J. Field Ornithol., 60(3):340–349

VARIATIONS IN AGE AND SEX RATIOS OF WINTERING AMERICAN GOLDFINCHES TRAPPED AT BAITED STATIONS

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Abstract.—Data from 3145 American Goldfinches (*Carduelis tristis*) trapped at baited stations in Guelph, Ontario during the winters of 1980–1986 were analyzed to examine the influence of weather and time of day on sex and age ratios of males. An imbalanced sex ratio of 1.55:1 (male : female) and male age ratio of 0.35:1 (adult : immature) was identified. Diurnal variations in sex and age ratios reflected an increase in the number of adult males around mid-day. No consistent relationship between temperature and sex or age ratios was found. However, immature males were less frequently trapped during snowy weather than during more favorable conditions.

VARIACIÓN EN LA RAZÓN DE EDAD Y SEXOS DE INDIVIDUOS INVERNALES DE *CARDUELIS TRISTIS*

Resumen.—Durante los inviernos del 1980–1986 se atraparon 3145 individuos de *Carduelis tristis* en Guelph, Ontario. Se encontró una relación de sexos de 1.55:1 (macho : hembra) y de edad de machos 0.35:1 (adulto : inmaduro) inbalanceada. A través del día hubo variaciónes en la razón de sexos y edad, con un incremento en el número de machos a mediodía. No se encontró relación entre las temperaturas y la razón de edad y sexo. Sin embargo, se atraparon machos jóvenes con menos frecuencia durante períodos de nevadas que durante tiempos más favorables.

Studies of the age and sex composition of avian populations generally require that birds be "captured" (trapped or shot) in order to ascertain the age and sex of each individual encountered. Such surveys implicitly assume that different cohorts of a population are equally likely to be encountered, and, therefore, the age and sex ratios in the captured sample reflect free-living populations at a given time and place. The validity of this assumption has been widely accepted, but evidence suggests that all individuals in a population might not have an equal probability of capture. For example, in Canvasbacks (*Aythya valisineria*) (Olson 1965) and blackbirds (Icterinae, Weatherhead and Greenwood 1981), young birds and females are more often shot or trapped than are adult males. Such differences might reflect a tendency of individuals in poorer body condition to be less wary of decoys or bait (Greenwood et al. 1986, Weatherhead and Ankney 1984). Conversely, in gregarious birds, intraspecific dominance hierarchies often occur (Dilger 1960, Ketterson 1979, Sabine 1949),

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and dominant individuals (usually adults and males) can apparently exclude subordinates from feeding areas (Fretwell 1969, Hepp and Hair 1984). Therefore, age or sex classes with preferential access to feeding areas might sometimes be overrepresented in trapped samples (e.g., Balph and Balph 1976).

During a long-term banding study of American Goldfinches (*Carduelis tristis*) in southern Ontario (see Middleton 1977), we assumed that the sex and age ratios of feeder-trapped birds are representative of local population ratios. While we have no evidence for any biases in our trapped samples, it became apparent that age and sex groups differed in their relative abundance at feeding stations at different times of the day, as well as on different days. This occurred despite the fact that overall ratios calculated from winter-trapped samples of golfinches remain relatively constant during the inter-migratory period (December–March, Prescott and Middleton, unpubl. data). In this paper, we quantify these apparent variations, and consider their influence on population studies involving feeder-trapped birds.

METHODS

American Goldfinches were banded at three baited stations in suburban Guelph, Ontario (43°32′N, 80°13′W) between 1980 and 1986. Trapping commenced with the appearance of goldfinches at feeders, usually in November, and terminated with the disbanding of flocks in April. Trapping effort varied from day to day at the different stations, but was usually concentrated in the morning when birds were most abundant at feeders. The majority of birds (>80%) were caught in sunflower-baited Potter or ground traps, the remainder being mist-netted near feeders. Individuals were sexed by plumage features, and aged by plumage (Middleton 1974) or skull ossification (Wood 1969). Because reliable aging techniques for females were not known until recently (Pyle et al. 1987), all females in this study were pooled. Males were designated as being immature (first winter) or adult (> first winter). The time of capture was recorded for each individual (±10 min). Because records of retrapped birds were not kept at all banding stations, we consider only original bandings in the present analyses. We estimate that unbanded birds represented at least 90% of all goldfinches captured.

