomes of alternative prescribed burning plans. Thus, we will present the USFWS, USGS, and their partner agencies with a model framework that links management actions with occupancy and reproductive success to provide dynamic, predictive population and habitat modeling in support of science-based, adaptive management decisions in conservation. Advancing beyond the static distribution models that commonly guide conservation decisions, these dynamic models will more easily integrate with efforts to predict population and habitat shifts under climate change scenarios and alternative management actions.

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DEVELOPMENT OF A WINTER SURVEY FOR WILSON'S SNIPE IN THE MISSISSIPPI FLYWAY

DAVID G. KREMENTZ, USGS Arkansas Cooperative Fish and Wildlife Research Unit, University of Arkansas, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, USA (krementz@uark.edu)

J. MATTHEW CARROLL, Arkansas Cooperative Fish and Wildlife Research Unit, University of Arkansas, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, USA Email: (jmc005@uark.edu)

Graduate Student: Matt Carroll (M.S.); **Expected Completion:** May 2011

Introduction

Despite being widespread and relatively important in the bag of webless game birds, the Wilson's snipe (*Gallinago delicata*) is one of the least studied North American game birds (Fogarty et al. 1977, Arnold 1994, Mueller 1999). Currently there are no reliable estimates of population numbers or trends for the snipe (Arnold 1994, Mueller 1999), and this absence of information was discussed by Tuck (1972), Fogarty et al. (1977), Arnold (1994), and Mueller (1999). The only continent wide trend survey for snipe is the Christmas Bird Count (CBC) which was not designed for surveying snipe. The CBC indicates that snipe significantly declined between 1959 and 1988 (trend: -1.2 (-2.2 - -0.1 95%CI), 1466 routes).

Tuck (1972) also discussed winter surveys that were based on line transects focused on winter concentration areas across the U.S. winter grounds. These surveys were to be augmented by CBC data recognizing that the CBC was not designed to survey snipe. As with the breeding ground surveys, Tuck (1972) indicated that there were problems with this approach. The primary issues noted were: 1) numbers of snipe recorded fluctuated among years at individual sites, 2) the number of snipe wintering outside of the United States was uncertain and could change annually, and 3) that weather and water levels affected survey-specific detection. Despite the stated limitations of the winter survey approach, Tuck (1972:380) concluded that, "Winter population censuses have most merit and would be most reliable if carried out in the southern states in early February when the population is relatively stable." Based on the combined consensus that population abundance estimation methods for snipe are needed (Tuck 1972, Fogarty et al. 1977, Arnold 1994, Mueller 1999) and that Tuck (1972) recommended that winter population surveys offered the most promise, we are proposing to develop a winter ground survey for Wilson's snipe in the Mississippi Flyway as a first step towards developing the methods for a United States-wide winter snipe survey.

The objectives of our study are to: 1) develop a feasible roadside survey for wintering snipe, 2) estimate winter snipe population abundance for the Mississippi Flyway, 3) to determine whether survey-specific covariates need to be included in the survey design, and 4) to examine factors affecting between-year variability in individual site abundance estimates.

Methods

The study area included the snipe wintering grounds in the lower Mississippi Flyway (Figure 1). Based on current CBC data (Sauer et al. 1996), the primary wintering states for the Mississippi Flyway include Arkansas, Louisiana, and Mississippi. Within these states there are 3 concentration areas that include the Arkansas/Mississippi Delta, the southwestern Louisiana coastal plain and the Red River Valley in Louisiana. These 3 regions were the focal areas for our sampling scheme. Within the study area, we used townships as the sampling unit. We included 50 townships of which 20 were based on Christmas Bird Count data and 30 were chosen randomly. We stratified the sampling frame into 3 landscape types on the basis of CBC snipe abundance. The number of random sites was based on the proportion of the 3 states surveyed to the overall study area.

