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Authors: MORRIS, SARA R., and GLASGOW, JAMIN L.

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COMPARISON OF SPRING AND FALL MIGRATION OF AMERICAN REDSTARTS ON APPLEDORE ISLAND, MAINE

SARA R. MORRIS[1,2] AND JAMIN L. GLASGOW[1]

ABSTRACT.—On Appledore Island, Maine, American Redstarts (*Setophaga ruticilla*) were encountered frequently during both spring and fall migration from 1990 to 1999. Males arrived earlier than females during spring, but arrival dates of males and females did not differ significantly during fall. Also, adults arrived earlier than young birds during spring, but not during fall. Recapture of banded birds at least one day after initial capture occurred more frequently during fall than spring, although mean stopover length did not differ significantly between the two seasons. Although recaptured individuals increased in mass during stopover during both seasons, mass increases were significant only during fall. However, rates of mass increase estimated by regression of condition over time of capture indicated greater mass increases during spring. Neither recapture rates, stopover lengths, nor mass changes differed significantly between males and females or between age groups within either season. These results indicate that although many American Redstarts were encountered on Appledore Island during both spring and fall migration, birds were using the site differently during the two seasons. Spring migration was more concentrated with few observed stopovers, while fall migration was protracted with increased rates of recapture. American Redstarts may have been responding differently to this site during spring and fall migration because of the proximity to breeding grounds and distance from winter grounds as well as the location of the Atlantic Ocean, which represents an ecological barrier during fall migration. *Received 20 Oct. 2000, accepted 23 Jun. 2001.*

Recent apparent declines in populations of Neotropical migrant passerines have caused renewed interest in the nonbreeding periods of their annual cycles (e.g., Keast and Morton 1980, Hagan and Johnston 1992). Migration may be energetically costly, reduce fitness, and increase mortality (Woodrey and Moore 1997). Migrants are particularly vulnerable during migratory periods, when they may have to contend with adverse weather conditions, concentrations of predators, uncertain food supplies, and unknown habitats. Migration is a particularly difficult period to study because birds migrate over large geographic areas, and it is difficult to follow the movements of an individual migrant. However, monitoring migrants intensively in a single location may provide some insight into the migration strategy of a single species (Winker et al. 1992a).

The American Redstart (*Setophaga ruticilla*) is a common, widespread Neotropical migrant that migrates through New England during both spring and fall (Sherry and Holmes 1997). Also, populations of this species may have experienced declines during the 1980s (Robbins et al. 1989, James et al. 1996). American Redstart populations have been studied extensively during their breeding (Ficken and Ficken 1967; Bennett 1980; Morris and Lemon 1988; Sherry and Holmes 1988, 1989; Lozano et al. 1996) and winter seasons (Bennett 1980, Holmes et al. 1989, Sliwa and Sherry 1992, Marra et al. 1993, Parrish and Sherry 1994). However, much less is known about American Redstarts during migration. Francis and Cooke (1986) documented earlier spring migration of male American Redstarts compared to females and of adult males compared to second year males (see also Ficken and Ficken 1967). Age specific differences also have been documented among males with respect to habitat use (Ficken and Ficken 1967), site fidelity (Lemon et al. 1996), success in obtaining territories in preferred habitat (Sherry and Holmes 1989), success in obtaining mates (Ficken and Ficken 1967, Lozano et al. 1996), and response to dominant competitors (Sherry and Holmes 1988).

Aspects of migration, including differences in recaptures and stopover lengths, also may be associated with age and sex in this species. Woodrey (2000) indicated that although intraspecific comparisons (between age and sex groups) are important, few have been undertaken. American Redstarts are sexually dichromatic, differ in plumage by age, and are

[1] Dept. of Biology, Canisius College, Buffalo, NY 14208 USA.

[2] Corresponding author; E-mail: morriss@canisius.edu

one of the most common migrants on Appledore Island during both seasons, allowing comparisons between seasons, between ages, and between sexes. In this study we examined both the timing of migration and the stopover patterns of American Redstarts during spring and fall migration on Appledore Island, Maine. In particular, we investigated differences in the migration and stopover ecology between seasons and between age and sex groups to gain a better understanding of the biology of this Neotropical migrant species.

