# CHRONOLOGY OF SHOREBIRD MIGRATION AT LAST MOUNTAIN NATIONAL WILDLIFE AREA, SASKATCHEWAN, CANADA

by Mark A. Colwell, Suzanne D. Fellows and Lewis W. Oring

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Migratory patterns of Nearctic shorebird species are most extensively documented in coastal regions. Relatively little quantitative data are available for wetlands of the continental interior, despite their importance for many species. Shorebird migration in south central Saskatchewan, Canada was documented at three wetlands during 1984, a drought year in which migrating and breeding waders were concentrated and easily observed. Overall, 29 species of waders were observed during the sampling period, 30 April - 30 August. Most northbound species (n=27) exhibited migration peaks that spanned approximately two weeks in mid to late May. Southbound migration peaks for 26 species were more protracted, occurring in several pulses for many species. Within sites, relative abundances of species varied seasonally as a result of changes in habitat availability, species-specific migratory routes, age and sex differences in migration, and variations in length of stay.

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## INTRODUCTION

Recent studies of shorebird migration patterns have added greatly to an understanding of the distribution and seasonal abundance of many North American species, particularly in marine habitats (see Pitelka 1979, Burger and Olla 1984, Morrison and Myers 1987). However, information on seasonal numbers of migrant shorebirds using wetlands in interior North America is especially difficult to come by (Morrison and Myers 1987). A geographical bias favoring coastal regions may stem from several factors, including 1) the concentration of large numbers of birds at a limited number of staging areas (Myers *et al.* 1987, Morrison and Myers 1987), 2) the importance of these sites owing to the potential impact on populations from human activities (Evans *et al.* 1979, Myers *et al.* 1987, Davidson and Pienkowski 1987), and 3) the geographical distribution of observers that undertake surveys. A large number of Nearctic shorebird species, however, use interior North American wetlands during some portion of their annual cycle (Morrison and Myers 1987).

Three principal migration corridors are used by Nearctic-breeding shorebirds; they are 1) Atlantic seaboard, 2) Pacific coastal region, and 3) central plains and mountainous regions (Morrison 1984, Morrison and Myers 1987). Among these three regions, a paucity of data exists concerning wader staging areas in central regions, especially in the Canadian prairies (Morrison and Myers 1987). Published accounts are generally qualitative, at best dealing with rank seasonal abundance of species at a given site (Oring and Davis 1966, Oring and Maxson 1984, Colwell in press), but more frequently reporting unusual flock size and composition for a species (McNicholl 1969, Hohn 1981), or notes of first spring and last fall sightings of species (Johnson *et al.* 1972, Springer *et al.* 1972, Loekemoen and Johnson 1975). Few studies have portrayed detailed changes in species numbers throughout migration periods. This paper summarizes migration chronology and relative abundances of 29 shorebird species that frequent Last Mountain Lake National Wildlife Area in southcentral Saskatchewan, Canada (51°, 10'N; 110° 2'W; Figure 1).

