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SPRING MIGRATION AND STOPOVER ECOLOGY OF COMMON YELLOWTHROATS ON APPLEDORE ISLAND, MAINE

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ABSTRACT.—Although Common Yellowthroats (*Geothlypis trichas*) are Nearctic-Neotropical migrants that are common breeders across the United States and Canada, very little has been published about the migration and stopover ecology of this species. We used spring migration banding records of Common Yellowthroats from 1992–2001 on Appledore Island, Maine, to investigate potential sexual and age-related differences in migration timing and stopover ecology of this species. Arrival dates of males were significantly earlier than arrival dates of females during spring, with mean male arrival five days earlier than female arrival. Also, after-second-year (ASY) birds arrived significantly earlier than second-year (SY) birds within each sex. Males also were significantly heavier than females upon arrival on Appledore. During spring migration, 5.0% of males and 4.2% of females were recaptured at least one day after initial capture, resulting in a mean stopover length of approximately three days for both sexes. We found no significant difference in the mean minimum stopover length nor the rate of mass change between the sexes based on recaptured individuals. Furthermore, we found no significant differences in stopover ecology between age groups within either sex. Both sexes significantly increased mass during stopover, both as calculated from recaptured individuals and as estimated by regression of condition (mass $\times$ 100/wing chord) over time. Results of this study confirmed differential migration among Common Yellowthroats, which is consistent with previous studies of passerine migration ecology. Lack of differences in stopover ecology between the sexes or between age groups suggests that earlier arrival of males than females and of ASY birds than SY birds may be due to an earlier onset of migration rather than increased migration speed. *Received 29 May 2002, accepted 14 December 2002.*

Stopover sites provide locations for migrants to rest and forage to replenish energy stores during migration (Biebach et al. 1986, Bairlein 1987, Moore and Kerlinger 1987, Winker et al. 1992a, Morris et al. 1996). Several factors may determine the length of stopover, including timing of migration (Alerstam and Lindström 1990, Lavee et al. 1991), condition of migrants upon arrival (Moore and Kerlinger 1987), the availability of food (Kuenzi et al. 1991, Morris 1996), and competition (Francis and Cooke 1986, Moore and Yong 1991). If sufficient rewards are not obtained from foraging, migrants will either leave the stopover site in search of rewarding habitat (Kuenzi et al. 1991) or be forced to delay departure in order to obtain sufficient resources for the continuation of migration (Moore and Kerlinger 1987). Authors recently have discussed the importance of stopover sites for the conservation of long distance migrants (Berthold and Terrill 1991, Moore and Simons 1992, Moore et al. 1995).

Previous research has shown that for most wood warblers (family Parulidae), males migrate earlier than females during spring (Francis and Cooke 1986, Moore et al. 1990, Yong et al. 1998). Information on arrival dates and stopover lengths along the migration route allows a comparison of the timing of migration between the sexes. Furthermore, because time spent at stopover sites increases the total time of migration, birds that are time limited might be expected to decrease the time spent at stopover sites. Thus, one might predict that males would be less likely to be recaptured and would stay at stopover sites for a shorter period of time than females.

The Common Yellowthroat (*Geothlypis trichas*) is a common summer resident in marshes and shrub habitats in much of North America (Guzy and Ritchison 1999). During spring, Common Yellowthroats migrate from their wintering grounds in the southern United States, Central America, and the Caribbean to their breeding grounds throughout the United States and southern Canada (Rappole et al. 1995, American Ornithologists' Union 1998). Relatively little research has been published

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TABLE 1. Common Yellowthroats were common spring migrants on Appledore Island, Maine, from 1992 to 2001. Although the ranges of capture dates often overlapped, males were captured earlier than females in each year of the study. Annual capture effort is provided for comparison.

