AGE AND SEX COMPOSITION OF WESTERN SANDPIPERS ON BOLINAS LAGOON

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INTRODUCTION

There is limited information on the age and sex composition of shorebirds (Charadrii) at migratory stopover points between the breeding and wintering grounds (Jehl, 1963; Mascher, 1966; Page and Bradstreet, 1968) and on the wintering grounds (Holmes, 1966). There are few comparable data for the Western Sandpiper *(Calidris mauri)*. We have been collecting data on the age and sex composition of this species at different times of the year on Bolinas Lagoon, Marin County, California. Our data show that adult and immature birds migrate at different times in the fall and that males and females migrate at different times in the spring. Further, we found that male and female Western Sandpipers have somewhat different wintering areas; to our knowledge, this is the only sandpiper for which such evidence currently exists.

The Western Sandpiper breeds chiefly in Alaska and winters from California and the southern United States to Venezuela and Peru. Details of the distribution can be found in Bent, 1927; Palmer, 1967; and Holmes, 1971.

METHODS

The major part of the study was conducted on Bolinas Lagoon, a 570-hectare estuary, 24 kilometers northwest of San Francisco, California. We made 71 censuses of Western Sandpipers on Bolinas Lagoon between 1 June 1971 and 31 May 1972 and trapped many of the sandpipers in 1971 and 1972. Birds were considered adults if they lacked buffy edges on all their upper wing coverts and tertials and immatures (less than one year of age) if they had buffy edges on at least some of these feathers. Some immatures may lose all their buffy-edged feathers in the spring molt; consequently, after late March we did not age birds. The sex of the birds was determined from their bill lengths using the methods described by Page and Fearis (1971). Birds were considered males if their bill lengths were $\leqslant$ 24.2 mm and females if their bills were $\geqslant$ 24.8 mm. To compare the

results from Bolinas Lagoon with other locations we examined the age and sex composition of birds trapped at Limantour Estero, 11 kilometers northwest of Bolinas Lagoon, and examined museum skins of Western Sandpipers from North America, South America, and the West Indies. A few specimens were not included in the study because the length of the birds' bills indicated a different sex than the specimen label. The sex composition of Western Sandpipers in other areas of California was also determined from bill measurements of birds trapped by one of the authors or other persons listed in the acknowledgements. In these samples bills were measured only to the nearest 0.5 mm and birds with bills $\leqslant$ 23.5 mm were considered males and $\geqslant$ 25.5 mm females. To test if the sex ratios of the sandpipers from different locations varied from an expected ratio of 1:1, we used the Chi-square test. Birds of unknown sex were not included in the calculations of the sex composition.

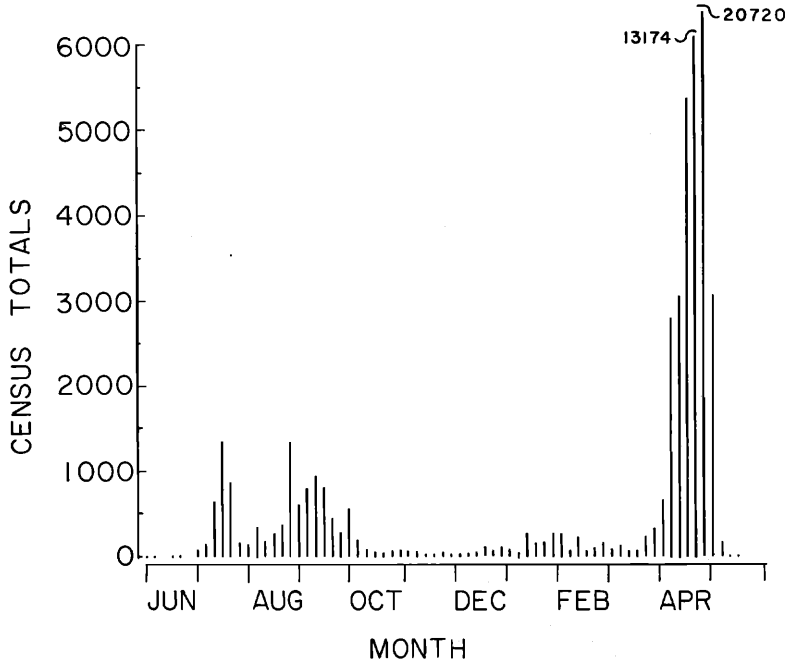

Figure 1. Number of Western Sandpipers on Bolinas Lagoon, California, June 1971 to May 1972.