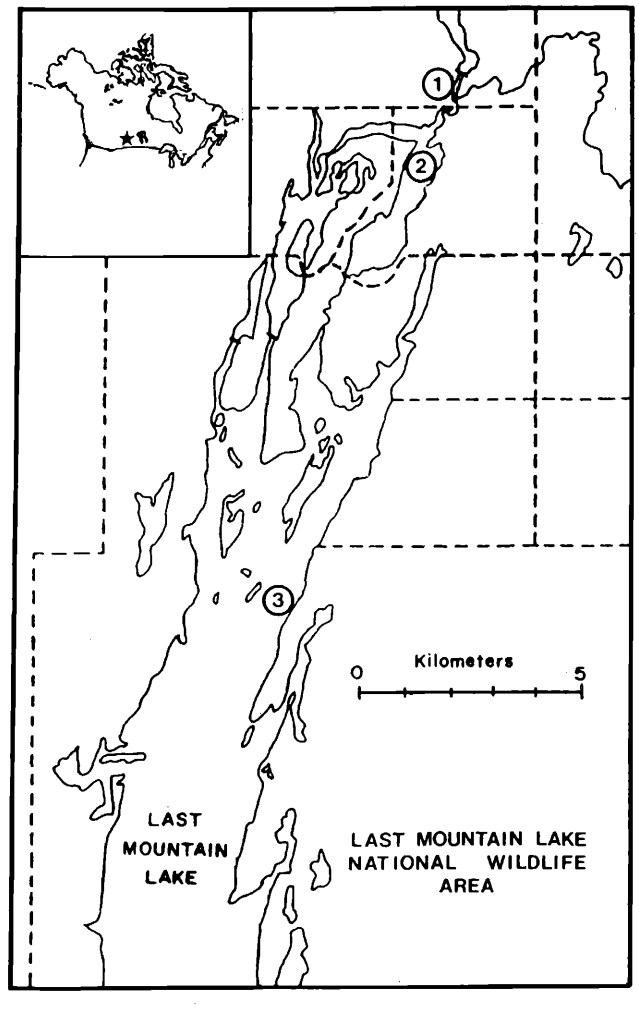


Figure 1. Location of study sites at Last Mountain Lake National Wildlife Area, Saskatchewan, Canada. Censuses were conducted at 1) Lanigan Creek, 2) Basin A, and 3) Perry's Beach.

## STUDY SITES AND METHODS

Shorebirds were censussed at three wetlands (see below) during 1984, a year in which extreme drought conditions prevailed in the area. As a result, approximately 90% of local wetlands were dry, forcing waders to use a limited number of permanent wetlands. The three sites were chosen for study because they represented a cross-section of habitat that was used by nearly all shorebirds known to occur in the area (Colwell in press, unpubl. data).

Site 1. During 1984, Lanigan Creek was one of the few remaining wetlands with sufficient water to support breeding shorebirds (Colwell 1986). Observers collected data from 30 April to 30 August on Lanigan Creek's 100 ha area, which included heavily grazed pasture and a permanent wetland bisected by a deep-water creek. Approximately 40 cattle grazed the area from early summer to autumn. On the northern half of the site, a dam formed a large, deep-water impoundment bordered by stands of bulrush (*Scirpus* spp.), flooded meadow (*Hordeum jubatum, Triglochin maritima, Juncus* spp., *Carex* spp., *Scirpus* spp.), and mudflats. Below the dam, salt-tolerant forbs (*Plantago eriopoda, Salicornia rubra, Glaux maritima*) and grasses (*Distichilis stricta*) occurred in low-lying areas. During late spring, foxtail barley and sedges became prominent in wet meadow habitat. In upland areas, over-grazed grasses (*Poa* spp.) and forbs (*Anemone canadensis, Achillea millefolium*) separated numerous patches of buckbrush (*Symphoricarpos occidentalis*) and rose (*Rosa acicularis*).

Site 2. Basin A, situated 1.5 km south of Lanigan Creek, was a large man-made impoundment with extensive areas of shallow water and unvegetated mudflats under varying moisture conditions. Late in summer, mats of *Salicornia rubra* covered dried mudflats. Shorebirds were censused at Basin A from 8 May to 28 August. Although large numbers of shorebirds used Basin A, censuses were restricted to approximately 10 ha of the basin to facilitate collection of data on habitat use by shorebirds (Colwell unpubl. data).

Site 3. Shorebirds were censused from 3 May to 20 August at Perry's Beach, a 1.5 km stretch of sandy and rocky beach on the east shore of Last Mountain Lake. Perry's Beach varied in width from 5 to 30 m and was largely unvegetated: lake water levels changed little during the study.

At Lanigan Creek and Basin A, scan samples (Altmann 1974) were conducted by one to three observers from 3 m high observation towers. One observer surveyed Perry's Beach while walking the lakeshore and recorded data from points that provided the best visibility. Observers censused birds using 20-25X spotting scopes and 7X35 binoculars. A stratified random sampling design was used to schedule censuses at Lanigan Creek; counts were conducted during random sampling periods that included all daylight hours of a week (0500-2100 hrs). Most Basin A censuses were paired with the Lanigan Creek surveys, while Perry's Beach was sampled opportunistically, and most often in the summer.