To check for variation in age and sex ratios during the day at feeders, we considered birds banded during December through March for three seasons (1983/84–85/86) when traps were operated throughout the day on numerous occasions. The day was divided into six 2-h periods (0700–1900 h EST), and all individuals of each age and sex class encountered during each period over the entire winter were tallied. A minimum sample size of 25 birds was selected to adequately reflect the relative abundance of ages and sexes during each time period. Time classes represented by less than the minimum number were omitted from each year's analysis. Because sex and age ratios vary substantially from winter to winter in Guelph (Prescott and Middleton, unpubl. data), we initially considered each year separately, and then repeated the analyses for all years combined. The overall ("expected") frequency of age and sex classes during each winter was computed, and compared with the observed hourly frequencies by means of a *G*-test (Sokal and Rohlf 1969).

To standardize the data, diurnal trends in sex and age composition were presented as ratios (male : female; adult : immature). However, a change in ratio could result from an increased presence of one cohort at feeders, or a decrease of the other. Thus, we examined the direction of the age and sex ratio trends by calculating a ratio of the numbers of each cohort trapped during each hour of a given year with a crude measure of trapping effort as follows. In general, traps were operated opportunistically (i.e., during periods when goldfinches occurred at feeders). Assuming that traps were tended only during those 2-h time classes when goldfinches were represented in the database, we summed the number of 2-h classes during each winter when at least one bird was trapped. We then compared bihourly trends in sex and age ratios with the numbers caught per 2-h period, under the premise that the numbers of all cohorts trapped relative to effort should be constant if cohorts are present with equal frequency at all times of the day.

Possible relationships between the observed daily sex and age ratios of goldfinches and meteorological variables were investigated by considering data obtained only during January and February. Because some goldfinches are migratory during other months of the year, and because daily ratios might be influenced by the differential arrival or departure of age or sex classes into or out of the local population, we used only the "midwinter" months, when the compostion of goldfinch flocks is most stable (Prescott and Middleton, unpubl. data). Again, a minimum (daily) sample of 25 birds was required to calculate ratios, and only those seasons where this minimum was obtained on at least 10 occasions were considered. Meteorological data for each day were compiled from records at the Department of Land Resource Science, University of Guelph. We considered mean daily temperature (°C), total daily snowfall (cm), and depth of snow cover (cm) as possible determinants of foraging activity, and of differential presence at feeders. Rank correlations (Sokal and Rohlf 1969) were made between sex and male age ratios and each weather variable.

RESULTS

A total of 3145 goldfinches were used in the analysis of diurnal age and sex ratios. Both sex and male age ratios varied between years. Sex ratios, in favor of males, ranged from 1.15:1 in 1984/85 (n = 1587) to 2.71:1 in 1983/84 (n = 919) (1.55:1 over all years). The ratios of adult to immature males ranged from 0.27:1 in 1984/85 (n = 830) to 0.50:1 in 1983/84 (n = 671), and was 0.35:1 overall. There were no diurnal differences in sex ratio during any year ($P > 0.05$), but in all years combined, sex ratio imbalance was highest during late morning ($P < 0.025$, Fig. 1). Male age ratios showed significant diurnal departures from expected values during 1984/85 ($G = 27.77$, $P < 0.001$) and 1985/