NUMBER, AGE, AND SEX OF WESTERN SANDPIPERS ON BOLINAS LAGOON

The number, age composition, and sex composition of Western Sandpipers on Bolinas Lagoon varied during the study. The largest numbers of Western Sandpipers occurred in the spring and fall migrations and only small numbers of birds occurred during the winter (Figure 1). In July a peak in numbers (Figure 1) marked the fall passage of adults through the area and in late August and September another peak marked the passage of immatures. This agrees with Holmes' (1972) observation that adults leave the breeding grounds by the end of July while immatures stay into August. Female Western Sandpipers were as abundant as males during the peak periods of both passages but by the end of the adult passage in late July and early August adult males outnumbered adult females by 8:1 and by the end of the immature passage in late September and early October immature males outnumbered immature females by 8:1 (Figure 2). On spring migration Western Sandpipers occurred on Bolinas Lagoon in numbers which greatly exceeded the number at other times of the year (Figure 1).

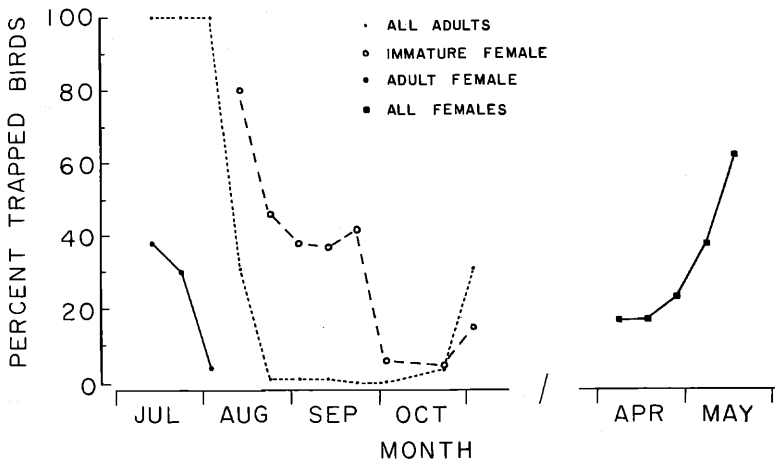

Figure 2. Age and sex composition of Western Sandpipers on Bolinas Lagoon, California in the autumn 1971, with spring sex composition data for 1971 and 1972 combined. Sex composition shown is for known-sex birds only. Sex compositions of adults and immatures are calculated separately. Sample is 1200 birds; minimum sample for any point is 11 birds.

During most of this spring passage males outnumbered females (Figure 2) but by late April and May, when the number of spring migrants on Bolinas Lagoon was declining, the female to male ratio increased (Figure 2). It was evident that males migrated before the females in the spring. In the winter, early October 1971 to late March 1972, the number of Western Sandpipers on Bolinas Lagoon fluctuated between 13 and 286 birds. From early October to mid-January there was an average of 55 (range 13 to 107 birds on the estuary and from mid-January until late March an average of 155 (range 77 to 286) birds. A few Western Sandpipers, marked between July and September, remained throughout the winter. Others marked after September were found at Limantour Estero before late March indicating some local movement of birds prior to migration. Between early October and late March we captured 64 birds of which 80% were immatures. Of the immatures, 86% were males; of the adults, 92% were males. It was apparent that male Western Sandpipers outnumbered females on Bolinas Lagoon in the winter of 1971-72.

SEX COMPOSITION OF WESTERN SANDPIPERS WINTERING IN CALIFORNIA

In most areas from which we obtained data on the sex of wintering Western Sandpipers in California males outnumbered the females by at least 2:1. Limantour Estero in contrast to Bolinas Lagoon has large numbers of wintering Western Sandpipers and in 1972-73 there were about 2000 Western Sandpipers at Limantour. We trapped 75 birds there in January and February 1973, of which 76% were adults. Males made up 89% of the adults and 94% of the immatures. At two locations on San Francisco Bay Western Sandpipers banded by Jurek during the winters of 1970-71 and 1971-72 were 90% males (Table 1). Farther south, at Anaheim Bay near Los Angeles, males made up 75% of the birds Jurek trapped during the winter of 1970-71, and at San Diego males made up 78% of those banded by Craig in 1969-70 (Table 1). In northern California, at Humboldt Bay, Gerstenberg (1972, Table 6) found that 78% of the adults and 67% of the immatures he trapped between October and March were males. Adults composed 61% of the 400 birds he caught. Gerstenberg's (1972) data are not strictly comparable with the data from the other locations we studied because the bill measurements he used to separate the sexes were different enough from our measure-

Table 1. Sex composition of Western Sandpipers at different locations. Birds of unknown sex were not included in the calculations of the percentages or in the sample sizes shown below.

