Survey of Wintering Loggerhead Shrikes in South Carolina Including Stable Hydrogen Isotope Feather Analysis

Samuel H. deMent[1], Kenneth S. Latimer[2], and Keith A. Hobson[3]

[1] *200 Lanham Springs Drive, Lexington, SC 29072, shdement@hotmail.com*
[2] *Dept of Veterinary Medicine, Athens, GA 30602*
[3] *Environment Canada, 11 Innovation Blvd., Saskatoon, SK CA S7N 3H5*

Introduction

Loggerhead Shrike (*Lanius ludovicianus*) populations are in decline in the southeastern United States, prompting several states to initiate population studies of both breeding and wintering populations. We report here the results of a survey of wintering shrikes in two upstate western piedmont counties and two lower state counties. In South Carolina, both wintering and breeding habitats occur, and determination of resident versus migrant status of the South Carolina wintering shrike population is problematic, since little information has been obtained from conventional banding techniques in this species. Recently, stable hydrogen isotope analysis of feathers has been utilized to assist in this determination (Hobson and Wassenaar 2001, Perez and Hobson 2006). We sampled shrike feathers and analyzed these for stable hydrogen isotope (δD) values in order to assist in the identification of resident versus migrant individuals. In addition, we assayed blood samples for parasite loads. Our objectives were to determine the breeding origins of Loggerhead Shrikes wintering in South Carolina and to evaluate whether such origins varied within the state or with land-use practices. We also were interested in evaluating whether breeding origin and wintering location were correlated with basic health parameters such as parasite load and body mass.

Methods

The study areas were four counties in South Carolina, two in the upstate western piedmont region (latitude N34.1) and two lower state counties (latitude N33.3–33.4). Loggerhead Shrikes were lured with bal-chatri noose traps containing house mice (*Mus musculus)* during the non-breeding season, defined as November through February (Cely and Sorrow 1988; deMent and deMent 2001). All Loggerhead Shrikes seen were exposed to these noose traps and if captured, banded according to Master Banding Permit 22771 restrictions. A total of 54 birds were studied from 2001 through 2006, with blood collected for smear analysis, air dried and later stained with Wright/Giemsa stain as previously reported (deMent and deMent 2001). Qualitative analysis for hematozoa was performed by two pathologists on 54

blood films (deMent et al. 2002). Body mass was recorded to the nearest gram, wing chord measured to the nearest millimeter (mm), and site and date of capture recorded. Birds were aged as Hatch Year (HY) or After Hatch Year (AHY) (North American Bird Banding Manual 1991, 1997). All birds were photographed on site, thereby documenting background habitat. A single outer rectrix was collected and placed in a paper envelope for later batch mailing to the Environment Canada stable isotope facility in Saskatoon, Saskatchewan, Canada. A total of 19 rectrices were randomly analyzed for stable hydrogen isotope (deuterium) values (δD) in a blinded fashion. A Eurovector 3000™ (Milan, Italy) high temperature elemental analyzer (EA) with autosampler was used to automatically pyrolyse feather samples to a single pulse of H_2 gas (and N_2 and CO gas). The resolved H_2 sample pulse was then introduced to the isotope ratio mass spectrometer (Micromass Isoprime™ [Manchester, England] with electrostatic analyser) via an open split capillary. All deuterium isotope values are reported in delta notation (δ) parts per thousand (^{o}/oo) relative to the international standards VSMOW/SLAP. A method of comparative equilibration was used to adjust for exchangeable hydrogen in feathers (Wassenaar and Hobson 2003). and so all values presented are for the non-exchangeable portion of feathers. Inter-group statistical analyses were performed using Tukey t test comparisons (GraphPad Instat).