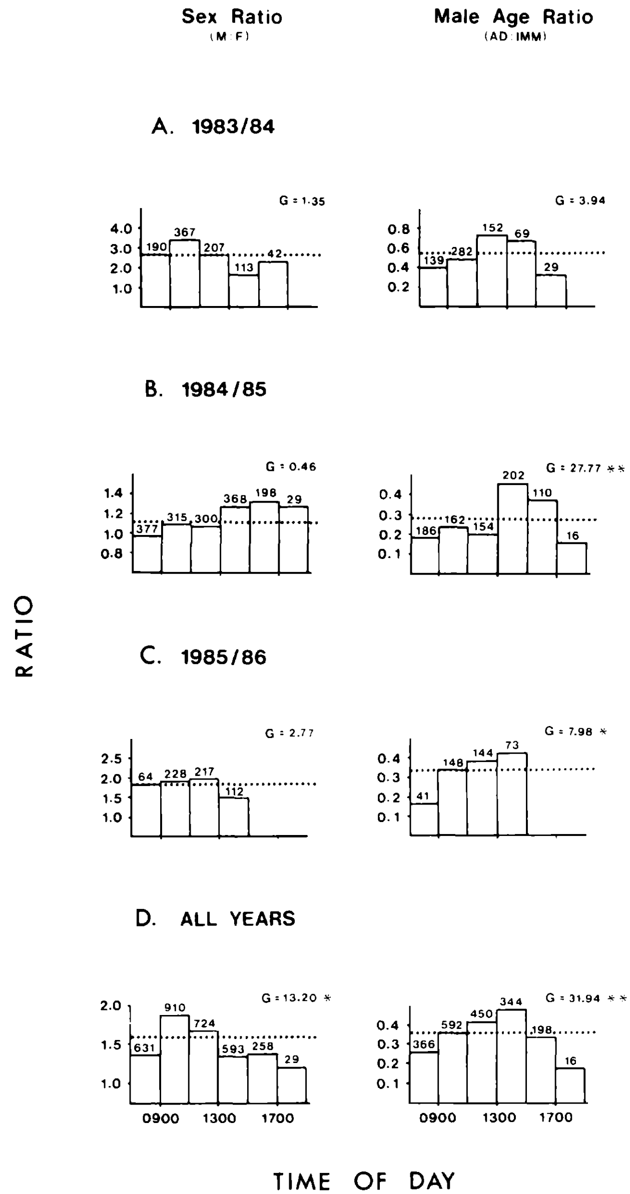

FIGURE 1. Sex and male age ratios of American Goldfinches by time of day. Numbers on bars represent sample sizes, dashed lines are overall ratios. *G*-statistics are tests of departure between observed and expected frequencies of each age and sex class in the population (*$P < 0.05$; **$P < 0.001$).

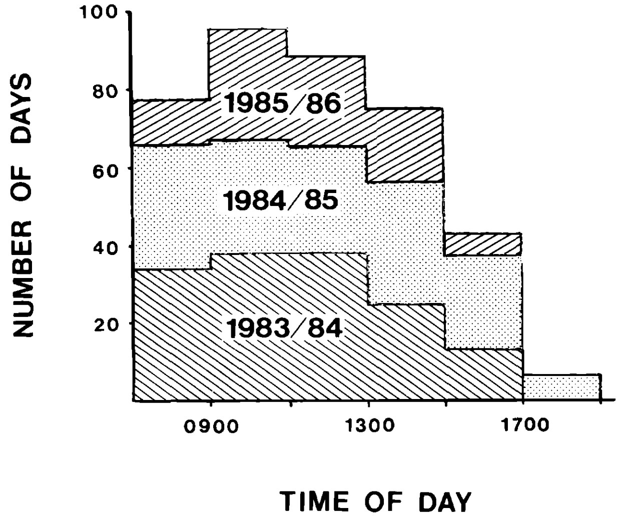

FIGURE 2. December to March trapping effort (see text) for each bihourly time period during three winters.

86 ($G = 7.98$, $P < 0.05$), as well as for all years combined ($P < 0.001$, Fig. 1). In all cases, age ratio imbalance was lowest during the middle hours of the day.

Trapping effort was highest from early morning to mid-afternoon, and declined rapidly after 1500 h (Fig. 2). In all years, the increased adult: immature ratio observed at mid-day and early afternoon resulted from an increased number of adults in the trapped samples, and a slight decline in immatures (Fig. 3C). The total numbers of males was highest in mid- to late morning, and declined through the afternoon. The abundance of females was relatively constant throughout the day, but was low in late afternoon (Fig. 3D). Thus, diurnal variations in sex ratio resulted primarily from differences in the numbers of males trapped.