## RESULTS AND DISCUSSION

Twenty-nine wader species were observed during the study, including nine that bred locally (Table 1). Total counts for spring and summer migratory periods (see below) numbered 27 and 26 species, respectively. Ruddy Turnstone *Arenaria interpres* and Dunlin *Calidris alpina* were observed only during spring counts, whereas Solitary Sandpiper *Tringa solitaria* occurred only during the summer. Additional species that were not observed during censuses but have been recorded in the area include: Whimbrel *Numenius phaeopus*, Long-billed Curlew *N. americanus*, Buff-breasted Sandpiper *Tryngites subruficollis*, Purple Sandpiper *C. maritima*, and Red Phalarope *Phalaropus fulicaria* (B. Dale pers. comm., M.A. Colwell unpubl. data).

The three study sites were similar in the total number of species observed, but differed widely in species composition. Overall, the similarity of species assemblages was greatest between Lanigan Creek and Basin A; Perry's Beach shared fewer species with the former sites (Colwell in press).

Species assemblages also changed seasonally within sites. Of 23 species observed at Lanigan Creek, 23 and 21 were present during spring and summer respectively. Spring and summer shorebird assemblages shared 78% of their species, owing to the summer absence of Black-bellied Plover *Pluvialis squatarola*, Lesser Golden Plover *P. dominica*, and Red Knot *C. canutus*, and the spring absence of Semipalmated Plover *Charadrius semipalmatus*. Of 25 species recorded at Basin A, 23 were observed during spring and summer. The seasonal similarity in species composition was 80%, stemming from the absence of Piping Plover *C. melodus* during summer and Solitary Sandpiper and Upland Sandpiper *Bartramia longicauda* in the spring. Of 23 species tallied at Perry's Beach, 18 and 23 taxa were observed during spring and summer respectively. Seasonal assemblages were 39% similar; the lack of Black-bellied Plover, Piping Plover, Solitary Sandpiper, Spotted Sandpiper *Actitis macularia*, Stilt Sandpiper *C. himantopus*, and Dowitchers *Limnodromus* spp. in spring, and Ruddy Turnstones in summer accounted for the dissimilar assemblages.

Migration patterns for the species assemblage (Table 1) differed between north and southbound migration periods. Spring migration was relatively synchronized, with migration peaks of most species usually spanning about two or three weeks from mid to late May. The largest species counts for the area (three study sites combined: n=20) occurred between 21 and 27 May, including seven species that bred locally. More protracted spring migration periods were observed for several calidridine sandpipers. Low numbers of birds between 4 and 17 June indicated the hiatus between north and southbound migration periods. Southbound migration patterns were typified by the passage of larger numbers of birds over longer periods. The largest species counts for the area (range: 19-22 species) occurred during July.

Seasonal differences in the relative abundance of migrants at a site may be influenced by several factors operating alone or simultaneously. First, seasonal changes in the availability of a species' preferred habitat and underlying food resources may make a site more attractive at different periods. During the period of study, drought conditions became progressively worse, with especially dramatic effects on ephemeral wetland habitat at Lanigan Creek and Basin A. At both sites, wetland desiccation exposed increasingly large areas of mudflat under varying moisture conditions. We suspect that seasonal differences in species composition and relative changes in species

Table 1. Chronology of shorebird migration at Last Mountain Lake National Wildlife Area. For each species, the three sub-entries within a column denote data for Ianigan Creek, Basin A, and Perry's Beach respectively (see text). Data are presented as the average number of birds seen (largest single census observation). Species that bred locally are identified by an asterisk.

