Accuracy of Sex Determination of Hatch-Year Common Yellowthroats (*Geothlypis trichas*) during the Fall

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ABSTRACT

Sexual dimorphism is widespread among birds. In the Common Yellowthroat (*Geothlypis trichas*), adult males and females differ in plumage characteristics, but young males and females often appear quite similar. Currently, the North American Bird Banding Program will not accept hatch-year (HY) female as an appropriate age-sex designation because males may not obtain their characteristic face mask for several months. However, many bird banders have noted substantial variation in the color of HY Common Yellowthroats in the fall. We hypothesized that the sex of many HY Common Yellowthroats could be determined accurately by an experienced bander. Using banding data from Appledore Island, ME, we compared sex designations at initial capture and at recapture of birds that were originally captured as HY and then returned to the island during a subsequent season. Our results established that banders had greater than 95% accuracy of sex designation at initial banding for both male and female HY Common Yellowthroats. Both young and adult Common Yellowthroats also exhibited sexual size dimorphism. Thus, our results suggest that banders should be able to use HY-female as an appropriate age-sex designation in this species.

INTRODUCTION

Sexual dimorphism is a difference between males and females that includes color, size, and other structural differences. Among vertebrates, sexual size dimorphism is common and, in most cases, males are the larger sex. Sexual dichromatism, which is widespread in birds, is a special case of sexual dimorphism in which males are generally brighter than conspecific females. Early sex determination may be important for studies concerning migration and habitat selection in birds, because males and females often show habitat segregation, geographic segregation, or competition for resources during migration and on wintering grounds (e.g., Marra et al. 1993, Dunn et al. 2001, Latta and Faaborg 2001, Jenkins and Cristol 2002, Nebel et al. 2002).

Adult Common Yellowthroats (*Geothlypis trichas*) exhibit substantial sexual dichromatism. Males of the species have an olive back, a bright yellow throat and breast, and a characteristic black face mask that is commonly outlined in grayish-white. In contrast, the adult females lack the face mask, often have a rusty tinge in the forehead, and have more subtle coloration on the throat, breast, and body (Roberts 1955, Pyle et al. 1987, Pyle 1997). Both male and female young Common Yellow-

throats exhibit features similar to the adult female. Although some young males begin growing black facial feathers during the fall, many do not exhibit typical male plumage characteristics until the winter or even into the spring, making separating young males and females difficult during fall migration (Pyle 1997, Guzy and Ritchison 1999). Because of the similarity between the plumages of females and many young males, the Bird Banding Laboratory will not accept hatch-year (HY) female as an appropriate age-sex classification (U. S. Fish and Wildlife Service and Canadian Wildlife Service 1977).

During the fall, young Common Yellowthroats vary substantially in the brightness of their plumage. This variation may reflect sexual dichromatism between young males and females. In the first prebasic plumage, some HY males may show a brown tinge in the forehead as suggested in several keys (e.g., Dwight 1900, Roberts 1955, Pyle et al. 1987), whereas HY females show a forehead nearly the same color as the back (Wood 1969). We hypothesized that the sex of many HY Common Yellowthroats could be determined accurately by an experienced bander. Furthermore, we expected male and female Common Yellowthroats would differ in morphological characteristics including wing chord, tail length, tarsus length, and body weight.

METHODS

Banding – The Appledore Island Migration Banding Station has operated regularly during both migratory seasons since fall 1981 on Appledore Island, ME (42°58'N 70°36'W), an island approximately 10 km southeast of Portsmouth, NH. During the spring, the station operated for approximately one week in late May during the 1980s and from late Apr or early May to mid-Jun since 1990. During the fall, the station operated from mid-Aug to mid-Sep during the 1980s and from mid-Aug to late Sep or early Oct since 1990. The station used up to 10 mist nets placed in shrubby habitat to capture spring and fall migrants, annually. The station operated from before sunrise until after sunset daily, weather permitting. More information about the station and station protocols are available in Morris et al. (1994).