Within each township, 9 line transects along secondary roads (1.8 km x ~200 m wide; 16.2 km total) were specified as the sub-sampling unit. Our criteria for secondary roads included in the survey were roads with low traffic and/or low speed limits and roads that were >1.8 km long. Survey sites (road sections) were based on random stratified points. We surveyed the nearest suitable road to the location of each random point. Routes were run from a slow moving truck using binoculars and window-mounted spotting scopes to count birds. All birds seen were recorded regardless of the distance from the observer. Briefly stopping the vehicle and alternating speeds was sometimes required to scrutinize certain habitat types. Also, the cryptic coloration and typically solitary nature of snipe required a methodical approach to conducting surveys. Along these routes, we recorded the GPS coordinates of start and stop location, distance from the road to each bird (or flock and how many individuals were in the flock), vegetation height, weather conditions, average water depth, percent water and vegetation cover in a segment, and general habitat type.

Figure 1. Study area including the lower Mississippi Valley, Red River region of Louisiana and southwestern Louisiana. Black symbols represent townships that were surveyed, February 2009.

We conducted line transect surveys throughout the daytime from 21 January to 23 February 2009 as Tuck (1972) indicated that snipe had not yet begun spring migration then and were relatively stable in distribution. Upon completion of the study, snipe densities will be estimated using program DISTANCE for the sample area and will be expanded to the township level assuming that landscape adjacent to the road is reflective of the township landscape. Site-specific and survey-specific covariates thought important to estimating detection will be formally tested for importance in DISTANCE. Factors affecting snipe densities for townships sampled in both years will be compared using appropriate candidate models and model selection will be based on Akaike's Information Criteria.

Results

Road availability and access varied greatly among townships. In more urban areas, surveys were many times not possible due to safety concerns and/or a lack of roads meeting our criteria for suitable road segments. In townships where there were not enough road segments, surveys were conducted on roads outside of the townships if they were within one surveys length from the border of the township (1.8 km). Incomplete surveys, although rare, were typically due to road conditions or access difficulties. Also, logistical issues such as gates, private property, treacherous roads and nonexistent roads/farm lanes, made some points impossible to use as a reference for surveys.

We detected 1492 Wilson's snipe from 21 January – 23 February 2009. We detected snipe in 49% of the townships surveyed. One township in Mississippi accounted for 338 snipe detected and one township in Arkansas had 232 snipe detected. The remaining 922 snipe were detected in townships throughout study area. However, no snipe were detected in the two townships that were surveyed in the Red River region of Louisiana. Most snipe (91%) were detected in association with shallow standing water (Fig. 2). 59% of snipe were detected in areas with between 25-<50% water cover. The next most commonly used sites by snipe had <25% water cover (29%), 50-<75% water cover (8%) and >75% water cover (5%).

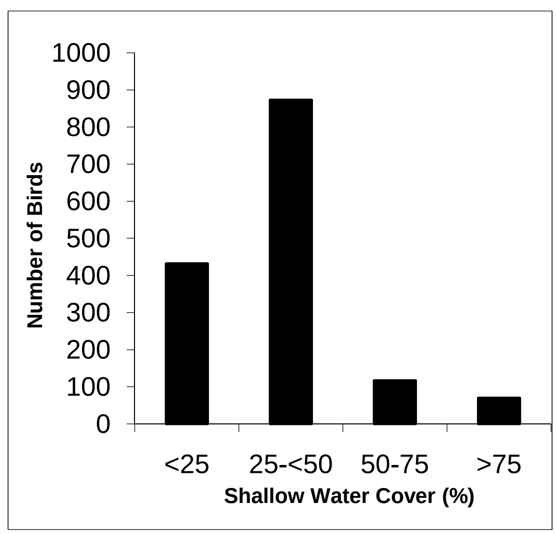

Figure 2. Number of birds detected in habitats with varying percentages of shallow water cover in the lower Mississippi Flyway, February 2009.

Comparing habitat available with numbers of snipe detected, we noted that snipe appeared to use agriculture more often than available (Fig. 3). General agricultural habitats defined as crop fields (including rice) and pasture had the highest number of snipe comprising 95% of the total number of snipe detected (Fig. 3). More specifically, of the 95% of birds detected in generalized agricultural habitats 14% were detected in rice fields and 6.5% were detected in pastures. Fish pond/ mudflat habitats accounted for about 5% of the total snipe detected but <1% of the total habitats observed. Residential areas and marshes each had <1% of the snipe detected. Wooded areas, open water areas, and various habitats categorized as other accounted for zero snipe detected.