| Species | Week | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 April - 6 May | 7-13 May | 14-20 May | 21-27 May | 28 May-3 June | 4-10 June | 11-17 June | 18-24 June | 25 June-1 July | 2-8 July | 9-15 July | 16-22 July | 23-29 July | 30 July - 5 Aug | 6-12 Aug | 13-19 Aug | 20-26 Aug | 27-28 Aug |
| Pluvialis squatarola | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 6 (6) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 0 (0) |
| | 0 (0) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 1 (1) | 1 (1) | 0 (0) | 4 (4) | 1 (1) |
| Pluvialis dominica | 0 (0) | 0 (0) | 5 (5) | 8 (8) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 15(15) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 1 (1) | —— | —— | —— | —— | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Charadrius semipalmatus | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 10(14) | 1 (1) | 0 (0) | 0 (0) | 1 (1) | 0 (0) |
| | —— | 5 (5) | 5 (5) | 1 (2) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 25(45) | 27(45) | 27(37) | 0 (0) | 0 (0) | 0 (0) | 49(71) | —— |
| | 6 (6) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 11(11) | 8(11) | 6 (6) | 1 (1) | 0 (0) | 3 (6) | 6 (6) |
| Charadrius melodus* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 1 (1) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Charadrius vociferus* | 3 (6) | 3 (6) | 2 (4) | 2 (7) | 3 (9) | 4 (8) | 4(10) | 5(10) | 4(10) | 4 (7) | 5(12) | 6 (9) | 6 (9) | 7(14) | 7(16) | 3 (5) | 4 (6) | 3 (6) |
| | —— | 2 (3) | 1 (1) | 2 (2) | 1 (1) | 3 (4) | 5(10) | 7(11) | 4 (5) | 5 (6) | 4 (6) | 3 (3) | 1 (1) | 6 (9) | 1 (1) | 3 (3) | 0 (0) | —— |
| | 5 (7) | 0 (0) | —— | —— | 2 (2) | —— | —— | —— | —— | 5 (6) | 4 (5) | 5 (7) | 9(13) | 8 (8) | 7 (8) | 31(33) | 6 (9) | 8 (8) |
| Recurvirostra americana* | 3 (6) | 3 (7) | 4(12) | 4 (9) | 6 (9) | 6 (9) | 2 (3) | 1 (2) | 2 (3) | 1 (1) | 1 (2) | 0 (0) | 0 (0) | 1 (2) | 1 (1) | 3(12) | 3 (9) | 6(10) |
| | —— | 19(27) | 32(54) | 5 (8) | 8(13) | 13(21) | 24(43) | 19(33) | 6 (8) | 9(15) | 2 (3) | 6(10) | 6 (8) | 10(12) | 1 (1) | 1 (1) | 1 (1) | —— |
| | 2 (2) | 1 (1) | —— | —— | 1 (1) | —— | —— | —— | —— | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Tringa melanoleuca | 6 (6) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 3 (3) | 1 (2) | 3 (5) | 1 (3) | 1 (2) | 3 (5) | 3 (7) | 1 (2) | 2 (4) | 5(10) | 3 (6) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (3) | 0 (0) | 0 (0) | 0 (0) | 1 (2) | 2 (3) | 3 (4) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 22(22) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 3 (3) | 5 (9) | 2 (2) | 3 (6) | 1 (1) | 0 (0) | 0 (0) | 10(21) | 3 (3) |
| Tringa flavipes | 3 (3) | 3 (7) | 2 (3) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 1 (2) | 2 (3) | 5(20) | 6(23) | 18(49) | 16(35) | 48(62) | 27(45) | 20(61) | 16(45) | 5 (9) |
| | —— | 3(10) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 29(64) | 63(106) | 104(108) | 41(67) | 27(31) | 72(127) | 80(108) | 39(39) | 17(23) | 5 (8) | —— |
| | 12(12) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 13(16) | 28(43) | 37(41) | 20(43) | 52(52) | 10(13) | 12(15) | 14(27) | 15(15) |
| Tringa solitaria | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) |
| Actitis macularia* | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 1 (2) | 1 (3) | 2 (2) | 1 (2) | 0 (0) | 1 (1) | 1 (2) | 2 (2) | 0 (0) | 1 (1) | 1 (1) | 2 (3) | 1 (2) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 2 (2) | 1 (2) | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 3 (5) | 0 (0) | 1 (1) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 2 (2) | 2 (2) | 4 (6) | 12(12) | 3 (4) | 1 (1) | 2 (2) | 0 (0) |
| Catoptrophorus semipalmatus* | 5(10) | 4(10) | 3 (5) | 3 (5) | 4 (5) | 3 (5) | 3 (5) | 3 (5) | 3 (5) | 6(36) | 1 (2) | 4 (9) | 3 (8) | 3 (3) | 1 (1) | 1 (1) | 0 (0) | 0 (0) |
