

MIGRATION ROUTES OF THE WESTERN SANDPIPER

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ABSTRACT.—We report the locations of 97 sightings of over 15,000 Western Sandpipers (*Calidris mauri*) color banded in Perú, Panamá, México, British Columbia, and Alaska. Ninety-five sightings were made in states and provinces along the Pacific Coast of Central America and North America. One sandpiper banded in British Columbia and one from Perú were seen east of the Rocky Mountains. We propose that most Western Sandpipers migrate from Central and South American winter quarters along the Pacific Coast of North America. We also propose that most post-breeding Western Sandpipers use a trans-Pacific route that bypasses southeast Alaska and makes landfall in southern British Columbia. Western Sandpipers that spend the winter on the Atlantic coast of the USA and in the Caribbean fly a trans-continental route beginning from the Pacific Coast of North America. Received 27 Sept. 1995, accepted 1 April 1996.

Most Arctic breeding shorebirds stop at several staging sites to rest and feed while migrating to and from their winter quarters. A generally held view is that staging sites contribute to the reproductive fitness of individual shorebirds (Davidson and Evans 1988, Alerstam and Lindstrom 1990, Ens et al. 1994) and the degradation of these sites will result in population declines (Davidson and Evans 1986, Davidson and Piersma 1992). As a beginning, an assessment of this hypothesis requires a description of migratory routes. For even the most abundant shorebird species, however, migratory routes and staging sites are not well known (Morrison 1984).

The Western Sandpiper (*Calidris mauri*) is the most numerous shorebird on the Pacific Coast of North America. Between 250,000 and one million individuals are present on single days in San Francisco Bay, Grays Harbor, the deltas of the Fraser, Stikine, Fox, and Copper rivers, and Redoubt and Kachemak bays during spring migration from mid-April through mid-May (Page et al. 1979, Butler 1994, Gill et al. 1994, O'Reilly and Wingfield 1995). Single-day counts at these sites are 10- to 15-fold smaller during the southward migration from late June to mid-September (Senner 1977, Page et al. 1979, Butler 1994). Radio-tagging studies by Iverson et al. (1996) confirmed that many of the same individuals used

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these sites during spring migration. Despite its abundance, the migratory pathways of the Western Sandpiper are incompletely known. It is clear that most Western Sandpipers migrate along the Pacific Coast of the United States and Canada (Gill 1979, Gill et al. 1994). Senner and Martinez (1982) used data from regional bird accounts and recoveries of banded birds to postulate that a small number of Western Sandpipers use an interior route through the Great Plains east of the Rocky mountains to and from Alaska's North Slope and that some Western Sandpipers travel north in spring along the Pacific Coast and return to wintering quarters by routes that cross portions of the continental interior. Migration routes south of the United States of America were not described.

The purpose of this paper is to report sightings of banded Western Sandpipers in the Americas up to February 1996 and to relate them to migration routes proposed by Senner and Martinez (1982).

STUDY AREAS AND METHODS

Perú, Panamá, and México represent the respective southern, central, and northern portions of the winter range of the Western Sandpiper on the Pacific Coast of the Americas (American Ornithologists' Union 1983), whereas British Columbia is a staging site used by large numbers of Western Sandpipers in spring and autumn (Butler et al. 1987, Butler 1994). Most Western Sandpipers were captured in mist nets and fitted with colored darvic plastic "flag" bands to the legs at Paracas near Pisco, Perú (13°42'S, 76°13'W), near Chitré, Republic of Panamá (7°58'N, 80°26'W), near Ensenada, México (31°52'N, 116°37'W), on Sidney Island, BC (48°40'N, 123°30'W), and at Safety Sound near Nome, AK (64°20'N, 164°56'W) (Figs. 1, 2).

About 300 Western Sandpipers were banded with yellow flags in Perú between December 1990 and May 1991, about 14,000 were banded with red over white flags in Panamá between January 1989 and April 1995, 100 were banded with red over yellow flags in México in February and March 1993, 553 were banded with white flags in British Columbia in July and August 1990–1994, and 1271 were banded with green flags in Alaska in June and July 1994–1995. We relied on birdwatchers and biologists to send us sightings of banded birds, which created a bias in the reporting locations since sighting rates will depend on the intensity of search. Ten juveniles had miniature (0.8 g) radio transmitters glued to the feathers of the back (Warnock and Warnock 1993) near Nome, Alaska on 11 July 1994. Daily scans with a hand-held Yagi antenna and radio receiver were made every kilometer along dykes near the high tide line on the Fraser River delta, British Columbia from 14 July to 10 August 1994. The search area was along Boundary Bay and southern Roberts Bank where large numbers of Western Sandpipers roost during high tide (Butler 1994).