In terms of habitats with varying percent water cover, general agricultural habitats with 25-50% water cover accounted for more than half of the snipe detections (807) (Fig. 4). Agricultural habitats with 0-<25% water cover had 429 birds detected, and agricultural habitats with 50-<75% had 116 birds detected. Fishpond/mudflat habitats were the only habitats with birds detected in association with >75% shallow water cover.

In examining the frequency histogram of snipe detected versus distance from the transect line, we determined that we needed to left truncate at 20 m because of the road and associated right of way were not used by snipe. We detected 85 snipe beyond 200 m and opted to truncate those observations. We used a global detection function, half normal cosine key function and cosine series expansion to estimate an overall snipe density. We estimated 9.1 (2.45 SE) snipe per square kilometer. Our estimated strip width was 70.4 m, and the mean cluster size was 1.82 (0.73 SE) individuals per cluster.

In 2010 we will repeat the line transects surveyed in 2009. We will also double survey coverage in 2010 by adding more townships within the study area. Habitat covariates will be recorded in order to detect possible patterns in habitats occupied by snipe. Yearly snipe abundances at sites for 2009 and 2010 will be compared with Christmas Bird Count data from each respective township for those years. Program DISTANCE will ultimately be used to generate a density estimation that will be expanded to determine an estimate of snipe abundance in the lower Mississippi Alluvial Valley.

Acknowledgements

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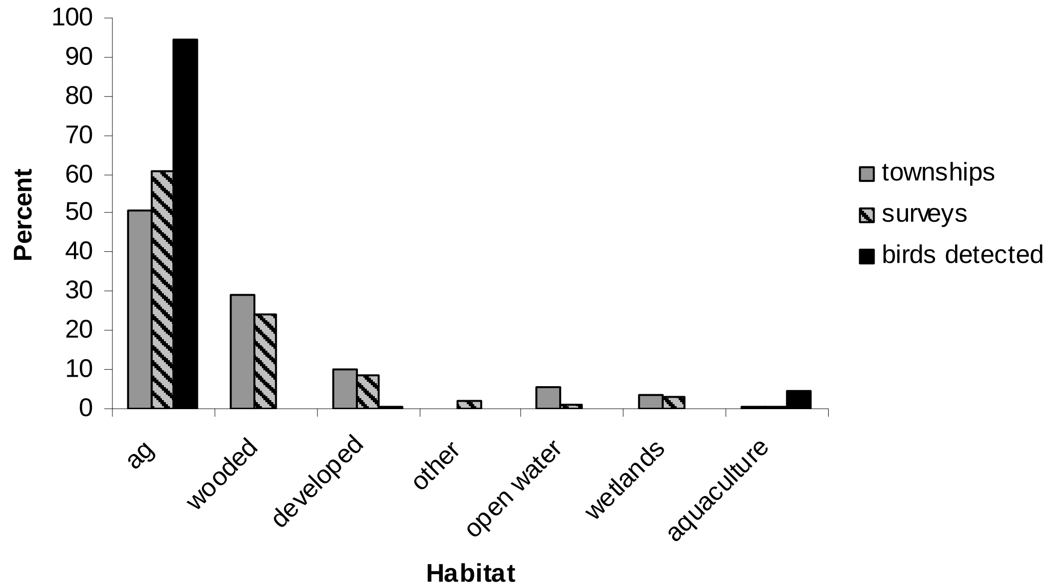

Figure 3. Percent of Wilson's snipe detected compared to the habitat types observed in the lower Mississippi Flyway during February, 2009 and township habitat types indicated by National Agricultural Statistics Service (USDA) data in the surveyed townships.