Results

A total of 54 Loggerhead Shrikes were captured from 2001 through 2006. The birds were captured in Abbeville and Newberry (upstate western piedmont) Counties, and Clarendon and Williamsburg (lower state) Counties. Field hours at each banding location were 88 hours in Abbeville Co., 63 hours in Newberry Co., 22 hours in Clarendon Co., and 20 hours in Williamsburg Co. Thirty Loggerhead Shrikes were captured in the upstate, requiring 151 field hours, while 24 Loggerhead Shrikes were captured in the lower state, requiring 42 field hours. There were no retraps or foreign band encounters during the study interval. Fifty-four smears were evaluated, with blood hematozoa identified in four specimens (7.4%). *Hemoproteus* species were the only hematozoa identified, with no *Plasmodium* or *Leukocytozoan* spp. identified. When body mass was analyzed, birds from Abbeville County were significantly lighter than birds in both Clarendon and Williamsburg Counties, while no other statistical differences were noted. There were no significant differences in body mass of birds trapped in Abbeville and Newberry Counties (Table 1).

Stable isotope analysis on 19 rectrices showed more enriched deuterium levels (i.e. higher feather δD values) for the combined upstate counties compared to lower state counties ($P \leq 0.05$, Table 1). Clarendon, Williamsburg, and Newberry County banding locations are highly agricultural with extensive cultivation in the areas studied, while Abbeville County is predominantly pasture with minimal cultivation in the landscape

studied (Table 2). No differences among groups for wing chord were identified.

Table 1. Comparison of Loggerhead Shrikes in two upstate and two lower state counties of South Carolina.

	Upstate		Lower state	
County	Abbeville	Newberry	Clarendon	Williamsburg
Latitude	N34.1	N34.1	N33.4	N33.3
N	24	6	8	16
Mean mass (g)	48.0 ± 3.1	49.3 ± 2.4	51.9 ± 3.8	52.4 ± 3.0
Parasites	2/24	0/6	1/8	1/16
Deuterium ratios * (per mil)	–30.7 ± 5.5 (n=12)		–44.0 ± 6.5 (n=7)	
Wing chord (mm)	95.5 ± 2.4	98.0 ± 3.1	96.5 ± 1.2	95.5 ± 2.1

* Nineteen rectrices were studied for stable hydrogen isotope (deuterium), with number captured in each group expressed in parentheses.

Discussion

In a breeding season study of Loggerhead Shrikes in Arkansas, reproductive success was positively associated with cultivation landscapes compared to pastureland (Norris et al. 2001). We identified significantly heavier Loggerhead Shrikes in counties that were predominantly cultivated compared to pasturelands. Comparison of county-wide farming practices indicates that in Abbeville County the predominant farming practice is beef cattle and the predominant landscape is pastureland (Table 2). Conversely, Newberry County, which has similar piedmont clay soil, has more cultivated lands used to raise feed grains for dairy and chicken farming. The two lower state counties (Clarendon and Williamsburg) also have more cultivation on a sandy soil conducive to row crop farming practices. Cultivated fields may improve access to prey for Loggerhead Shrikes with resultant increased body mass in the lower state counties. Furthermore the growing season is also slightly longer in the lower state compared to the upstate, which may provide more abundant prey opportunities over the extended growing season. In this study we are unable to ascertain the effect of a bird's sex on body mass.

Loggerhead Shrikes were more plentiful in the lower state compared to western piedmont, a fact reflected in the reduced field time required for capture. Although smaller pastures surrounded by woody areas are more plentiful in the piedmont and may reduce chances to recognize birds for capture, it took 151 field hours to capture 30 birds in the upstate compared to 42 hours to capture 24 birds in the lower state.

Table 2. Comparisons of farming practices in 4 counties of South Carolina.