We used data from this station to investigate sexual dimorphism among Common Yellowthroats during the fall. We banded birds with a USFWS aluminum leg band. For each bird captured, banders recorded age, sex, wing chord (to the nearest 0.5 mm), tail length (to the nearest 0.5 mm), tarsus length (to the nearest 0.1mm), and mass (to the nearest 0.01 g). We recorded age and sex designations appropriate to Bird Banding Laboratory guidelines and thus, if the individual did not exhibit distinct male characteristics, the sex of HY Common Yellowthroats was recorded as "unknown" (U. S. Fish and Wildlife Service and Canadian Wildlife Service 1977). Banders also often assigned a presumed sex based upon a combination of wing chord and plumage characteristics, particularly the brightness and extent of the yellow in the throat and breast (Pyle et al. 1987, Pyle 1997). The presumed sex refers to the sex that the bander would have assigned the bird, based on initial plumage characteristics, if the banding program allowed a designation other than unknown. Birds that were intermediate between male and female characteristics were not assigned a specific sex. During subsequent seasons, a number of these birds were recaptured and their sex was determined based on their adult plumage.

Statistics – To test for the correspondence between the initial sex determination and final designations for each bird, we used a likelihood ratio chi-squared test (χ^2). Two sample *t*-tests (*t*) compared morphological measurements between males and females, within each age class during each season. We used SYSTAT Version 10.2 to perform chi-squared and *t*-tests. To determine which morphological variables were most important in indicating the sex of Common Yellowthroats, we used a discriminant function analysis.

RESULTS

We captured 2,552 HY Common Yellowthroats during the fall from 1981 to 2001. Of those birds, 37.4% were designated as male and 62.6% were designated as unknown sex (Fig. 1). Banders recorded a presumed sex for 87.7% of all the HY Common Yellowthroats banded (Fig. 1 and Table 1).Sixty-six Common Yellowthroats that were captured initially in their hatching year returned and were recaptured in a subsequent year. Based upon sex determination in a subsequent season, more than 95% of these birds were characterized correctly as male or female during the fall (χ^2 = 53.8, df = 1, $p < 0.001$). This correspondence occurred among both males (95.2%, $n = 42$) and females (95.8%, $n = 24$; Fig. 2).

Fig. 1. Of the HY Common Yellowthroats banded on Appledore Island, ME, similar numbers of birds were designated as male and female guidelines and bander designation. Only 13% were designated as unknown due to lack of defining characteristics. No birds were designated as HY-F under the BBL-approved designation because the BBL would not allow the designation of that age-sex classification.

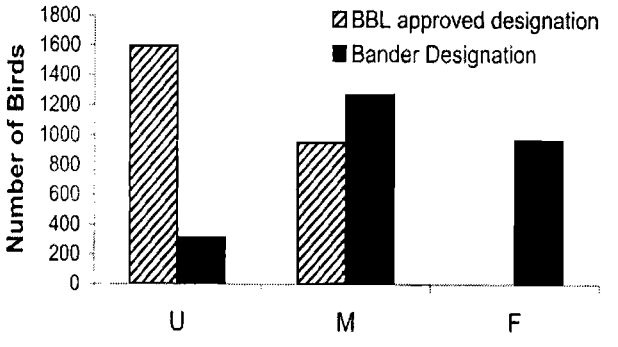
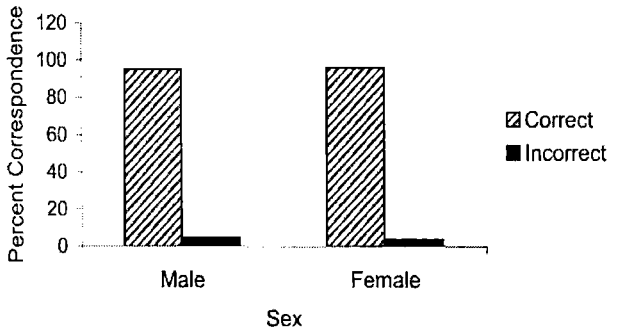


Fig. 2. More than 95% of HY Common Yellowthroats banded on Appledore Island, ME, were characterized as male or female during the fall, based upon sex determination in a subsequent season (χ^2 =53.8, df = 1, p < 0.001).



Our data showed substantial evidence of sexual dimorphism during both the fall and the spring. During both the fall and the spring, males were larger than females and these differences were seen among both young and adult birds (Table 2). During the fall, HY males had longer wings (t_{2185} = 51.9, p < 0.001), tails (t_{600} = 15.3, p < 0.001), and tarsi (t_{1262} = 9.2, p < 0.001) than females (Table 2). Additionally, after-hatch year (AHY) males had longer wings (t_{122} = 15.4, p < 0.001) and tails (t_{19} = 3.1, p < 0.01), but not tarsi (t_{57} = 1.5, p = 0.14) than females during the fall (Table 2). Among both age classes, males were heavier than females (HY: t_{2141} = 18.3, p < 0.001; AHY: t_{113} = 2.0, p = 0.043; Table 2). During the spring, the same pattern of males being larger than females was displayed among both second-year (SY) and after-second-year (ASY) birds. Males had longer wings (SY: t_{2142} = 45.1, p < 0.001; ASY: t_{397} = 23.1, p < 0.001), tails (SY: t_{1606} = 19.3, p < 0.001; ASY: t_{422} = 12.5, p < 0.001), and tarsi (SY: t_{1972} = 12.5, p < 0.001; ASY: t_{401} = 5.4, p < 0.001) than females (Table 2). Furthermore, males were heavier than females among both age classes during the spring (SY: t_{2113} = 21.3, p < 0.001; ASY: t_{438} = 10.1, p < 0.001; Table 2).