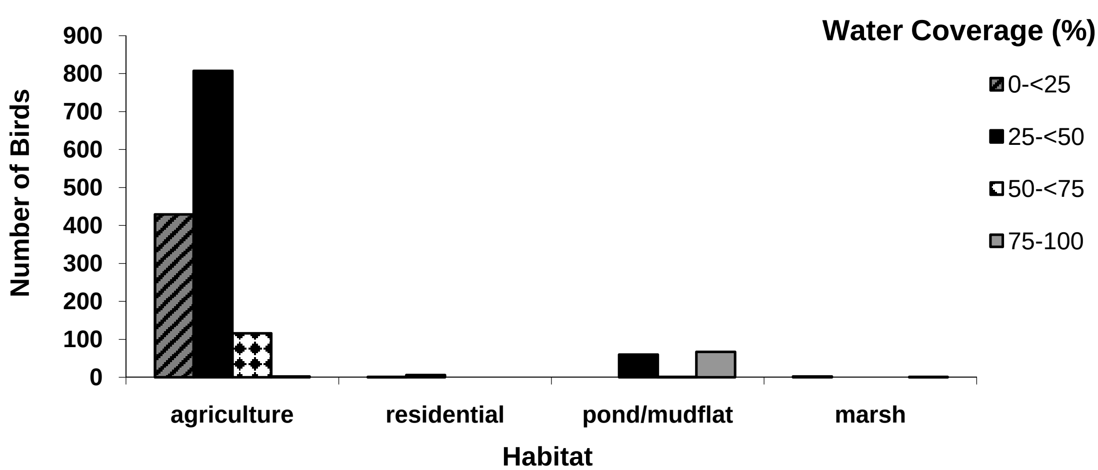

Figure 4. The relationship between water cover and habitat type used by Wilson's snipe in the primary wintering area of the lower Mississippi Flyway, February 2009.

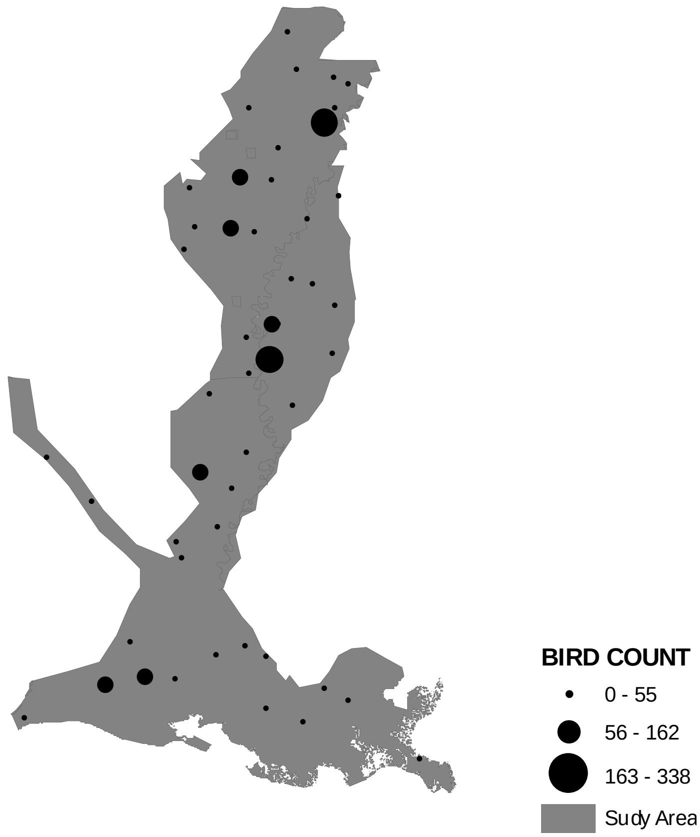

Figure 5. Snipe counts within the study area. Each circle represents a township where surveys occurred with the corresponding count number.

ASSESSING POPULATION TRENDS AND STATUS OF WEBLESS MIGRATORY GAME BIRDS USING VOLUNTEER COLLECTED DATA

DEBRA S. BADZINSKI AND RYAN ARCHER, Bird Studies Canada – Ontario Region**,** 115 Front Street, P.O. Box 160, Port Rowan, Ontario, Canada, N0E 1M0 (dbadzinski@bsc-eoc.org).
DR. PHIL TAYLOR, Department of Biology, Acadia University, Wolfville, Nova Scotia, Canada, B4P 2R6

Final Report

Reliable annual population indices, harvest estimates, and information on distribution, recruitment and habitat associations are essential for webless gamebird management. However, webless migratory game birds are a distinct group of birds with specialized habitat requirements, and unique behavioural characteristics, which makes management of these species very difficult. Many of these species are secretive, crepuscular, have early breeding seasons, breed in relatively inaccessible areas and overall, are very difficult to count.

