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**ABSTRACT**

I identified sexual dimorphism in wing length (unflattened chord) of Carolina Wrens *(Thryothorus ludovicianus)* within the central Mississippi Alluvial Valley (northeast Louisiana and west-central Mississippi) and used this difference to assign a sex to captured wrens. Wrens were identified as female when wing length was less than 57.5 mm or male when wing length was greater than 58.5 mm. Verification of predicted sex was obtained from recaptures of banded individuals where sex was ascertained from the presence of a cloacal protuberance or brood patch. Correct prediction of sex was 81% for adult females and 95% for adult males. An alternative model, which categorized wrens with wing lengths of 58 and 59 mm as birds of unknown sex, increased correct prediction of females to 93% but reduced the number of individuals to which sex was assigned. These simple, predictive, wing-length-based models also correctly assigned sex for more than 88% of young (hatching-year) birds.

**INTRODUCTION**

Female and male Carolina Wrens *(Thryothorus ludovicianus)* share a common plumage. Thus, only during the breeding season can males be identified by the presence of a cloacal protuberance and females by the development of a brood patch. As this species is generally resident and frequently encountered by banders outside the breeding season, the ability to distinguish between sexes based on other criteria is warranted.

Pyle (1997) stated that morphometric measurements are useful for sexing within subspecies of Carolina Wren, but offers little guidance in discriminating between sexes for the nominative subspecies *(T. l. ludovicianus)*. This subspecies is common to most of eastern North America. Within a population from northwest Alabama, Haggerty and Morton (1995) reported wing chords of male Carolina Wrens (mean = 59.3 mm ± 1.5 SD, n = 30) were significantly longer than wings of females (mean = 55.7 mm ± 1.4 SD, n = 34). While banding Carolina Wrens in the Mississippi Alluvial Valley (northeast Louisiana and west-central Mississippi), I noted similar differences in wing length between sexes. I developed criteria based on wing length dichotomy that can be used to identify the sex of Carolina Wrens.

**METHODS**

From 1994 through 2004, Carolina Wrens were captured, sexed when possible, measured, and banded during constant-effort mist-netting during summer (e.g., DeSante 1992) and during winter. Birds were captured within two to eight forest stands annually, from a total of 12 bottomland hardwood forest stands on Tensas River National Wildlife Refuge, Madison Parish, Louisiana, and two intensively managed cottonwood stands on Fitler Managed Forest, Issaquena County, Mississippi. All data presented are from Carolina Wrens that were identified with uniquely numbered bands. I aged birds as hatching-year (HY) young or after-hatching-year (AHY) adult based on differences in plumage or skull ossification (Pyle 1997). Each capture (or recapture) of a bird was assigned categorically to one of three groups: (1) adult birds that were sexed by presence of cloacal protuberance or brood patch, (2) adult birds that could not be sexed, or (3) young birds that could not be sexed. Because I sought to use wing length (unflattened wing chord measured to the nearest 1 mm) to discriminate between sexes, only birds with measured wing lengths (mm) and no flight feather molt were used for analyses.

Often, multiple captures of the same bird were within a group. I examined the range of wing lengths for each individual within a group. If the range of wing lengths exceeded 2 mm, I removed the most discrepant value. I then used the mean wing length within each group for analyses. Based on differences in wing length of female and male Carolina Wrens, I developed predictive models and applied these models separately to adult and young Carolina Wrens of unknown sex. I assessed the predictive ability of these models by comparing the sex predicted from models to the known sex of the same individual, as determined by the presence of cloacal protuberance or brood patch.