We used multiple axis discriminant function analysis, using combinations of wing chord, tail, tarsus, and mass. Wing chord was the overwhelming indicator of sex, with little additional information provided by any of the other variables.

DISCUSSION

Our results indicate that HY Common Yellowthroats exhibited sexual dimorphism, both in size and in color. This dimorphism was used by experienced banders to determine the sex of HY birds at greater than 95% accuracy. Although sexual dimorphism was apparent, a small percentage of fall birds in this study could not be assigned a sex by an experienced bander. Based on both the ability of experienced banders to determine the sex of these birds by plumage and on morphological differences, HY Common Yellowthroats should be able to be designated as male or female after the first prebasic molt is completed.

Males at every age had longer wing chords and tails than females of comparable ages in this study. Additionally, males at every age had a greater mass than corresponding females. These results were similar to sexual size differences reported for Common Yellowthroats, and many other passerines (Pyle et al. 1987, Pyle 1997). Although size differences were apparent, our results also indicate that size alone cannot be used to determine the sex of Common Yellowthroats, because the size differences were too small and measurements overlapped extensively between the sexes (Table 2). However, these measurements combined with plumage characteristics (i.e., throat color and contrast between throat and breast) can be used to determine sex of known HY birds after the first prebasic molt. Banders are cautioned to determine age prior to determining

Table 1. Number of Common Yellowthroats by age and sex captured on Appledore Island during spring and fall migration from 1981-2001. Birds that were designated as unknown sex or as after-hatch-year (AHY) in the spring were excluded. For hatch-year (HY) birds, the sex refers to the bander's designation rather than the sex designation submitted to the Bird Banding Laboratory. Age designation as second-year (SY and after-second-year (ASY) was not attempted regularly until 1997 (using Pyle 1997).

	Fall				Spring			
	HY		AHY		SY		ASY	
Year	F	M	F	M	F	M	F	M
1981	3	9	1	0				
1982	11	14	2	1	0	10	0	0
1983	29	25	3	5	1	2	0	0
1984	14	31	1	1	4	6	0	0
1985	22	43	2	2	12	2	0	0
1986	42	67	5	8	9	23	0	0
1987	55	63	3	5	0	42	0	0
1988	92	98	5	4	0	10	0	0
1989	118	117	5	2	2	8	0	0
1990	74	85	4	0	2	74	0	5
1991	35	57	2	6	1	100	0	0
1992	52	52	5	6	7	90	0	0
1993	42	78	0	1	10	62	0	0
1994	59	88	5	6	0	40	0	0
1995	54	81	4	3	0	4	0	1
1996	56	71	1	4	14	87	0	0
1997	51	82	1	2	151	67	7	15
1998	42	58	4	4	291	213	66	82
1999	35	37	3	4	207	175	37	85
2000	51	63	0	3	71	81	49	64
2001	33	50	0	1	182	153	26	58

sex, because the juvenal plumage of both sexes is similar and AHY females often have plumages similar to HY males.

Sex determination in young Common Yellowthroats could prove beneficial in various areas of ornithological research such as timing of migration, habitat selection, and morphological research. The "unknown" sex classification leads to incomplete statistical analyses and hinders research concerning other aspects of avian biology. A number of studies have demonstrated that sexual differences occur in a variety of ecological characteristics, including timing of migration (Kissner et al. 2003, Morris and Glasgow 2001), winter territory quality (Parrish and Sherry 1994), and parental care and intrasexual competition (Owens and Hartley 1998). It is interesting to note that in this study, a greater percentage of returning birds were males (63%, n = 67). The higher natal fidelity among males than females is similar to other reported studies (Flynn et al. 1999, DiQuinzio et al. 2001) and demonstrates the importance of being able to determine the sex of HY individuals. Early sex determination may contribute to a greater understanding of other aspects of the behavior of the Common Yellowthroat.