STUDY SITE AND METHODS

American Redstarts were banded during spring and fall migration on Appledore Island, Maine (42° 58′ N, 70° 36′ W), from 1990 to 1999. Appledore is a 33.6-ha island located approximately 14.5 km southeast of Portsmouth, New Hampshire, and 9.7 km from the nearest point of the mainland; it is dominated by shrubby vegetation. A detailed description of the study site was presented by Morris et al. (1994). Several volunteers helped operate the banding station daily during spring and fall migration, weather permitting. We captured migrants in mist nets and took all captured birds to a central location for banding. For each redstart captured or recaptured, we recorded age, sex, unflattened wing length (to 0.5 mm), and mass (to 0.01 g). In the case of recaptured individuals we did not refer to initial data so that measurements would not be influenced by previous observations. During fall we also recorded the degree of skull pneumatization to confirm age. Throughout this study we were able to differentiate adult (after hatch year, AHY) and young (hatch year, HY) birds of both sexes during fall, and between adult (after second year, ASY) and young (second year, SY) males during spring, using criteria in Pyle et al. (1987) and Pyle (1997). However, regular aging of SY and ASY females did not begin until spring 1997 when we began using criteria in Pyle (1997).

Because American Redstarts do not breed regularly on Appledore Island (Borror and Holmes 1990), all of the individuals captured were assumed to be migrants. A lack of between year recaptures of American Redstarts further supported this assumption because other passerine species that do regularly breed on Appledore frequently were recaptured between years. Individuals involved in manipulative experiments conducted on the island (Morris 1996) were included in calculations of arrival date and initial mass but were excluded from all recapture analyses.

We tested for annual variation within each variable. If significant variation occurred, we performed tests that included year as a variable in the analysis. Data from variables that did not differ significantly among years were pooled across years to increase sample sizes for analyses. We report both means (±SD) and medians in arrival date to allow comparison of our data with data from other studies. Differences in arrival date, wing chord, and mass were investigated using two-way ANOVAs that included year in the analysis. We used Likelihood Ratio Chi-squared tests to analyze differences in recapture rates in each year. Because of nonnormal distributions, we used the Mann-Whitney *U* statistic to test for differences in minimum stopover length, which was calculated as the time in days between initial and final capture. Changes in mass of recaptured individuals were analyzed using *t*-tests. We investigated both total mass change between initial capture and final recapture and rate of mass change, which was calculated as (total mass change/minimum stopover length). We used paired *t*-tests to examine mass changes within a season or sex, and separate variances *t*-tests to compare mass changes between seasons or groups. Mass gains also were calculated by regressing condition over hour after sunrise. Condition was calculated as mass $\times$ 10,000/wing^3 following Winker et al. (1992b, 1992c), and regressions over hour after sunrise follow Dunn (2000). Differences between seasons were tested for significance using ANCOVA analyses after verifying that interactions between time and season were not significant (Sokal and Rohlf 1995). Mass gains then were estimated using the regression coefficients and mean wing length for the season. Two-tailed probabilities are presented for all analyses.

RESULTS

During the ten years of this study, we captured 1669 redstarts during spring and 1276 during fall (Table 1). Capture of American Redstarts on Appledore Island typically began in mid-May and continued throughout the remainder of spring banding (Fig. 1). Their spring migration usually peaked during the last week in May (Table 2). Migrant American Redstarts also were common throughout fall migration, and while no peak was obvious, their numbers were greatest between the last week of August and the third week of September (Fig. 1, Table 2). The difference in median capture dates between spring and fall migration was 104 d.

During spring, males arrived earlier than females ($F_{1,1648} = 695.8$, $P < 0.001$; Fig. 1, Table 1) and mean arrival date varied significantly among years ($F_{9,1648} = 690.8$, $P < 0.001$; Table 2). There was no significant interaction between year and sex ($F_{9,1648} = 29.4$, $P = 0.36$). Adult males arrived significantly earlier than young males during spring (SY: $n = 684$, $\bar{x} = 27$ May ± 5.4 d; ASY: $n = 215$, $\bar{x} = 23$ May ± 5.6 d; $F_{1,876} = 3399.9$, $P = 0.001$). Among females, adults arrived slightly earlier than young birds during spring, but this

TABLE 1. Summary of the migration and stopover biology of American Redstarts captured during spring and fall migration on Appledore Island, Maine, from 1990 to 1999. Data were pooled across years. Recaptures include only birds that were captured at least one day after initial capture.