| | —— | 2 (4) | 2 (2) | 2 (2) | 1 (1) | 4 (7) | 4 (7) | 5 (7) | 1 (2) | 1 (2) | 2 (2) | 2 (2) | 2 (2) | 4 (5) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 3 (4) | 1 (1) | —— | —— | 2 (3) | —— | —— | —— | —— | 15(18) | 10(15) | 12(14) | 4 (6) | 10(10) | 5 (7) | 3 (4) | 2 (4) | 1 (1) |
| Bartramia longicauda* | 0 (0) | 1 (1) | 2 (3) | 2 (4) | 1 (2) | 2 (4) | 1 (2) | 2 (2) | 2 (4) | 2 (5) | 3 (5) | 3 (7) | 4 (6) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Limosa haemastica | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 9(25) | 0 (0) | 9(17) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 1 (1) |
| | —— | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 3 (3) | 2 (2) | 4 (4) | 9(17) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 2 (2) | —— | —— | —— | —— | 105(209) | 28(28) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 5 (8) | 0 (0) |
| Limosa fedoa* | 5(13) | 5 (9) | 2 (4) | 2 (4) | 3 (6) | 4(10) | 3 (7) | 3 (6) | 5(31) | 3 (6) | 2 (4) | 2 (2) | 2 (5) | 5(13) | 2 (3) | 5(11) | 4 (7) | 1 (1) |
| | —— | 16(28) | 2 (2) | 2 (3) | 2 (2) | 2 (2) | 3 (3) | 9 (9) | 2 (3) | 45(88) | 3 (3) | 5 (5) | 4 (4) | 4 (5) | 1 (1) | 4 (4) | 0 (0) | —— |
| | 2 (2) | 2 (2) | —— | —— | 4 (6) | —— | —— | —— | —— | 61(120) | 118(136) | 7 (9) | 5 (8) | 0 (0) | 3 (5) | 5 (5) | 3 (5) | 4 (4) |
| Arenaria interpres | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 4 (4) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Calidris canutus | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | —— | —— | 52(82) | —— | —— | —— | —— | 0 (0) | 0 (0) | 16(16) | 8 (8) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Calidris alba | 0 (0) | 0 (0) | 0 (0) | 5 (5) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 0 (0) | 5 (8) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 66(66) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 61(67) | 0 (0) | 5 (5) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 87(87) | 0 (0) |
| Calidris pusilla | 1 (1) | 0 (0) | 0 (0) | 3 (4) | 12(27) | 6(11) | 3 (3) | 0 (0) | 1 (1) | 2 (2) | 15(18) | 0 (0) | 6(10) | 4 (6) | 3 (4) | 2 (2) | 47(95) | 29(60) |
| | —— | 76(151) | 0 (0) | 27(97) | 15(26) | 92(165) | 114(220) | 7 (9) | 5 (6) | 19(29) | 65(65) | 160(202) | 94(159) | 120(173) | 0 (0) | 0 (0) | 585(904) | —— |
| | 1 (1) | 0 (0) | —— | —— | 2 (0) | —— | —— | —— | —— | 0 (0) | 0 (0) | 7 (7) | 2 (2) | 9 (9) | 5 (5) | 6(11) | 6 (6) | 0 (0) |
| Calidris minutilla | 1 (1) | 0 (0) | 7(12) | 5(11) | 1 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 3 (3) | 2 (2) | 1 (1) | 2 (2) | 5(10) | 0 (0) | 7(19) | 2 (2) |
| | —— | 17(49) | 39(70) | 81(245) | 53(62) | 76(76) | 0 (0) | 1 (1) | 0 (0) | 50(76) | 45(45) | 18(35) | 3 (7) | 3 (3) | 0 (0) | 0 (0) | 50(73) | —— |
| | 2 (2) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 8(15) | 4 (4) | 2 (2) | 2 (2) | 4 (4) | 0 (0) | 0 (0) | 6 (6) | 0 (0) |
| Calidris fuscicollis | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 3 (6) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 4 (4) | 0 (0) | 0 (0) |
| | —— | 0 (0) | 0 (0) | 11(20) | 15(26) | 13(38) | 12(18) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | —— |
| | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Calidris bairdii | 0 (0) | 0 (0) | 0 (0) | 1 (2) | 4 (5) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 10(25) | 1 (1) | 1 (2) | 0 (0) | 2 (2) | 0 (0) | 5(10) | 1 (1) |
| | —— | 0 (0) | 0 (0) | 38(70) | 23(23) | 5 (5) | 5 (6) | 2 (3) | 0 (0) | 1 (1) | 5 (5) | 7(17) | 25(27) | 0 (0) | 0 (0) | 0 (0) | 6(14) | —— |
| | 13(13) | 0 (0) | —— | —— | 0 (0) | —— | —— | —— | —— | 4 (4) | 9(15) | 35(35) | 8(13) | 0 (0) | 2 (2) | 0 (0) | 3 (4) | 8 (8) |