For these reasons, most species of webless migratory gamebirds are poorly monitored by existing bird monitoring programs such as the Breeding Bird Survey (BBS) and Christmas Bird Count (CBC). The BBS currently has limited capacity to produce population trends for secretive wetland-obligate bird species such as Virginia Rail, Sora, Common Moorhen and American Coot, and for crepuscular species such as American Woodcock and Wilson's Snipe. Population status of American Woodcock is monitored by the Singing-Ground-Survey (SGS), however, current monitoring effort is not adequately covering the northern extent of this species' range (e.g. BCR 8 in Ontario, BCR 14 in New Brunswick) (Sauer et al. 2008).

As a result of the loss and degradation of marsh habitats (e.g, wetland draining and filling, non-point source pollution inputs, hydrological regime alterations, invasive species proliferation) that have occurred over the past several decades, it is widely believed that marsh birds, (including American Coot, Common Moorhen, Virginia Rail and Sora) are in decline (Gibbs et al. 1992, Conway, 1995, Melvin and Gibbs 1996), particularly for those nesting within the Great Lakes basin (Blancher et al. 2007). American Woodcock populations are also showing long-term population declines (Kelley et al. 2007, Sauer et al. 2008), which may be related both to wetland habitat loss and to natural succession. In Ontario (particularly in the south), many of the old fields have been allowed to regenerate to forest, or have been developed as subdivisions or industrial parks, which eliminates American Woodcock habitat.

The goal of this project is to use data from a variety of volunteer-based surveys to describe the short and long-term population trends, distribution and population status for the following webless migratory gamebirds: American Coot, American Woodcock, Common Moorhen, Sora, Virginia Rail, and Wilson's Snipe. Our specific objectives were to:

1. Describe changes in American Coot, Common Moorhen, Sora, and Virginia Rail in the Great Lakes/St.Lawrence region from 1995-2008 using data from the Great Lakes Marsh Monitoring Program
2. Describe the long-term (1981-2005) changes in population status and trends for American Coot, American Woodcock, Wilson's Snipe, Common Moorhen, Sora, and Virginia Rail in Ontario using data from the Ontario Breeding Bird Atlas; and
3. Using data from the Nocturnal Owl Survey, calculate annual population indices (2001-2008) for American Woodcock and Wilson's Snipe in Ontario, New Brunswick, Nova Scotia, and Prince Edward Island.

These are the results of preliminary analyses of using volunteer-collected data to monitor population change of webless game birds. The Great Lakes Marsh Monitoring Program is a partnership between Environment Canada, Bird Studies Canada and the US-EPA GLNPO. The nocturnal owl surveys are coordinated by Bird Studies Canada in partnership with the Ontario Ministry of Natural Resources – Wildlife Assessment Program, the New Brunswick Department of Natural Resources, New Brunswick Wildlife Trust Fund, and the Prince Edward Island Department of Environment, Energy and Forestry. The

Atlas of the Breeding Birds of Ontario was a collaborative effort among the following organizations: Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources and Ontario Nature.

According to atlas data (1st: 1981-1985; 2nd: 2001-2005), Common Moorhen and American Coot are showing long-term declines in southern Ontario. Declines are more pronounced for Common Moorhen. Marsh Monitoring Program data show that both species declined during the period 1995-2008, but appear to be increasing on routes outside of the Great Lakes basin. Atlas and MMP data both suggest that the Sora population has been stable or increasing throughout the Great Lakes basin and Ontario. Virginia Rail showed a significant increase in Ontario between atlas periods (1981-1985; 2001-2005). Virginia Rails in the Great Lakes basin declined during the period 1995-2002 but seem to have rebounded since that time (Figure 1).

Approximately 150 routes are surveyed annually in central and northern Ontario and 120 routes in Atlantic region (NB, NS, PEI). On average, 58% of routes in Ontario recorded American Woodcock. The probability of detecting a woodcock at an individual survey station significantly increased over time in central Ontario, northern Ontario and in Atlantic Canada (Figure 2). Further analyses of the data are needed, but these preliminary results suggest that the Ontario and Atlantic Nocturnal Owl Surveys have the potential to contribute to American Woodcock (and Wilson's Snipe) monitoring.