Farm practice*	Upstate		Lower state	
	Abbeville Co.	Newberry Co.	Clarendon Co.	Williamsburg Co.
Corn (acres)	nr	4,500	35,700	14,200
Cotton (acres)	300	800	2000	22,500
Hay (acres)	10,300	10,800	2100	2800
Peanuts (acres)	nr	nr	nr	4200
Wheat (acres)	nr	4800	15,500	5700
Soybeans (acres)	nr	3200	35,900	26,200
Tobacco (acres)	nr	nr	800	2600
Cattle (head)	19,100	25,100	4400	4000
Broilers (birds)	nr	5,583,000	13,395,000	1,445,000
Turkeys(birds)	nr	387,000	nr	nr
Land in farms (acres) #	95,170	103,570	147,890	205,904
Pastureland (acres)	24,000	15,600	nr	nr
cropland (acres)	35,100	43,000	91,800	100,900
woodlands (acres)	31,600	40,500	48,400	88,900

* 2005 U.S. Department of Agriculture Quickstats.
# 2002 U.S. Department of Agriculture Census data
nr = none reported

Bird feathers retain stable hydrogen isotope information which depends upon the isotopic landscape or isoscape where the feather is generated. Feather keratin, once formed, is isotopically inert apart from a small amount of exchangeable hydrogen that is accounted for in the analytical process (Wassenaar and Hobson 2003). Furthermore, feather molt is predictable, symmetrical and typically occurs prior to migration in Loggerhead Shrike (Miller 1928; Perez and Hobson 2006). Feather δD values are strongly correlated with those of foodwebs (Hobson and Wassenaar 1997) which, in turn, follow a strong latitudinal pattern in North America (e.g. Meehan et al. 2004; Hobson 2005). A large series of feather analyses of raptors has better defined predicted feather δD values in different regions of North America for that taxonomic group of birds (Lott and Smith 2006). Interestingly, counties near coastal South Carolina have a relative depletion of predicted

precipitation or feather deuterium compared to more northern latitudes in South Carolina (Meehan et al. 2004; Lott and Smith 2006), a reversal of the general continent-wide trend. Roughly the site of feather growth can be predicted with a resolving power of about 1.5 degrees of latitude (Hobson 2005). Our study of 19 rectrices supports that finding in wintering Loggerhead Shrikes and suggests that Loggerhead Shrikes in South Carolina are resident and not migrant, as was also found in an isotopic study of shrikes wintering in Georgia (Hobson and Wassenaar 2001). In that study, feathers with lower δD values (or more depleted in deuterium) were identified in several wintering Loggerhead Shrikes taken at Florida locations, suggesting the occurrence of migrant shrikes from more northern locations. Perez and Hobson (2006) recently determined that for northern breeding populations of Loggerhead Shrike there is an increased probability that the outer rectrix can be molted on the wintering grounds. This determination suggests that studies using this feather for analysis will tend to underestimate the proportion of migrants in a wintering population. Nevertheless, those authors expected this to be the case only for shrikes at the northern limits of their range since they have a shorter period in which to complete molt prior to migration. We think that our isotopic data make a strong case for South Carolina birds being residents year-round.

Blood parasite studies in Loggerhead Shrikes did not identify significant numbers infected (7.4 %) or adverse effect on body mass. All birds captured were healthy and without external parasites or deformities noted.

Conclusions

Loggerhead Shrikes in two regions (upstate western piedmont and lower state) of South Carolina were studied, with heavier birds identified in the lower state, perhaps related to cultivated landscapes compared to pasturelands. Loggerhead Shrikes were more plentiful in the lower state, as supported by field observation and time required to capture the birds. Blood parasitemia appeared inconsequential in South Carolina Loggerhead Shrikes. Randomly analyzed rectrices from 19 individuals from both upstate and lower state locations were used for δD analysis. The results were consistent with those expected for the South Carolina regions, and suggested Loggerhead Shrikes in South Carolina are non-migratory residents. The possibility remains that a northern migrating Loggerhead Shrike could molt its outer rectrix on wintering grounds and regenerate the feather in South Carolina causing underestimation of migrants from more northern latitudes. However, the predicted stable hydrogen isotope values for the latitudes studied are consistent with a resident population.

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