Year	Dates of operation	Total Net-hours[a]	Individuals captured	Range of capture dates (mean)	
				Males	Females
1992	2 May–31 May	2,428	581	11 May–1 June (23 May ± 5.4)	11 May–1 June (26 May ± 4.0)
1993	8 May–5 June	2,407	661	9 May–2 June (17 May ± 5.3)	11 May–3 June (22 May ± 6.1)
1994	30 April–4 June	3,461	599	4 May–1 June (20 May ± 6.3)	10 May–4 June (25 May ± 3.9)
1995	30 April–8 June	4,550	665	10 May–6 June (20 May ± 3.7)	17 May–8 June (24 May ± 4.1)
1996	6 May–8 June	3,504	359	7 May–9 June (17 May ± 4.7)	12 May–8 June (25 May ± 7.6)
1997	6 May–9 June	3,382	495	11 May–9 June (20 May ± 6.0)	12 May–9 June (26 May ± 5.1)
1998	7 May–9 June	3,929	793	8 May–7 June (21 May ± 4.7)	8 May–7 June (25 May ± 4.6)
1999	6 May–10 June	4,107	533	9 May–8 June (21 May ± 6.0)	12 May–8 June (26 May ± 4.5)
2000	4 May–10 June	4,093	283	4 May–9 June (16 May ± 7.0)	9 May–9 June (22 May ± 7.3)
2001	3 May–11 June	4,494	465	3 May–9 June (22 May ± 7.8)	9 May–10 June (29 May ± 5.1)

[a] Net-hours are a unit of effort equal to one 12-m net open for 1 h.

on migratory patterns of the Common Yellowthroat prior to the present study (Guzy and Ritchison 1999, but see Francis and Cooke 1986, Woodrey and Chandler 1997).

This study used banding data to document the migration and stopover ecology of Common Yellowthroats on Appledore Island, Maine. Although many warbler species use Appledore Island as a stopover site (Morris et al. 1994, 1996), the Common Yellowthroat is one of the few species of warblers that breeds at that site (Borror and Holmes 1990). Because they regularly have bred on the island, Common Yellowthroats are likely to find Appledore Island to be a high quality stopover site. We investigated the timing of arrival, stopover ecology, and change in mass during stopover of the Common Yellowthroat to examine differences in migration and stopover ecology between the sexes and between age groups. Our hypotheses were that (1) males would arrive earlier than females, (2) adults would arrive earlier than young birds within each sex, (3) males would be less likely to be recaptured and have shorter stopovers than females, (4) both males and females would gain mass during stopover, and (5) because females migrate later when food is more abundant, they would have greater mass gains than males.

STUDY AREA AND METHODS

Data collection.—The Appledore Island Migration Banding Station was operated during spring migration from 1992–2001 on Appledore Island, Maine. Appledore Island (42° 58′ N, 70° 37′ W) is the largest island in the Isles of Shoals, is dominated by shrubby vegetation, and is approximately 10 km southeast of Portsmouth, New Hampshire. Morris et al. (1994) provided a detailed description of the field site. The banding station generally opened during late April or early May and ran until early June (Table 1). We captured migrants in mist nets (up to 10 nets, 12 m long, 30 mm mesh) that were opened just prior to sunrise, closed just after sunset, and checked at least once every 30 min throughout the day. We took all birds captured to a central location for banding. For each bird captured and recaptured, we recorded band number, species, age, sex, wing chord (to 0.5 mm), tarsus length (to 0.1 mm), fat class (0–4), and mass (to 0.01 g). We determined the age of yellowthroats according to the U.S. Fish and Wildlife Service (1977), Wood and Beimborn (1981), Pyle et al. (1987), and Pyle (1997). We did not assign yellowthroats to second-year (SY) and after-second-year (ASY) categories regularly until 1998.

Although Common Yellowthroats regularly breed on Appledore Island (Borror and Holmes 1990), most of the individuals captured likely were migrants for several reasons. First, the number of individuals captured each spring was at least an order of magnitude greater than the number of breeding pairs on the island, estimated by Borror (1995) at nine pairs (Table 1). Second, few individuals were recaptured during subsequent seasons or years. To reduce the likelihood of including residents, any bird that was captured during a subsequent banding season (e.g., the subsequent fall or the following spring) was considered to be a resident and was excluded from the analyses of stopover patterns.

Data analysis.—We created two condition variables to give scaled indices of body mass. The condition index was calculated as mass × 100/wing chord (following Winker 1995). Because wing chord varies with age as well as with overall size and sex (Pyle et al. 1987, Pyle 1997), we also created an alternative condition index, calculated as mass × 100/tarsus.