**Table 1 (continued)**

| Species | Week: 30 April - 6 May | 7-13 May | 14-20 May | 21-27 May | 28 May-3 June | 4-10 June | 11-17 June | 18-24 June | 25 June-1 July | 2-8 July | 9-15 July | 16-22 July | 23-29 July | 30 July - 5 Aug | 6-12 Aug | 13-19 Aug | 20-26 Aug | 27-28 Aug |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unidentified peeps[a] | 0 (0) | 0 (0) | 5 (8) | 8(20) | 8(15) | 4 (5) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 0 (0) | 8 (8) | 34(34) | 0 (0) | 38(38) | 95(101) | 60(60) | 0 (0) |
| | — | 0 (0) | 0 (0) | 55(55) | 10(10) | 132(240) | 5 (5) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 130(130) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Large unidentified peeps[b] | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 12(12) | 1 (1) | 3 (3) | 4 (5) | 12(24) | 1 (1) | 0 (0) |
| | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 152(152) | 0 (0) | 0 (0) | 14(14) | 0 (0) | 166(318) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 18(18) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Small unidentified peeps[c] | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 5 (5) | 0 (0) | 5(11) | 5(10) | 9(15) | 35(103) | 67(110) | 0 (0) |
| | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 11(16) | 117(117) | 0 (0) | 0 (0) | 41(41) | 31(31) | 246(517) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 9 (9) | 0 (0) | 0 (0) |
| Calidris melanotos | 0 (0) | 0 (0) | 2 (3) | 3 (7) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 1 (1) | 1 (1) | 5 (9) | 3 (6) | 1 (2) | 1 (2) | 1 (2) | 1 (1) |
| | — | 7 (9) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1) | 2 (2) | 3 (6) | 0 (0) | 1 (1) | 11(11) | 2 (2) | 0 (0) | 1 (1) | 5 (5) | — |
| | 3 (3) | 0 (0) | — | — | 0 (0) | — | — | — | — | 1 (1) | 1 (1) | 6 (6) | 4 (8) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Calidris alpina | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | — | 2 (2) | 3 (3) | 4 (5) | 13(13) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Calidris himantopus | 0 (0) | 0 (0) | 28(116) | 25(202) | 4 (8) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 13(20) | 45(45) | 4 (8) | 1 (1) | 9 (9) | 18(23) | 12(45) | 14(28) |
| | — | 12(21) | 218(218) | 229(365) | 343(501) | 43(55) | 9 (9) | 4 (4) | 0 (0) | 10(15) | 36(36) | 83(178) | 8(10) | 14(18) | 0 (0) | 22(22) | 33(72) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Limnodromus spp. | 0 (0) | 2 (2) | 8(19) | 6(16) | 0 (0) | 2 (2) | 0 (0) | 0 (0) | 2 (2) | 0 (0) | 12(24) | 32(70) | 16(32) | 16(30) | 6(10) | 11(31) | 3(10) | 1 (1) |
| | — | 60(147) | 38(50) | 25(38) | 0 (0) | 0 (0) | 7 (7) | 16(38) | 81(141) | 120(144) | 171(200) | 103(308) | 6 (7) | 27(37) | 5 (5) | 36(70) | 10(12) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 15(15) | 11(21) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Gallinago gallinago[d] | 2 (4) | 2 (5) | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Phalaropus tricolor[e] | 2 (2) | 6(23) | 18(43) | 15(28) | 21(33) | 14(25) | 11(18) | 10(17) | 9(23) | 6(13) | 2 (4) | 3 (3) | 2 (3) | 11(22) | 45(97) | 44(143) | 3 (3) | 0 (0) |
| | — | 41(67) | 56(102) | 12(33) | 5 (5) | 9(14) | 40(64) | 67(101) | 37(61) | 51(73) | 17(21) | 9(15) | 4 (9) | 29(51) | 11(11) | 17(22) | 0 (0) | — |
| | 0 (0) | 0 (0) | — | — | 5 (5) | — | — | — | — | 0 (0) | 0 (0) | 0 (0) | 3 (2) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Phalaropus lobatus | 0 (0) | 0 (0) | 13(13) | 4 (8) | 9(23) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 17(17) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 27(59) | 20(20) |
| | — | 8(15) | 9(15) | 53(74) | 49(55) | 30(43) | 9(14) | 4 (6) | 0 (0) | 0 (0) | 5 (5) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 31(50) | — |
| | 0 (0) | 0 (0) | — | — | 0 (0) | — | — | — | — | 3 (3) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Total Number of Censuses | 15 | 14 | 11 | 17 | 11 | 17 | 16 | 12 | 18 | 11 | 16 | 12 | 11 | 8 | 8 | 14 | 12 | 4 |
| | 0 | 7 | 2 | 5 | 2 | 4 | 5 | 3 | 4 | 3 | 2 | 4 | 3 | 2 | 1 | 4 | 3 | 0 |
| | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 3 | 1 |