Within-winter (daily) variations in sex and age ratios were tabulated from captures of 2161 individuals during January and February of 1980, 1984, and 1985. No significant relationships between daily sex ratios and weather variables were found during any of the 3 yr ($P > 0.05$). Male age ratios correlated positively with mean daily temperature in 1984 ($r = 0.422$, $P < 0.02$), but negatively in 1985 ($r = -0.649$, $P < 0.02$). Age ratios increased with daily snowfall in 1985 ($r = 0.618$, $P < 0.03$) and with increasing snow cover in 1980 ($r = 0.422$, $P < 0.05$) and 1985 ($r = 0.857$, $P < 0.0004$).

As a final consideration, the influence of snowy weather on diurnal age and sex ratios was investigated. Here, we considered "snowy" days to be those with ≥ 1 cm daily snowfall combined with ≥ 10 cm of snow

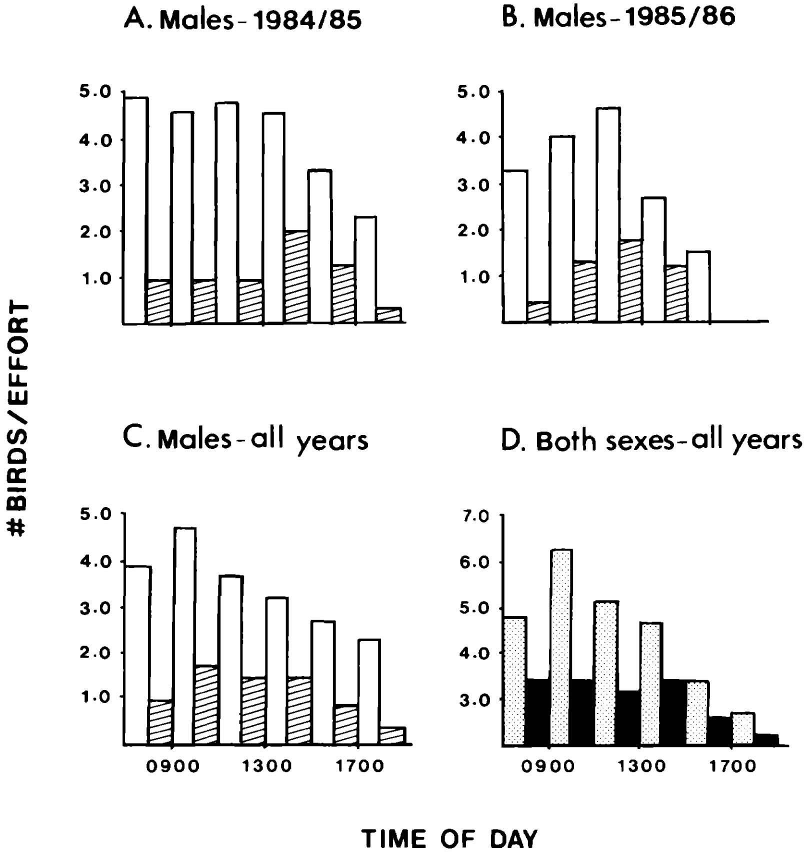

FIGURE 3. Ratios of numbers of birds caught per unit trapping effort. Open bars are immature males, hatched bars are adult males, stippled bars are all males, solid bars are all females.

cover during December to March of 1983–1986. A G-test between the observed frequencies of the sexes on snowy (n = 36 d) and "non-snowy" (n = 128 d) showed no differences ($G = 0.3$, $P > 0.8$), but male age ratios were significantly different ($G = 115.9$, $P < 0.0001$; Fig. 4). On snowy days, age ratios were less imbalanced than on non-snowy days, and by late morning approached unity. Ratios of numbers caught per unit effort suggest that immature birds were less frequently trapped during snowy weather, and that the numbers of adults were comparable under both conditions (Fig. 4). Therefore, the less imbalanced male age ratios on snowy days resulted primarily from a lower number of immature birds in the trapped sample at all times of the day, rather than an increase in adults.