We calculated stopover length by subtracting the initial capture date from the date of final recapture. This value is the minimum time a bird spent on Appledore because we could not assume that we captured an individual on its first day on the island nor could we assume that final recapture occurred on its last day on the island (Cherry 1982, Biebach et al. 1986, Moore and Kerlinger 1987). We calculated relative mass change for each individual recaptured at least one day after initial capture by using the following formula (final mass − initial mass)/initial mass. To account for potential differences based on the length of time a migrant stayed at the site, we also calculated daily relative mass change as relative mass change/minimum stopover length. We did not include birds captured later during the same day they were banded in analyses of mass changes to avoid handling effects (Schwilch and Jenni 2001). We also used simple linear regression to investigate the relationship between condition index (described above) and time of capture for all individuals captured (Winker et al. 1992a, 1992b; Winker 1995).

We performed all statistical analyses using SYSTAT 9.0 (SPSS, Inc. 1998). Differences between sexes in the timing of migration and initial mass were investigated using two-way ANOVAs that included year as a factor. We also performed these analyses to investigate all four age-sex categories simultaneously. To investigate the relationship of body condition with arrival date, we regressed both condition indices over time. After verifying no significant variation among years, we pooled data for stopover variables across years. We used likelihood ratio chi-squared analyses to test for differences in recaptures between males and females. We used paired *t*-tests to investigate mass change among recaptured individuals. We investigated differences between sexes in stopover lengths and mass gains among recaptured individuals using two-sample *t*-tests, assuming unequal variance. We also calculated mass gains by regressing condition over time of capture (h after sunrise) following Winker (1995) and Dunn (2000). Differences between sexes were tested for significance using ANCOVA analyses after verifying that interactions between time and sex were not significant. All P values from statistical analyses tests reflect two-tailed tests. Whenever tests were performed on individual years, we used a sequential Bonferroni procedure to correct for multiple tests (Rice 1989, Beal and Khamis 1991).

RESULTS

We captured a total of 5,378 Common Yellowthroats during spring migration from 1992–2001 (Table 1). The Common Yellowthroat was the most common migrant captured on Appledore during spring, accounting for a mean of 20.6% ± 4.9 SD of the individuals captured each spring. The range of capture dates was 3 May through 10 June for males and 8 May through 10 June for females (Tables 1 and 2). Males arrived significantly earlier than females ($F_{1,5358} = 116.4$, $P < 0.001$). Arrival dates differed significantly across the ten years of this study ($F_{9,5358} = 66.1$, $P < 0.001$), and males arrived before females during each of the 10 years ($P < 0.001$; Table 1). The mean arrival date of males was 5 days earlier than females (Table 2). Timing of migration varied significantly among age and sex categories, with ASY birds arriving earlier than SY birds ($F_{3,1835} = 216.4$, $P < 0.001$; Fig. 1), and this pattern held for each of the four years in which we regularly assigned individuals to all four age categories ($P < 0.001$). Males were significantly heavier than females upon arrival ($F_{1,5318} = 120.5$, $P < 0.001$; Table 2), and although mass varied significantly across years ($F_{9,5318} = 16.4$, $P < 0.001$); the same pattern held for each of the ten years of this study ($P < 0.001$).

Regression of wing chord by date of arrival indicated that individuals with longer wing chords tended to arrive earlier than individuals

TABLE 2. Although male Common Yellowthroats arrived earlier than females, males and females used Appledore Island, Maine, similarly as a stopover site during spring migration (data from 1992 to 2001 was pooled). Capture dates, mean wing chord, and initial mass include data from residents. Recapture rate, stopover length, and mass change refer to data from migrants only. Means are presented with standard deviations.