Variable	Males		Females	
	Spring	Fall	Spring	Fall
Number of individuals captured	899	586	769	627
Range of capture dates	8 May–9 June	14 August–7 October	8 May–9 June	15 August–4 October
Median date of capture	27 May	7 September	28 May	8 September
Mean date of capture (± SD in d)	26 May (± 5.7)	6 September (± 5.7)	28 May (± 5.3)	6 September (± 11.1)
Percent of young (SY/total in spring, HY/total in fall)	76.3%	95.4%	75.4%[1]	95.4%
Wing chord (mm)	62.6 ± 1.8	62.5 ± 1.8	59.8 ± 1.7	60.0 ± 1.8
Initial mass (g)	8.85 ± 0.75	8.44 ± 0.85	8.38 ± 0.73	8.10 ± 0.82
Number of individuals recaptured (%)	29 (3.2)	48 (8.2)	21 (2.7)	67 (10.7)
Stopover length (d)	2.5 ± 2.0	2.4 ± 2.0	1.8 ± 1.2	3.1 ± 3.6
Mass change of recaptured individuals (g)	0.17 ± 0.58	0.12 ± 0.71	0.06 ± 0.62	0.23 ± 0.77
Rate of mass change of recaptured individuals (g/d)	0.05 ± 0.28	−0.02 ± 0.40	0.02 ± 0.49	0.03 ± 0.34
Rate of mass change of individuals estimated by regression (g/h)	0.050 ± 0.007	0.044 ± 0.010	0.058 ± 0.007	0.036 ± 0.009

[1] All females were considered AHY during spring until 1997; thus our sample size was much reduced for this analysis ($n = 197$).

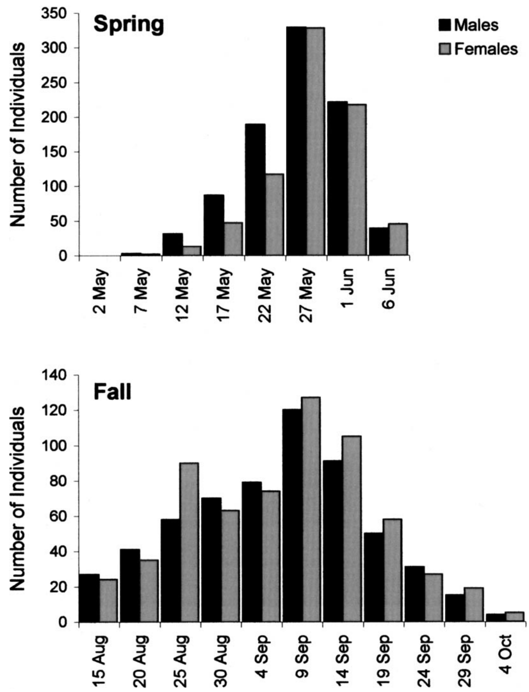

FIG. 1. Capture dates of American Redstarts on Appledore Island, Maine, from 1990 to 1999 (new captures only). Dates indicate the middle of each five-day period during banding with the exception of the final period during fall, which was a six-day period.

trend was not significant (SY: $n = 150$, $\bar{x} =$ 27 May ± 4.6 d; ASY: $n = 49$, $\bar{x} =$ 26 May ± 7.3 d; $F_{1,185} = 0.2$, $P = 0.65$).

Although mean arrival date differed significantly among years during fall ($F_{9,1193} = 577.8$, $P < 0.001$; Table 2), arrival date did not differ significantly between the sexes ($F_{1,1193} = 8.2$, $P = 0.79$; Fig. 1, Table 1) nor was there a significant interaction between year and sex ($F_{9,1193} = 54.2$, $P = 0.91$). During fall, adult and young birds did not differ significantly in the timing of migration ($F_{1,1256} = 0.42$, $P = 0.52$). The median arrival date for both adult and young birds was 8 September. However, when males and females were analyzed separately, the young and adult males did not differ significantly in arrival date ($F_{1,567} = 0.25$, $P = 0.62$), while adult females arrived slightly later than young ones (HY: $n = 598$, $\bar{x} =$ 6 Sep ± 11.0 d; AHY: $n = 29$, $\bar{x} =$ 12 Sep ± 10.5 d; $F_{1,607} = 4.0$, $P < 0.05$).