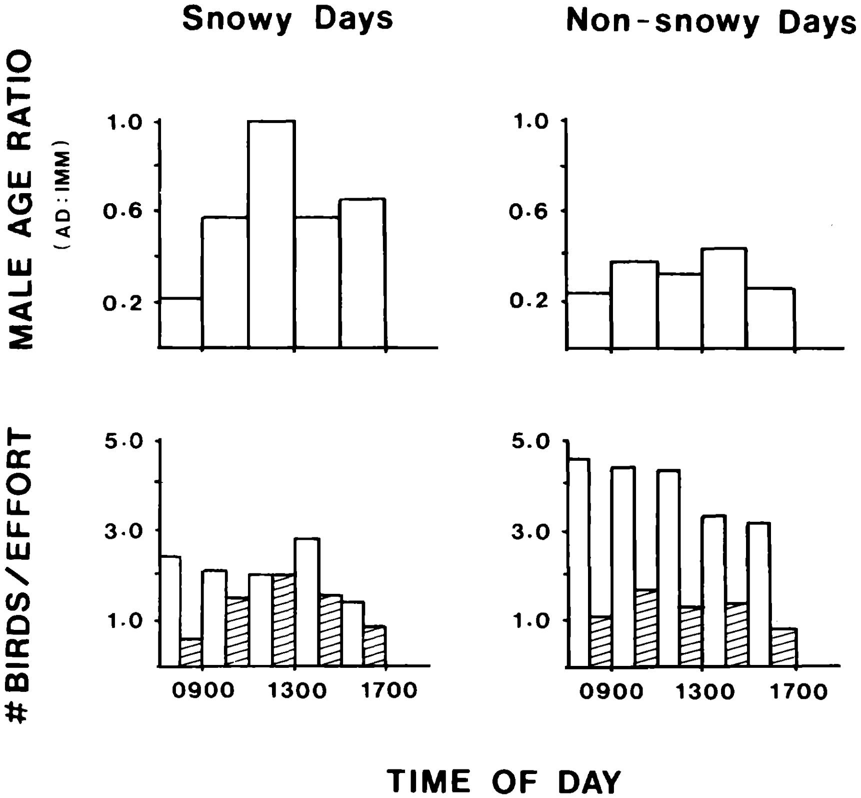

FIGURE 4. Comparison of male age ratios and numbers of birds caught per unit effort throughout the day during "snowy" and "non-snowy" conditions (see text), December to March 1983–1986. Open bars are immature males, hatched bars are adult males.

DISCUSSION

The results show that male age ratios, and to a lesser degree, sex ratios of the trapped sample vary throughout the day and also that age ratios differ from day to day depending on snow conditions. We assume that these differences reflect a differential presence of cohorts at feeders but emphasize that we know nothing of whether the age and sex ratios observed in the trapped samples as a whole differ from those of free-living wintering populations in the study area. Such differences could arise if the ages and sexes differ in their response to traps when feeding (i.e.,"trapability"), or if different cohorts use artificial food sources to differing extents during the winter. Although differential trapability may have influenced our results, we doubt that it is of primary importance. Other studies have shown that the degree of vigilance in foraging birds is inversely related to hunger levels (Krebs 1980, Metcalfe and Furness

1984). If goldfinches are wary (vigilant) towards traps, "trap-shyness" should occur during periods when hunger levels are lowest and foraging conditions most favorable. Yet, adult males were most frequently trapped during the mid-day hours when, presumably, hunger is minimal and foraging favorable. Likewise, young males were less frequently encountered during snowy weather, when natural food supplies would likely be least accessible. We have little information to determine whether the age and sex groups rely on feeding stations to differing extents, but have noted (Middleton 1977) that many more goldfinches are found in suburban areas during the winter than in the surrounding agricultural areas. Thus, most local goldfinches rely on suburban feeders to a large extent during the winter. We therefore expect that the overall sex and age ratios we observed are representative of local population ratios, and that observed variations in these ratios reflect differential presence of age and sex classes at feeders on a temporal basis.