ACKNOWLEDGMENTS

Canisius College generously supported this research with faculty-student research grants from the Biology Department and a Canisius Teaching Professorship, sponsored by the John R. Oishei Foundation, to SRM. The Shoals Marine Lab provided substantial logistic and moral support

Table 2. Comparison of morphometrics by age and sex. Males were generally larger than females of the same age class. Values presented are means ± standard deviation; the sample size is given in parentheses.

	Fall				Spring			
	HY		AHY		SY		ASY	
YEAR	F	M	F	M	F	M	F	M
Wing (mm)	51.2 ± 1.2 (969)	54.1 ± 1.4 (1268)	52.5 ± 1.0 (56)	55.7 ± 1.3 (68)	50.5 ± 1.4 (964)	53.3 ± 1.5 (1249)	51.7 ± 1.4 (185)	54.8 ± 1.5 (310)
Tail (mm)	46.4 ± 1.7 (267)	48.6 ± 1.8 (358)	47.6 ± 1.5 (9)	49.6 ± 1.7 (18)	45.6 ± 2.1 (910)	47.7 ± 2.2 (768)	47.1 ± 2.1 (185)	49.7 ± 2.4 (302)
Tarsus (mm)	19.4 ± 0.8 (582)	19.8 ± 0.8 (802)	19.4 ± 0.8 (29)	19.7 ± 0.7 (40)	19.3 ± 0.7 (935)	19.7 ± 0.6 (1100)	19.5 ± 0.6 (185)	19.8 ± 0.6 (308)
Mass (g)	9.9 ± 0.8 (961)	10.5 ± 0.9 (1258)	10.5 ± 0.8 (52)	10.8 ± 0.8 (67)	9.7 ± 0.8 (958)	10.4 ± 0.8 (1242)	9.9 ± 0.7 (185)	10.7 ± 0.9 (307)

Fall HY sample sizes reflect individuals that banders were comfortable assigning to an age-sex category, not strictly to BBL approved sex determination. Differences in sample sizes reflect differences in morphometrics collected during banding.

during the operation of the Appledore Island Migration Station. This research would not be possible without the enormous contributions of the many volunteers at the Appledore Island Migration Station. In particular, we would like to thank the additional banders who run the station tirelessly: Anthony Hill, Mac McKenna, John Munier, Rebecca Suomala, and Mary Wright. H. David Sheets graciously ran the discriminant function analyses and aided in the interpretation of their results. We would like to thank Robert J. Morris, Martha Stauffer, Hannah Suthers, and Rebecca Suomala for critically reviewing this manuscript. This article is contribution 10 of the Appledore Island Migration Station and contribution 114 of the Shoals Marine Lab. The authors wish to dedicate this article to the memory of Mac McKenna, a devoted supporter of the Appledore Island Migration Station and the Shoals Marine Lab, who had a long-time love-hate relationship with the "threats," as we commonly refer to yellowthroats, on the island.

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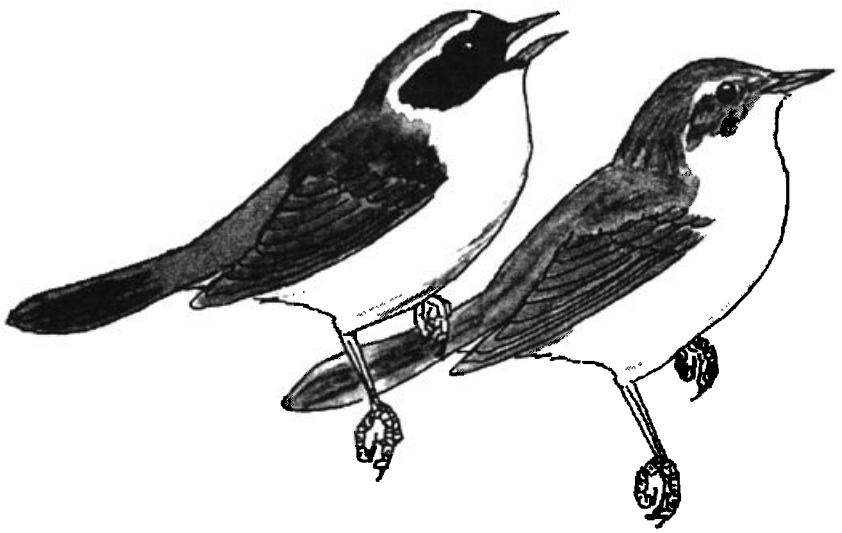

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