Young birds were more prevalent than adults during both spring and fall migration

TABLE 2. Arrival date, wing length, and mass of American Redstarts during spring and fall migration on Appledore Island, Maine, from 1990 to 1999. Arrival date is Julian date; Julian 140 is May 20 and Julian 244 is September 1. Values are means ± SD.

	n		Arrival date		Wing (mm)		Mass (g)	
	Male	Females	Males	Females	Males	Females	Males	Females
Spring								
1990	80	56	149.9 ± 4.4	150.2 ± 4.5	62.4 ± 1.8	59.6 ± 1.9	8.91 ± 0.73	8.39 ± 0.75
1991	116	81	145.1 ± 5.2	145.6 ± 5.0	62.8 ± 1.6	60.2 ± 1.6	8.89 ± 0.78[a]	8.52 ± 0.75
1992	48	26	144.2 ± 3.5	145.9 ± 3.5	63.1 ± 2.1	59.6 ± 1.8	8.90 ± 0.86[b]	8.41 ± 0.77
1993	92	100	142.3 ± 6.5	145.4 ± 6.3	61.9 ± 1.8	59.0 ± 1.7	9.04 ± 0.81	8.56 ± 0.66
1994	142	128	146.5 ± 3.8	147.6 ± 2.4	62.7 ± 2.0	60.0 ± 1.7	8.78 ± 0.71	8.29 ± 0.77
1995	127	122	147.1 ± 5.4	147.8 ± 5.0	62.6 ± 1.9[a]	59.9 ± 1.5	8.82 ± 0.74[a]	8.37 ± 0.73[b]
1996	63	46	150.2 ± 6.1	151.9 ± 5.4	62.8 ± 1.4[a]	59.7 ± 1.7	8.79 ± 0.85[b]	8.25 ± 0.70
1997	41	62	146.6 ± 6.3	148.5 ± 6.1	62.5 ± 1.5	59.3 ± 1.5[a]	8.93 ± 0.67[a]	8.45 ± 0.86[b]
1998	114	78	146.8 ± 5.4	148.6 ± 4.9	63.0 ± 1.8	60.1 ± 1.9	8.82 ± 0.65	8.28 ± 0.66[a]
1999	76	68	144.8 ± 6.3	146.0 ± 5.8	62.7 ± 2.1	59.9 ± 1.7	8.75 ± 0.69	8.28 ± 0.62
Fall								
1990	42	38	248.2 ± 9.1	247.7 ± 8.6	62.5 ± 2.0	60.0 ± 1.6	8.35 ± 0.77	7.98 ± 0.87[a]
1991	52	40	247.7 ± 8.9	248.6 ± 8.2	62.1 ± 1.7	60.2 ± 1.8	8.46 ± 1.06[a]	7.97 ± 0.82
1992	53	72	245.5 ± 9.5	247.0 ± 9.9	62.9 ± 1.5	60.2 ± 1.5	8.76 ± 0.81	8.37 ± 0.70[a]
1993	35	50	247.0 ± 11.9	248.0 ± 12.8	62.1 ± 1.8	60.2 ± 1.7	8.68 ± 0.95	8.02 ± 0.74
1994	96	105	250.3 ± 11.3	250.2 ± 11.5	62.6 ± 1.6	60.1 ± 2.0	8.35 ± 0.80	8.15 ± 0.83
1995	48	74	253.5 ± 14.5	254.0 ± 12.1	62.0 ± 1.7	59.6 ± 1.7	8.28 ± 0.88	8.00 ± 0.90
1996	69	68	249.8 ± 7.8	249.0 ± 9.2	63.2 ± 1.8	60.3 ± 1.7	8.63 ± 0.77[a]	8.17 ± 0.87[a]
1997	65	69	252.4 ± 8.7	249.9 ± 9.5	62.8 ± 2.0[a]	60.5 ± 1.8	8.40 ± 0.76[a]	8.32 ± 0.76
1998	74	70	248.0 ± 11.0	249.9 ± 12.3	62.2 ± 1.5	59.4 ± 1.8	8.22 ± 0.84[b]	7.83 ± 0.74
1999	52	39	246.9 ± 15.1	246.7 ± 13.5	62.6 ± 2.2	59.7 ± 1.8	8.45 ± 0.88	8.08 ± 0.93

[a] One bird was not included in the sample because it escaped before measurements were completed.
[b] Two birds were not included in the sample because they escaped before measurements were completed.