Variable	Males	Females
Number of individuals captured	2,773	2,605
Range of capture dates	3 May–10 June	8 May–10 June
Mean date of capture (days)	20 May ± 6.0	25 May ± 5.4
Mean wing chord (mm)	53.8 ± 1.6	50.7 ± 1.4
Mean initial mass (g)	10.44 ± 0.80	9.67 ± 0.73
Mean recapture rate (%)[a]	5.2 ± 2.8	4.3 ± 1.2
Mean stopover length (days)	3.2 ± 2.5	3.6 ± 2.8
Mean mass change (g)	0.21 ± 0.80	0.30 ± 0.82
Mean mass change (%)	2.34 ± 8.10	3.45 ± 8.65
Mean rate of mass change (g/h)[b]	0.012 ± 0.004	0.029 ± 0.004

[a] Mean recapture rate refers to mean annual recapture rate.
[b] Rate of mass change was calculated using regression coefficients of condition (mass × 100/wing chord) over time of capture and mean wing chord.

with shorter wing chords among both males and females (males: $F_{1,2771} = 215.5$, $P < 0.001$; females: $F_{1,2602} = 113.5$, $P < 0.001$). Regression of tarsus length on date of arrival indicated that there was no significant effect for either sex (males: $F_{1,2770} = 1.3$, $P = 0.25$; females: $F_{1,2601} = 0.3$, $P = 0.60$). The regression of condition index (based on wing chord) on arrival date indicated that for both sexes, relatively heavier individuals arrived earlier than lighter individuals (males: $F_{1,2751} = 67.0$, $P < 0.001$; females: $F_{1,2583} = 96.0$, $P < 0.001$). A similar regression of alternative condition index (based on tarsus length) on arrival date also found significant correlation between higher condition and earlier arrival (males: $F_{1,2751} = 4.6$, $P < 0.05$; females: $F_{1,2582} = 35.9$, $P < 0.001$).

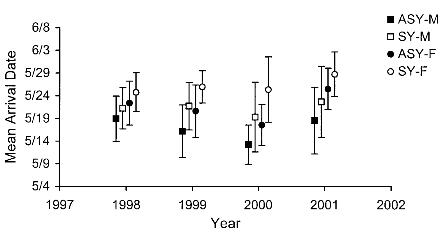

FIG. 1. Arrival dates of male Common Yellowthroats were significantly earlier than arrival dates of females during spring on Appledore Island, Maine, from 1998–2001. Also, after-second-year (ASY) birds arrived significantly earlier than second-year (SY) birds within each sex. Sample sizes are as follows. 1998: ASY-M, $n = 82$; SY-M, $n = 213$; ASY-F, $n = 66$; SY-F, $n = 291$. 1999: ASY-M, $n = 85$; SY-M, $n = 175$; ASY-F, $n = 37$; SY-F, $n = 207$. 2000: ASY-M, $n = 64$; SY-M, $n = 81$; ASY-F, $n = 49$; SY-F, $n = 71$. 2001: ASY-M, $n = 58$; SY-M, $n = 152$; ASY-F, $n = 26$; SY-F, $n = 182$.

Both sexes had a similar recapture rate. Among males 5.0% (138 of 2,773) of individuals and among females 4.2% (110 of 2,605) of individuals were recaptured at least one day after their initial capture ($\chi^2_1 = 1.7$, $P = 0.19$; Table 2). Recapture rates were similar between the sexes during each year of the study except during 1997, when males were significantly more likely to be recaptured than females ($\chi^2_1 = 9.7$, $P < 0.01$). We did not find a significant difference in recapture rate between age groups in either sex (males: $\chi^2_1 = 2.0$, $P = 0.16$; females: $\chi^2_1 = 1.1$, $P = 0.30$). There was not a significant difference in stopover length between the sexes ($t_{222.5} = 1.15$, $P = 0.25$; Table 2), between age categories within a sex (males: $t_{14.9} = 0.46$, $P = 0.66$; females: $t_{3.4} = 0.9$, $P = 0.41$), or among years in males ($F_{9,128} = 1.07$, $P = 0.39$; Table 3), although females did differ significantly among years ($F_{9,100} = 2.62$, $P < 0.01$; Table 3). Regression of capture date on length of stay indicated no relationship between arrival date and amount of time spent on Appledore in either sex (males: $F_{1,136} = 1.32$, $P = 0.25$; females: $F_{1,108} = 0.26$, $P = 0.61$).