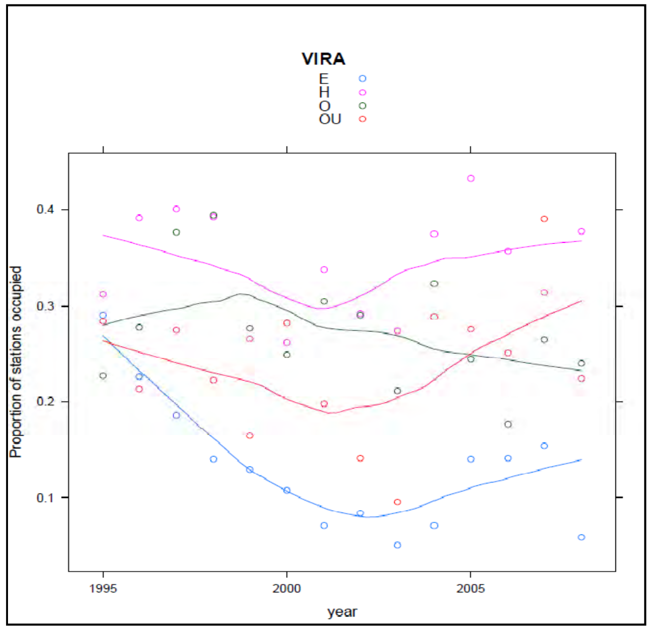

Figure 1. Probability of detecting Virginia rail in the Lake Erie (E), Lake Ontario (O) and Lake Huron (H) basins, and for routes outside of the basin (OU) from 1995-2008 using data collected from participants in the Marsh Monitoring Program.

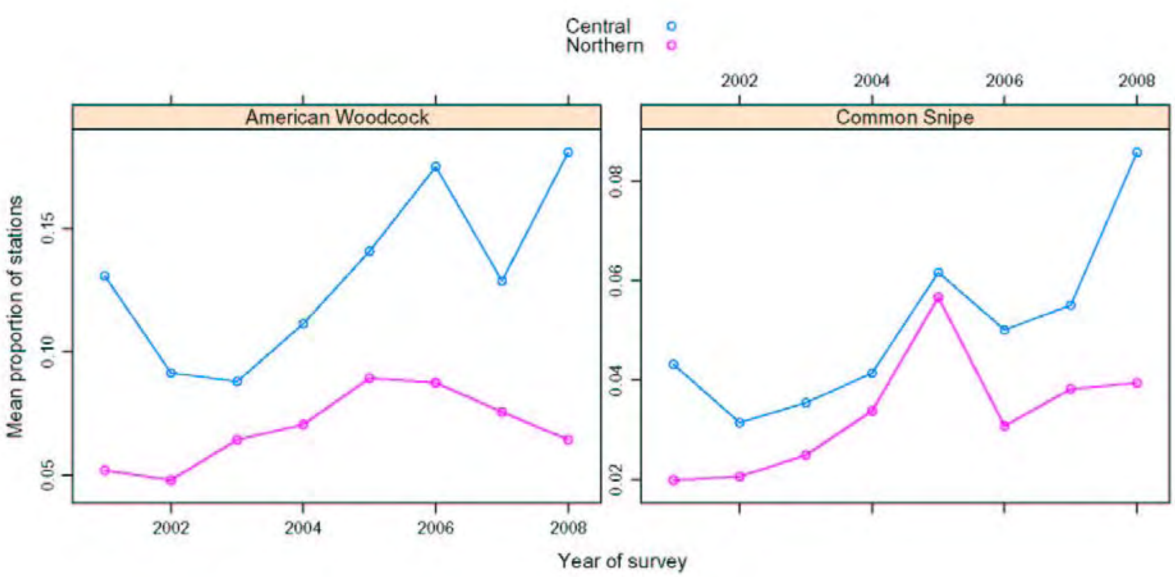

Figure 2. Mean proportion of stations that detected American Woodcock and Common (Wilson's) Snipe on Nocturnal Owl Survey routes in central and northern Ontario (2001-2008).

Division of Migratory Bird Management
1 Federal Drive, Room 501
Minneapolis, MN 55111
612-713-5338

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