[a] Unidentified peeps include *C. pusilla*, *C. minutilla*, *C. fuscicollis*, and *C. bairdii*.
[b] Large peeps include *C. fuscicollis* and *C. bairdii*.
[c] Small peeps include *C. pusilla* and *C. minutilla*.

number were caused largely by the effect of changing habitat on species such as Semipalmated Plover. Similarly, habitat differences between sites may account for differences in species composition and abundance.

Second, separate migration routes used by a species to and from breeding areas (Morrison 1984, Morrison and Myers 1987) may account for seasonal differences in abundance. In all likelihood this hypothesis accounts for the summer absence at Last Mountain Lake of species such as White-rumped Sandpiper *C. fuscicollis*, which migrates north through the interior of North America and uses Atlantic routes during southbound migration (Morrison 1984).

Third, increases in abundance during southbound migration may be greatly affected by a species' breeding biology, including mating system, conditions and performance on the breeding grounds and subsequent timing of migration by different components of the population (Pienkowski and Evans 1984). The most obvious example is the chronological passage of individuals of different reproductive classes, in the sequence of failed breeders, successful breeders and young-of-the-year. Furthermore, in some species, differences in the timing of migration are apparent between the ages and sexes (Pienkowski and Evans 1984). Although our observations were insufficient to categorize migrants according to age or sex, we suspect that multiple-peaked migration patterns for some species such as Semipalmated Plover, Sanderling, Semipalmated Sandpiper and Stilt Sandpiper resulted from passage of different components of the population. Similarly, we suspect that the bimodal peak in autumn migration of Red-necked Phalaropes resulted from the earlier departure of females from breeding grounds (Reynolds 1987) and the subsequent passage of males and fledged young.

Finally, differences in the apparent abundance of species at a site may be an artifact of varying lengths of stay at staging areas (Pienkowski and Evans 1984). Species that remain for extended periods in an area to moult or replenish energy reserves prior to migration may build up in numbers and be over-represented in counts. Although we have no evidence to indicate that Last Mountain Lake serves as a major moulting area, it may be of geographical importance to arctic migrants. Food resources at northern prairie wetlands may represent the first appreciable energy sources available to arctic waders after their passage over the boreal forests of northern Canada. The effect

of drought on staging behaviour of shorebirds at interior wetlands remains poorly understood.

In contrast to seasonal patterns for most migrants, numbers of locally breeding species did nor exhibit June declines. This period corresponds to the peak of breeding for these species (Colwell unpubl. data). Some species that bred locally (e.g., Marbled Godwit *Limosa fedoa* and Wilson's Phalarope *Phalaropus tricolor*) exhibited a peak in numbers during early May, which represented flocks of pre-breeding individuals. Similarly, relatively large counts of Willet *Catoptrophorus semipalmatus* and Marbled Godwit in early June reflect the presence of post-breeding birds that failed to raise chicks. Further indication that large flocks of locally breeding waders are composed of pre- and post-breeding individuals comes from the absence of suitable breeding habitat at the Basin A and Perry's Beach, the sites that most commonly supported large flocks. The relative decline in numbers of Wilson's Phalarope in early July reflects the departure of females from the breeding grounds (Colwell 1987).

This study represents the first detailed account of shorebird migration in the northern prairie region of North America. Our data suggest that Last Mountain Lake and surrounding wetlands may offer critical resources for large numbers of Nearctic-breeding shorebirds, especially during periods of extreme drought. Further studies of marked individuals are required to establish the importance of northern prairie wetlands as staging areas for migrants.

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