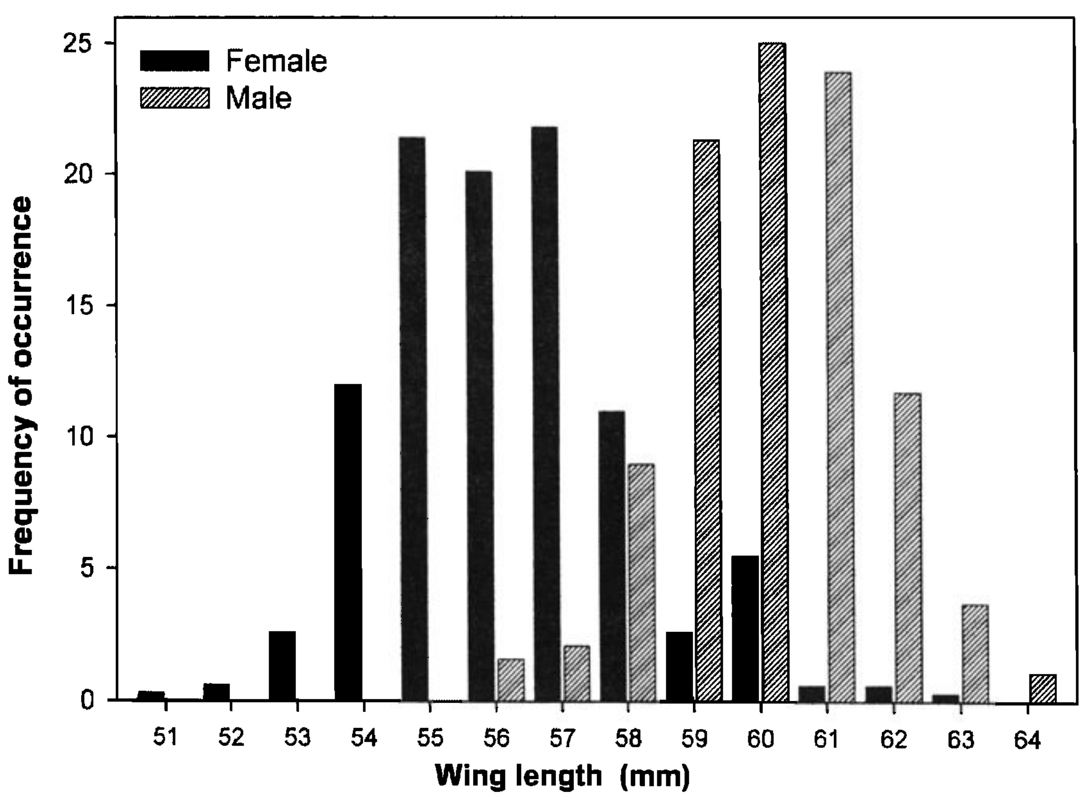
## RESULTS

Of 2,957 captured Carolina Wrens, 877 had a brood patch and were identified as female, 794 had a cloacal protuberance and were identified as male, whereas 1286 wrens could not be sexed. However, because 582 wrens were captured more than once, these captures represented only 1,637 unique individual wrens. I captured 292 wrens twice, 130 captured thrice, and 160 captured four or more (up to nine) times.

I found few discrepancies among wing lengths of individuals captured more than once; 69% differed by 1 mm or less, 19% differed by only 2 mm. I examined the wing lengths of birds where range of wing lengths was 3 mm (18 individuals) or 4 mm (four individuals) and removed captures with disparate wing lengths. Thus, in my analyses, only six individuals had a range of wing lengths that exceeded 2 mm.

Mean wing length of females was 56.2 mm ±1.9 SD (n = 308 individuals) whereas mean wing length of males was 60.1 mm ±1.5 SD (n = 188 individuals). The frequency distribution of wing lengths (Fig. 1) indicated 80% of female wing lengths were less than 58 mm, 11 % were 58 mm, and 9% were greater than 58 mm. Conversely, 87% of male wing lengths were greater than 58 mm, 9% were 58 mm, and only 4% were less than 58 mm. Based on these data, application of a 57.5 mm cut point to discriminate between sexes, and excluding birds with 58 mm wing length, should result in less than 10% of females and less than 4% of males incorrectly sexed.

**Fig. 1. Frequency of occurrence (%) in wing length (mm) of female (n=308) and male (n=188) Carolina Wrens captured in northeastern Louisiana and west-central Mississippi.**



Using 57.5 mm as a cut point with no exclusion, I assigned a sex of female to unsexed wrens with wing length less than 57.5 mm and male to wrens with wing length greater than 57.5 mm. When I compared predicted sex with known sex (identified from a different capture of the same individual), 38 of 51 females (75%) and 87 of 91 males (96%) were correctly sexed (Table 1). However, because many females and males had wing lengths of 58 mm, I applied a different model that used the same cut point, but birds with 58 mm wing length remained as undetermined sex. In this model, correct prediction of males was 95%, whereas correct prediction of females increased to 81% (Table 1).Similarly, an alternative model in which birds remained of undetermined sex when wing length was either 58 or 59 mm yielded correct prediction for 93% of females and 93% of males (Table 1).

## CONCLUSION

Female and male Carolina Wrens in the central Mississippi Alluvial Valley (northeast Louisiana and west-central Mississippi) are sexually dimorphic This dimorphism in wing length can be exploited to predict the sex of Carolina Wrens. Although the range of wing lengths overlaps slightly between sexes, it appears that assignment of female to wrens with wing length less than 57.5 mm and male to wrens with wing length greater than 58.5 mm will provide 95% correct identification of males and 81% correct identification of females within this population of Carolina Wrens. Correct identification of females can be improved to 93% by retention of wrens with wing lengths of 58 or 59 mm as birds of undetermined sex. However, by doing so, the sex of fewer individuals will be identified.