(Table 1). This difference was particularly evident during fall, when adults accounted for less than 5% of all individuals encountered. Significantly more young birds were encountered during fall than spring (Table 1; $\chi^2_1 = 2371$, $P < 0.001$). This trend occurred in every year of the study, and the difference was significant in every year except 1990 (1990: $P = 0.14$, 1991: $P < 0.05$, 1999: $P < 0.01$, all other years: $P < 0.001$).

Although mass varied among years ($F_{9,2904} = 3.6$, $P < 0.001$), the mean mass of American Redstarts captured during spring was significantly greater than the mean of individuals captured during fall ($F_{1,2904} = 142.6$, $P < 0.001$). Both males and females showed this pattern (Tables 1, 2; males: $F_{1,1453} = 83.9$, $P < 0.001$; females: $F_{1,1368} = 43.4$, $P < 0.001$). During both spring and fall migration, males weighed significantly more than females (Tables 1, 2; spring: $F_{1,1636} = 145.7$, $P < 0.001$; fall: $F_{1,1185} = 54.9$, $P < 0.001$). Adults (ASY) were significantly heavier than young birds (SY) during spring among males ($F_{1,869} = 12.5$, $P < 0.001$) but not females ($F_{1,183} = 0.04$, $P = 0.84$). Older females (AHY) were heavier than young females (HY) during fall ($F_{1,604} = 10.8$, $P < 0.001$); however, this difference was not significant in males ($F_{1,562} = 0.2$, $P = 0.66$). Adult birds had significantly longer wing chords than young birds among both sexes during spring (males: $F_{1,874} = 189.5$, $P < 0.001$; females: $F_{1,185} = 14.7$, $P < 0.001$) and during fall (males: $F_{1,566} = 29.5$, $P < 0.001$; females: $F_{1,607} = 7.5$, $P < 0.01$). Males had significantly longer wing chords than females during both spring (Tables 1, 2; $F_{1,1645} = 926.7$, $P < 0.001$) and fall migration (Tables 1, 2; $F_{1,1192} = 547.5$, $P < 0.001$).

Recapture of banded birds at least one day after initial capture occurred significantly more frequently during fall (9.6% recaptured) than spring (3.0%; $\chi^2 = 57.7$, df = 1, $P < 0.001$; Table 1). Mean stopover length did not differ significantly between the two seasons (Fig. 2; Mann-Whitney *U*-test, $P = 0.36$), although mean stopover length was two days during spring and three days during fall. Recaptured individuals increased their mass during stopover during both seasons. Mean mass increase was 0.13 ± 0.59 g ($n = 48$) during spring and 0.24 ± 0.79 g ($n = 122$) during fall; however, this difference was significant

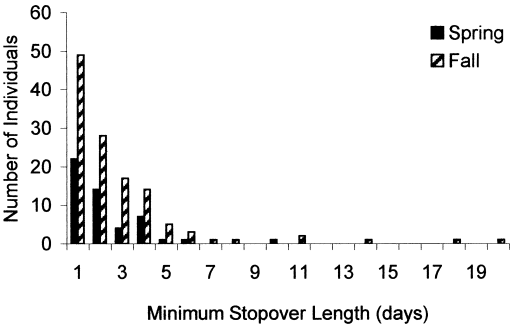

FIG. 2. Minimum stopover length (days between initial and final capture) of American Redstarts during spring and fall migration on Appledore Island, Maine, from 1990 to 1999.

only during fall (spring: $t_{47} = 1.5$, $P = 0.14$; fall: $t_{121} = 3.3$, $P = 0.001$) and did not differ significantly between seasons ($t_{114.6} = 1.0$, $P = 0.33$). The rate of mass gain by recaptured individuals also did not differ significantly between seasons ($t_{84.7} = 0.1$, $P = 0.92$). Furthermore, the rate of gain was not significant in either season (spring: $t_{47} = 0.7$, $P = 0.46$; fall: $t_{121} = 1.0$, $P = 0.31$). Within each season, recaptures, stopover lengths, and mass changes among recaptured individuals did not differ significantly between the sexes or between age groups.