Location	Inclusive Dates Banded	Percent Male	Percent Female	Sample size	Unknown sex
Bolinas Lagoon (38°N)	3 Oct. 1971-21 Mar. 1972	85.9	14.1	64	0
Limantour Estero (38°N)	24 Jan., 7 Feb., 1973	90.7	9.3	75	0
Oliver Brothers Salt Co. (San Francisco Bay) (37°N)	28-29 Oct. 1970 1 Jan. 1971	93.5	6.5	31	7
Palo Alto (37°N) (San Francisco Bay)	9-10 Nov., 8-10 Dec., 1971	89.6	10.4	69	6
Anaheim Bay (34°N)	18 Oct., 27-30 Nov., 1970 26-28 Feb. 1971	74.6	25.4	71	17
San Diego (33°N)	8 Oct. 1969-20 Mar. 1970	78.3	21.7	230	20
	Collected				
California Baja California	9 Oct.-20 Mar., 1882-1969	72.5	27.5	69	0
South Carolina Georgia Florida	26 Oct.-15 Mar., 1890-1959	65.5	34.5	29	0
South America West Indies	22 Jan.-1 Dec., 1893-1963	36.8	63.2	38	0

ments to change the sex ratios we calculated from our data.

In 69 study skins of Western Sandpipers collected from 9 October to 20 March, 1882 to 1969, from California and Baja California, 72% were males. Of the 21 study skins of adult birds 57% were males; and of the 48 study skins of immature birds 79% were males. Consequently, in the populations of wintering Western Sandpipers from California we examined, males outnumbered females. The degree to which males outnumbered females was significantly different ($P < 0.01$) from a 1:1 sex ratio and ranged from 3 males per female at Anaheim Bay to 14 males per female at one location on San Francisco Bay.

EVIDENCE THAT FEMALE WESTERN SANDPIPERS WINTER FARTHER SOUTH THAN MALES

From museum specimens of Western Sandpipers collected outside California there is some evidence that female birds winter farther south than the males. In 29 Western Sandpipers collected between 26 October and 15 March, 1890 to 1959, in South Carolina, Georgia, and Florida, males made up 65.5% of the specimens (Table 1). In the 17 specimens of adult Western Sandpipers 59% were males; in 12 immatures 75% were males. Although these samples are small they suggest that males also outnumber females in the winter populations of Western Sandpipers in the southeastern United States.

In 38 Western Sandpipers collected in the West Indies and South America at all times of the year between 1893 and 1963, only 37% of the birds were males (Table 1). In 24 winter specimens (19 October to 24 February) 5 of 15 adult birds were males and 3 of 9 immature birds were males. These are the only data we obtained on the populations of Western Sandpipers wintering south of the mainland United States. They suggest for this species that females outnumber males at the southern extremity of the wintering range. More data are obviously needed before a firm conclusion can be drawn on the status of males and females in the southern part of the Western Sandpipers' wintering range.

DISCUSSION

It is possible that in the species males outnumber females. Holmes (1971) studied Western Sandpipers on the Alaskan breeding grounds but gave no information to suggest an unequal sex ratio in breeding

birds. We examined 101 adult Western Sandpiper specimens collected in Alaska between 10 April and 26 July, 1896 to 1967; 64.4% were males, a ratio that differs significantly ($P < 0.01$) from the expected 1:1 sex ratio. Holmes (1971, 1972) found that male Western Sandpipers arrived on the breeding grounds slightly before the females and the males remained with the brood longer than their mates. These differences between the sexes of the Western Sandpiper plus the fact that the males take the lead in courtship and are always more likely to be shot than the inconspicuous females increase the likelihood of males being collected on the breeding grounds. In fact 5 of 7 Western Sandpipers collected in Alaska in April and 16 of 20 birds collected in July were males. From May and June only 59% of 67 birds from Alaska were males. This does not differ significantly ($P > 0.05$) from the 1:1 sex ratio expected in breeding populations of Western Sandpipers.

The use of study skins to determine the sex ratio of breeding or migrating birds is unsatisfactory, since many factors involved in the collecting of the specimens were unknown to us. Consequently, further studies of the age and sex composition of Western Sandpipers at other locations on the wintering grounds and on the breeding grounds are necessary to supplement this study.

SUMMARY

Banding studies and censuses indicate that the Western Sandpiper is primarily a migrant at Bolinas Lagoon. In autumn adult Western Sandpipers reach this estuary a month prior to the immature birds, and in spring males on their way to Alaska pass through Bolinas Lagoon prior to most females. In spring and winter males outnumber females. Banding studies and data from museum specimens suggest that a large proportion of adult and immature male Western Sandpipers remain in North America during the winter, whereas a large proportion of the females move farther south.

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