**Table 1. Cut point and exclusion models for wing length (mm) used to predict female (F), male (M), or undetermined (U) sex of Carolina Wrens in the Mississippi Alluvial Valley, the number (n) of wrens for which sex was predicted, and the number (c) and percentage (%) of correct sex determinations.**

| | After-Hatching-Year | | | | | | Hatching-Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Female | | | Male | | | Female | | | Male | | |
| | n | c | % | n | c | % | n | c | % | n | c | % |
| F<57.5mm; M>57.5mm | 51 | 38 | 75 | 91 | 87 | 96 | 34 | 27 | 80 | 21 | 19 | 90 |
| F<58.5mm; M>58.5mm | 51 | 42 | 82 | 91 | 74 | 81 | 34 | 31 | 92 | 21 | 14 | 67 |
| F<57.5mm; M>58.5mm | 47 | 38 | 81 | 78 | 74 | 95 | 30 | 27 | 90 | 16 | 14 | 88 |
| F<56.5mm; M>58.5mm | 36 | 27 | 75 | 74 | 74 | 199 | 22 | 19 | 86 | 14 | 14 | 100 |
| F<57.5mm; M>59.5mm | 41 | 38 | 93 | 60 | 56 | 93 | 28 | 27 | 96 | 10 | 8 | 80 |
| F<56.5mm; M>59.5mm | 30 | 27 | 90 | 56 | 56 | 100 | 20 | 19 | 95 | 8 | 8 | 100 |

Greater accuracy in predictions, however, came at the cost of being able to predict the sex of fewer individuals. For example, I predicted the sex of 142 wrens when considering all wing lengths but sexed only 101 individuals when birds with wing lengths of 58 and 59 mm remained of undetermined sex (Table 1). Excluding only 58 mm wing lengths from predictions of sex may be a judicious compromise.

Application of this model with a 57.5 mm cut point and 58 mm exclusion to young (HY) birds resulted in the correct determination of sex for 27 of 30 females (90%) and 14 of 16 males (88%; Table 1).

Notably, these predictive models can also be applied to young (HY) birds with similar expectation of correct sex identification.

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# Swainson's Hawk Productivity in Saskatchewan, 1944 - 2004


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## ABSTRACT

The number of nestlings banded was recorded at 2,427 successful Swainson's Hawk (*Buteo swainsoni*) nests in Saskatchewan between 1944 and 2004. A sudden and prolonged drop in ground squirrel numbers appeared to explain decreased Swainson's Hawk productivity in grassland regions over ten consecutive years, 1987 - 1996.


## INTRODUCTION

The world's first specimens of the Swainson's Hawk (*Buteo swainsoni*) and its main prey - Richardson's ground squirrel (*Spermophilus richardsonii*) - were collected at Carlton, Saskatchewan, in 1827 and 1820, respectively (Houston 1990). In Saskatchewan, long-term banding efforts have contributed to our knowledge of Swainson's Hawk productivity and of its annual 20,000 km migration to and from Argentina (Schmutz et al. 1996, Houston and Fung 1999).

The senior author (CSH) began incidental banding of Swainson's Hawks in 1944 but did not begin intensive studies of productivity until 1967. This 38-year program has benefitted from extensive assistance in nest-finding and banding from the junior author (DZ) for the past 16 years, including the contribution of the 71 nestlings banded under DZ's master banding permit in 2004. This paper adds the final nine years to reproductive results reported in Schmutz et al. (2001). Altogether, we have followed this species through a sudden crash in its main prey item and a very gradual, patchy and incomplete recovery in numbers of Richardson's ground squirrel in grassland areas over 16 subsequent years.

## METHODS

Since 1969, CSH concentrated much of his Swainson's Hawk banding on and near large Prairie Farm Rehabilitation Administration (PFRA) pastures near Kindersley in west-central Saskatchewan. These pastures host beef cattle without feed lots. Incubating Swainson's Hawk pairs were located during Ferruginous Hawk (*Buteo regalis*) banding in June, and were revisited for banding in the latter half of July, when the nestlings were between 10 days and six weeks old In 1972, Jean Harris began finding nests for us, in crop land interspersed with small pastures near Kindersley; during a period of 33 years, she found 898 nests (about 28% of our total) of which 635 were successful and from which 1,132 young were banded. From 1985 to 1995, Dean Francis found 228 nests along the Saskatchewan-Alberta boundary south of Alsask, of which 150 were successful and from which 288 young were banded. The study area was not searched completely and had no well-defined boundaries.