Mean mass gains indicated that recaptured birds of both sexes increased their mass significantly during stopover (males: $t_{134} = 3.37$, $P < 0.001$; females: $t_{107} = 4.14$, $P < 0.001$; Table 2), although some individuals did lose

TABLE 3. Male and female Common Yellowthroats showed slight annual variation and little difference between the sexes in stopover ecology on Appledore Island, Maine, from 1992 to 2001. Means are presented with standard deviations.

	Males			
Year	Percent recaptured (*n*)	Stopover length in days (*n*)	Mass change (% of initial mass)	Rate of mass change[a] (g/h)
1992	3.0 (338)	2.0 ± 1.3 (10)	2.3 ± 7.9	0.016 ± 0.010
1993	3.4 (350)	3.4 ± 2.4 (11)	8.4 ± 8.8	−0.033 ± 0.011
1994	6.3 (284)	3.1 ± 2.1 (18)	−0.6 ± 5.9	0.030 ± 0.012
1995	4.0 (326)	2.5 ± 2.6 (13)	2.5 ± 8.4	0.025 ± 0.010
1996	4.4 (203)	2.4 ± 1.6 (9)	1.2 ± 6.2	−0.011 ± 0.015
1997	11.4 (219)	3.8 ± 2.6 (25)	2.3 ± 9.3	0.011 ± 0.012
1998	5.9 (376)	3.6 ± 3.6 (22)	2.3 ± 7.4	0.022 ± 0.009
1999	3.3 (274)	2.4 ± 1.2 (9)	−0.3 ± 4.9	0.046 ± 0.013
2000	7.7 (156)	4.3 ± 2.2 (12)	4.6 ± 8.7	0.001 ± 0.020
2001	4.9 (243)	3.6 ± 3.0 (5)	6.0 ± 9.7	0.026 ± 0.017

[a] Rate of mass change was calculated using regression coefficients of condition (mass × 100/wing chord) over time of capture and mean wing chord.

mass at the site. Among these recaptured birds, males and females did not differ significantly in their relative mass change during stopover ($t_{222.1} = 1.02$, $P = 0.31$), nor did they differ significantly in their daily relative mass change during stopover ($t_{230.5} = 0.87$, $P = 0.39$). Within each sex, there was no significant difference in mass gain or rate of mass gain between age categories. Relative mass change for both sexes was significantly correlated with length of stay, with individuals that stayed longer gaining more mass (males: $F_{1,132} = 45.8$, $P < 0.001$; females: $F_{1,107} = 11.3$, $P = < 0.01$; Fig. 2).

Positive slopes of regression of condition over time of capture indicated that Common Yellowthroats were gaining mass on Appledore Island and that this gain was significantly different between sexes (mass gain: $F_{1,5332} = 56.9$, $P < 0.001$; sex: $F_{1,5332} = 77.3$, $P < 0.001$). Both males and females experienced significant mass gains as estimated by regression of condition over time of capture (males: $F_{1,2732} = 10.1$, $P < 0.01$; females: $F_{1,2573} = 55.0$, $P < 0.001$), although variation among years also was significant (males: $F_{9,2732} = 4.6$, $P < 0.001$; females: $F_{9,2573} = 12.2$, $P < 0.001$). We also found a significant difference among the four age and sex categories in mass gain as estimated by regression of condition over time of capture ($F_{3,1823} = 11.7$, $P < 0.001$). This difference occurred in three of the four years during which most birds were assigned to a specific age category (1998: $P < 0.001$; 1999: $P < 0.01$; 2000: $P < 0.001$), but during 2001 the same pattern did not hold ($P = 0.12$).

DISCUSSION

The mean arrival of Common Yellowthroats on Appledore Island (May 22) was approximately 10 days later than the mean arrival at Powdermill Nature Reserve, Pennsylvania (Rotenberry and Chandler 1999). A striking feature of Common Yellowthroat migration on Appledore Island was differential migration as evidenced by the earlier arrival of males than females at this stopover site during spring. These results corresponded to results of other studies of Neotropical migrants. Moore et al. (1990) reported earlier arrival dates of male passerines on a stopover island after spring trans-Gulf migration and suggested an earlier departure of males from wintering grounds rather than a differential rate of migration to explain the observed difference between the sexes. Francis and Cooke (1986) reported a mean arrival date for Common Yellowthroats of 19 May for males and 23 May for females at a banding site in the Great Lakes region positioned 1° north of Appledore Island. Our reported 5-day difference in arrival dates between the sexes was similar to their findings, although arrival dates on Appledore Island were two days later than the arrival dates that Francis and Cooke reported.