Rates of mass increase estimated from regression of condition over hour after sunrise were significantly greater than 0 during both seasons (spring: $F_{1,1655} = 103.1$, $P < 0.001$; fall: $F_{1,1264} = 37.3$, $P < 0.001$). Mean rates of mass gain during spring were significantly greater than gains during fall (Table 1; spring: $\bar{x} = 0.053 \pm 0.005$ g/h; fall: $\bar{x} = 0.042 \pm 0.007$ g/h; ANCOVA $F_{1,2920} = 93.5$, $P < 0.001$). Also, rates of mass increase within each season were significant for all age and sex categories ($P < 0.001$), except adults during fall ($F_{1,54} = 0.02$, $P = 0.88$).

DISCUSSION

These results indicate that several aspects of the migration of American Redstarts differed between spring and fall, including span of capture dates, association of age and sex with capture date, likelihood of stopover, and estimated rate of mass gain during stopover. However, other aspects of migration, including length of stopover and mass gain by re-

captured individuals, did not appear to differ between the seasons for this species.

This study provided additional documentation of the earlier spring migration of male American Redstarts compared to females and of adult males compared to young males. The observed difference in the timing of spring migration between males and females was similar to the results of other studies of North American wood warblers (Francis and Cooke 1986; Otahal 1994, 1995). However, the difference of only one day in median and two days in mean migration dates between males and females was less than differences reported in previous studies. Francis and Cooke (1986) reported a difference of three days in mean arrival date between male and female American Redstarts at Prince Edward Point, Ontario. Moreover, the mean arrival dates they reported were earlier than those reported here, even though Appledore Island is slightly north of Prince Edward Point. However, arrival on Appledore appeared to be slightly later than arrival of birds in New Hampshire, where most males had arrived several days earlier than the mean of 26 May on Appledore (Hunt 1996, Marra et al. 1998). Similar results were seen when the timing of different age groups of male American Redstarts were compared between Appledore and Ontario during spring. Both adults and young birds arrived on Appledore later than they arrived at Prince Edward Point, although the difference between the two groups was the same at both locations (4 d). The later arrival of males on Appledore may have resulted from the preponderance of young birds in the population because young males migrate later than older ones during spring.

The observed earlier spring arrival of males compared to females could be due to earlier onset of migration, an increased rate of migration, or both. Because we found no difference in stopover patterns between males and females during spring, it was unlikely that males had a greater speed of migration compared to females. Rather, males probably were initiating migration before females, either geographically or temporally. Parrish and Sherry (1994) reported that sexual habitat segregation occurred with males holding territories in better spring habitats on the winter range, allowing males to depart wintering sites earlier than females. Marra et al. (1998) observed that male American Redstarts generally leave common wintering grounds in Jamaica before females. Therefore, earlier encounters of male American Redstarts at northern stopover sites may be due to males leaving the same geographic area before females. Regardless of what causes differences in spring migration between males and females, earlier male arrival on the breeding grounds would provide males the opportunity to establish territories prior to the arrival of females. Thus, when females arrive, breeding can begin without delay.

Although males arrived earlier than females during spring, timing of fall migration appeared to be similar in the two sexes. Otahal (1995) also found no difference in the timing of fall migration between the sexes in his study of Wilson's Warblers (*Wilsonia pusilla*). Both his results and results from this study support the idea that during fall both sexes may be experiencing similar pressures, resulting in the same timing of migration and similar stopover patterns. Both male and female American Redstarts defend territories during the winter against conspecifics (Rappole and Warner 1980, Holmes et al. 1989, Parrish and Sherry 1994). Because all birds must compete for resources during the winter, both sexes would be under pressure to arrive at the wintering grounds in time to secure quality territories. Therefore, it is not unexpected that we found no difference in the timing or stopover patterns of males and females during fall. Woodrey and Chandler (1997) reported no difference in the timing of fall migration between young and adult redstarts at two sites over two years, although at a third site young birds preceded adults in one year. Our results were similar, with no significant difference in timing when age was the only factor investigated.