We suspect that goldfinches wintering at Guelph roost in dense stands of White Cedar (*Thuja occidentalis*) along river valleys close to the city, and enter urban areas during the day to feed. The data suggest that immature and female birds generally arrive at feeders earlier in the day than adult males. Assuming that the presence of birds at feeders is related to hunger levels, then immature birds and females may be less capable of withstanding overnight fasting than are adult males. This would imply a body-condition bias in the observed diurnal ratios. A comparison of body weights of goldfinches trapped before 0900 h and after 1100 h (Table 1) shows that individuals of all 3 cohorts were lighter in the early morning ($P < 0.05$), but that the magnitude of difference is greatest in immature males (2.6%), followed by females (2.1%) and adult males (1.3%) (see also Thiel 1980). Consequently, adult male birds may retain more energy reserves following nocturnal fasting than immatures and females, and therefore may not need to feed until later in the day. Body-condition biases have been well documented in waterfowl shot over decoys (Bain 1980, Greenwood et al. 1986, Weatherhead and Ankney 1984). However, the relationship between sex or age and body condition in waterfowl is not well known (but see Whyte and Bolen 1984), nor has a diurnal effect been documented.

If immature goldfinches have less energy reserve than adults, then the abundance of immatures should be at least as high during poor feeding conditons (e.g., snowy days) as during more favorable weather. However, immatures were less abundant on snowy days, whereas the numbers of adult males were similar under both conditions. This might indicate that immature males are less likely to use suburban feeders during snowy weather (i.e., forgo feeding until conditions improve), or that they are excluded from feeding areas by more dominant individuals during such conditions. We have observed that adult male goldfinches dominate young birds during the winter, but the extent to which social dominance can exclude subordinate goldfinches from preferred feeding areas is not known. Fretwell (1969) observed that in Dark-eyed Juncos (*Junco hyemalis*),

TABLE 1. Comparison of body weights (mean ± SD) of goldfinches trapped before 0900 h and after 1100 h from December to March. Sample sizes are in parentheses.

	Time of day			
	<0900 h	>1100 h	*Z*	*P*
Immature males	14.6 ± 0.9 (162)	15.4 ± 0.9 (278)	8.70	<0.0001
Adult males	15.3 ± 1.1 (46)	15.7 ± 1.1 (103)	2.02	0.045
Females	14.2 ± 0.9 (100)	14.8 ± 1.1 (247)	5.44	<0.0001

subordinates (young birds and females, Ketterson 1979) are forced to forage in marginal areas as a result of social dominance. Hepp and Hair (1984) have reported a similar pattern in waterfowl. Ketterson (1978) suggested that the role of dominance in limiting access to resources by subordinates might differ with environmental conditions, but thought that subordinates might be more aggressive toward dominants during stressful conditions. A dominance effect might also be related to time of day. In general, the number of juvenile males trapped declined after mid-day, when the numbers of adults was increasing. Young birds, with their smaller energy reserves might be expected to use feeders throughout the day if possible, but may be prevented from doing so by the arrival of adults. However, we cannot refute the possibility that young birds replenish energy reserves by early afternoon, and need not feed as intensively later in the day. Morton (1967) has shown that individual White-crowned Sparrows (*Zonotrichia leucophrys gambelii*) terminate feeding when body weight reaches a maximum level.

Other studies of feeder-trapped goldfinches have reported that trapping was most intensive during the morning (Thiel 1980, Wiseman 1975), and our experiences with other banders suggest that this might be true of many small winter banding operations. We also suspect that trapping effort tends to be lower during inclement weather. Accordingly, cohorts most abundant at feeders during the morning, or during fair weather, might be disproportionately represented in trapped samples. In the present study, trapping effort was highest during the middle hours of the day, when adult males, and males in general were most abundant. Thus, the observed overall ratios of 1.55:1 (sex) and 0.35:1 (male age) may be slightly inflated. However, traps were operated regardless of weather conditions (except for heavy rain), and we suspect that the observed ratios are representative of the local wintering population.

It is not known whether the patterns of variation observed in goldfinch age and sex ratios can be extrapolated to other populations of wintering finches. However, the results emphasize that studies of population structure, based on trapping data, require large sample sizes obtained over a wide variety of times and under various environmental conditions.

ACKNOWLEDGMENTS

We thank D. Brewer, M. Wernaart, and B. Wyatt for contributing their goldfinch banding data to this study, and L. Beattie for constructing the figures. G. Barnes, L. Beattie, M. H.

Balph, and an anonymous reviewer provided valuable comments on previous versions of the manuscript. The study was supported by a Natural Sciences and Engineering Research Council grant (#A6495) to A.L.A.M.

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Received 11 May 1988; accepted 28 Nov. 1988.