Several hypotheses have been proposed to suggest reasons why it may be advantageous to arrive early at the breeding grounds, where males are likely to encounter intrasexual com-

TABLE 3. EXTENDED

Females			
Percent recaptured (*n*)	Stopover length in days (*n*)	Mass change (% of initial mass)	Rate of mass change[a] (g/h)
3.3 (236)	1.8 ± 1.4 (8)	2.4 ± 7.4	0.017 ± 0.010
3.4 (297)	3.4 ± 1.9 (10)	2.8 ± 6.6	0.037 ± 0.013
5.6 (302)	2.6 ± 1.3 (17)	1.2 ± 4.9	0.029 ± 0.010
5.8 (326)	3.7 ± 3.0 (19)	3.7 ± 8.4	0.025 ± 0.010
4.1 (148)	3.0 ± 2.5 (6)	7.5 ± 10.1	0.024 ± 0.016
4.1 (272)	6.1 ± 4.6 (11)	4.5 ± 8.4	0.006 ± 0.010
3.4 (416)	3.0 ± 2.8 (14)	1.7 ± 10.4	0.025 ± 0.009
3.9 (258)	2.8 ± 2.7 (10)	0.5 ± 12.9	0.032 ± 0.012
6.3 (127)	4.6 ± 2.1 (8)	6.8 ± 8.9	0.035 ± 0.019
2.7 (220)	5.7 ± 3.0 (6)	10.8 ± 5.9	0.050 ± 0.013

petition for territory and mates. Males may migrate earlier because they (1) winter farther north and have a shorter distance to travel, (2) proceed at a faster rate than females, or (3) initiate migration earlier than females (Chandler and Mulvihill 1990). There are both advantages and disadvantages for males arriving early at the breeding grounds. Early-arriving males may experience harsher weather conditions or lower food availability than males arriving later. However, early males may have a greater likelihood of establishing favorable territories (Lavee et al. 1991) and attracting mates since there are fewer competitors (Francis and Cooke 1986). Females may be at a greater disadvantage to arrive at the breeding grounds early, since their smaller size would be less suitable for severe weather (Ketterson and King 1977). In addition, females have less selective pressure to arrive early, since even a late-arriving female would likely find a mate, though possibly of lower quality, while a late-arriving male would likely not mate at all (Francis and Cooke 1986). Our finding that individuals captured earlier during the season had higher condition indices than later migrants may indicate that early migrants are prepared for potentially harsh weather conditions on the breeding grounds early during the season.

Our results suggest that males may be initiating migration at an earlier date rather than proceeding at a faster rate than females. If males were to migrate at a faster rate, patterns of stay at stopover sites might vary between the sexes; however, results presented here indicate that there was no significant difference in recapture rate or stopover length between the sexes. Both males and females were re-