A striking feature of coastal studies of migration is the preponderance of young birds. A large proportion of young birds in the population of autumn migrants (85–100% young) was documented on the eastern (Baird and Nisbet 1960, Drury and Keith 1962, Murray 1966, Morris et al. 1996) and western coasts of North America (Ralph 1971, Stewart et al. 1974), and on coasts in Europe (Williamson 1959, Evans 1968, Ehnbom et al. 1993). This study presented similar data with juveniles

comprising more than 95% of the autumn population. Ralph (1971) summarized the principal hypotheses to explain the large numbers of young birds encountered at coastal sites. Adults might avoid the coast, either by learning to avoid the coast during their first migration or from inherited mechanisms to migrate over land (Drury and Keith 1962, Ralph 1981). The latter possibility suggests that many young birds inheriting mechanisms using coastal or over-water routes would perish during migration. Adults may migrate prior to young birds and prior to the initiation of migration studies, and therefore be underrepresented in the sampled population. Alternatively, young birds may be less likely to initiate crossing an ecological barrier than adults (Drury and Keith 1962, Ehnbom et al. 1993) or, when finding themselves over water at dawn, may be more likely to stop at the first available landfall, whereas adults continue farther inland (Murray 1966). The hypothesis of hesitancy by young birds to cross ecological barriers was further supported by Dunn and Nol (1980), who found that although numerous adults passed through their study site north of Lake Erie, adults did not stop before crossing Lake Erie, and thus their numbers appeared to be underestimated by mist netting.

The large proportion of young birds during spring is less well documented. The proportion of young in our sample is close to, but slightly larger than, the 70% reported by Sherry and Holmes (1991) on the breeding grounds, but was substantially larger than the 20–55% reported in different habitats by Hunt (1996). Hunt reported fewer than 20% SY individuals in early successional stages and less than 40% in mature deciduous habitats, thus suggesting that the proportion of young birds in shrubby habitats on Appledore is unusual.

Significantly greater mass and longer wing chords of males compared to females during both seasons were expected because female passerines generally are smaller than males (Pyle et al. 1987, Pyle 1997). Among many passerines, males have longer wing chords than females, and adults have longer wing chords than young birds (Pyle et al. 1987, Pyle 1997). Our wing chord data supported this pattern of longer wing chords among adults compared to young birds during both seasons.

Our study indicates that although many American Redstarts were encountered on Appledore Island during both spring and fall migration, birds were using the site differently during the two seasons. Spring migration was concentrated with few observed stopovers, and fall migration was extended with more frequent stopovers. Furthermore, the stopover patterns appeared to be the same for males and females during both seasons. Otahal (1995) found similar results in his work on Wilson's Warblers during spring migration in California. Likewise, stopover duration did not differ between age classes of redstarts in this study. Thus, our results on redstarts were similar to the work of Woodrey and Moore (1997), which did not find any difference in rate of recapture or length of stopover among different age classes of White-eyed Vireos (*Vireo griseus*) during fall on the coast of Alabama.

The increased recaptures during fall migration reported in this study were similar to previously summarized stopover behavior on Appledore (Morris et al. 1994). Likewise, the increase in mass in individuals recaptured during fall was similar to the earlier study. The lower mass among individuals captured during fall compared to those captured during spring in this study may partially explain the increased recapture rate by individuals during fall, because these lean individuals might need to build up additional fat stores before continuing migration. Other factors also may help explain the observed difference in stopovers between the seasons (Morris et al. 1994). Relatively few stopovers during spring may result from the proximity of this site to the final destination of migration and the ability of birds to see the mainland in the direction of spring migration. During fall, birds would be close to the origin of migration and quite distant from the wintering grounds, and would see open water in the direction of fall migration, likely resulting in more stopovers. Furthermore, fall stopovers may be increased by the inexperience of young birds.

Appledore Island did appear to be a suitable stopover site for American Redstarts based on mass gains by individuals during both seasons, particularly as estimated by regressions of condition over time. Furthermore, our data indicated greater mass increases by redstarts

during fall than that observed by Woodrey and Moore (1997) on the coast of Alabama.

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