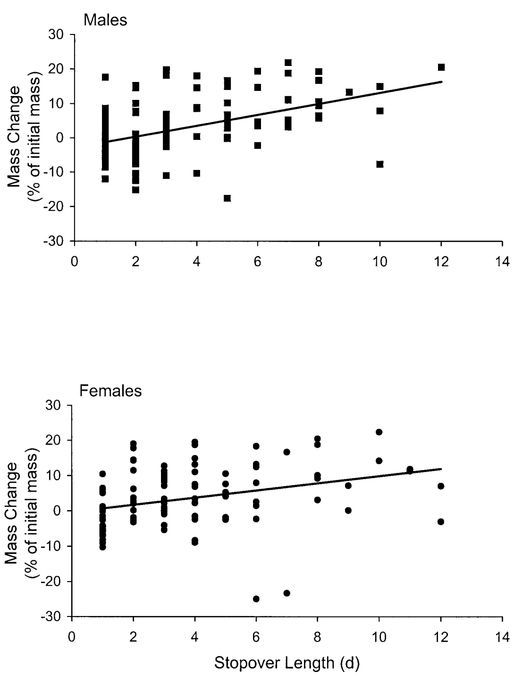

FIG. 2. Mass changes generally increased with length of stopover for recaptured male and female Common Yellowthroats on Appledore Island, Maine. Data from 1992–2001 were pooled for the regression analysis. For males, $n = 135$, $r^2 = 0.26$, and the equation for the regression line is $y = 1.62x - 2.85$. For females, $n = 108$, $r^2 = 0.11$, and the equation for the regression line is $y = 1.02 \times -0.25$.

captured at the same rate and stayed on Appledore Island for the same length of time, suggesting that a differential rate of migration was not occurring. Our results differed from the results of a spring study of Wilson's Warblers (*Wilsonia pusilla*) in New Mexico in which males were less likely than females to be recaptured (Yong et al. 1998). However, our results for Common Yellowthroats were similar to findings by Morris and Glasgow (2001) for American Redstarts (*Setophaga ruticilla*) and the findings of Otahal (1995) for Wilson's Warblers in California, neither of which indicated a differential rate of recapture between the sexes.

Our finding that larger individuals of both sexes tended to arrive early on Appledore was consistent with results reported for Common Yellowthroats by Francis and Cooke (1986). The tendency for individuals with longer wing chords to arrive earlier may be attributed to either an age effect, a distribution effect (if larger birds were from northern populations), or both. Analyses of timing of migration relative to age indicated that ASY birds indeed were arriving earlier than SY birds in both sexes (Table 2, Fig. 1). However, to investigate the possibility that the observed relationship in arrival date and wing chord was related to size as well as age, we also performed regressions with tarsus length. This relationship was not significant among individuals of either sex. Since tarsus length does not increase with age, these results suggest that age, not simply size, was a factor in the arrival date in Common Yellowthroats, with SY birds arriving later than ASY birds in both males and females.

Moore and Kerlinger (1987) concluded that a stopover site was suitable if migrants gained mass during stopover, indicating that Appledore Island was a suitable stopover site for migrant Common Yellowthroats during spring. We found mean mass gains among recaptured males and females on Appledore, and we found that mean rates of mass gain were similar for both sexes, suggesting that both sexes utilized the stopover site to forage similarly. Therefore, it is not likely that males would require fewer stopovers to maintain energy reserves, which would lead to a faster rate of migration. Instead, both sexes obtained similar energetic gains during the same time period. In contrast, rates of mass gain as estimated by regressions of condition on time of capture indicated that males were gaining mass more slowly than females, potentially indicating an increased need for stopovers by males. The differences between the sexes in mass gains may indicate that there were greater food resources available to later migrants. In his study of the Wilson's Warbler, Otahal (1995) found that males and females gained the same mass during stopover. However, Yong et al. (1998) found that male Wilson's Warblers had a higher rate of mass gain than females during spring. This study found a positive relationship between length of stay and amount of mass gain, which indicated that Appledore Island apparently provided sufficient food rewards for stopover migrants, although the rate of mass gain was lower than two sites studied in southern Ontario (Dunn 2001). Winker et al. (1992a) also reported mass gain among Common Yellowthroats during spring at an inland stopover site in Minnesota, although several other species lost mass during spring at that site. It is interesting that Winker et al. (1992a) reported a mean stopover length of 3.3 days for Common Yellowthroats during spring at their site located 2° north of Appledore Island, which was similar to our findings.

The lack of difference in stopover ecology of recaptured individuals between males and females and between age groups in this study was similar to a recent study of American Redstarts on Appledore Island (Morris and Glasgow 2001). Similar work on Wilson's Warblers yielded contradictory results. Yong et al. (1998) reported increased recapture rates of females, increased rates of mass gain by males, and no difference in stopover length among age or sex groups in New Mexico. However, in California, Otahal (1995) found no difference in recapture rate or mass gain among males and females, although stopover length was significantly longer in males. Because these studies of stopover ecology of individual species have had different results related to sex, more study of potential sexual differences is warranted.

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