There is the possibility that some birds that lost a flag were identified with the wrong country. We received two reports of birds with only red flags out of about 14,000 that were banded. Red flags are the designated color for Chile where Western Sandpipers are very rare (Modinger et al. 1986), and none has been banded (M. Sallaberry, pers. comm.). These also could have been Mexican-banded sandpipers that lost a yellow flag. Sightings of yellow flags from Perú were made before red and yellow flags were used in México. Some white flags attached to sandpipers in Panamá had become stained yellow when the birds were recaptured a few years later. All birds in Canada were banded with white flags and colored

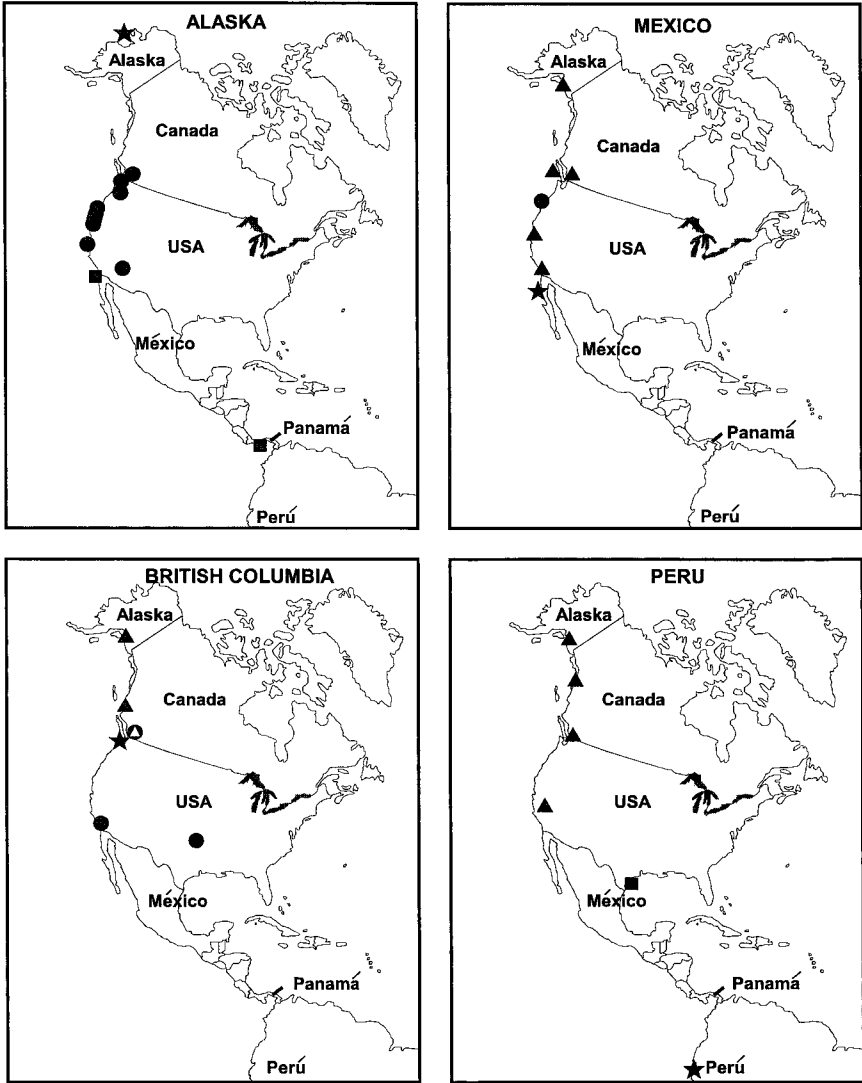


FIG. 1. Location of sightings of Western Sandpipers banded in Perú, México, British Columbia, and Alaska up to 28 February 1996. Some sightings are omitted for clarity. Stars indicate banding site, squares indicate locations of sightings during winter (Oct.-Feb.), triangles are during northward migration (March-May), and circles are during southward migration (July-Sept.).



FIG. 2. Location of Western Sandpipers banded in Panamá up to 28 February 1996. Symbols as in Fig. 1.

TABLE 1
NUMBER OF SIGHTINGS AND RECOVERIES BY 28 FEBRUARY 1996 OF WESTERN SANDPIPERS
BANDED AT FIVE SITES ALONG THE PACIFIC COAST

Banding site	USA											Total
	Perú	Panamá	México	CA	OR	WA	TX	AZ	KS	BC	AK	
Perú	—	0	0	1	0	0	1	0	0	1	2	5
Panamá	0	—	2	11	7	1	0	0	0	18	16	55
México	0	0	—	4	1	0	0	0	0	4	1	10
BC	0	0	0	1	0	0	0	0	1	3	1	6
Alaska	0	4	2	3	5	1	0	1	0	5	—	21
Total	0	4	4	20	13	2	1	1	1	31	20	97

bands to prevent confusion. We discarded any records when the observer was in doubt about the color of a flag or if the country of origin was in doubt.

RESULTS

Ninety-seven sightings of flag-banded Western Sandpipers were reported by 29 February 1996 (Table 1). Five sightings were from sandpipers banded in Perú, 55 from Panamá, 10 from México, six from British Columbia, and 21 from Alaska (Table 1). No flag-banded birds from the other banding sites were seen in Perú, four were seen in Panamá, four in México, 38 in continental US, 31 in British Columbia, and 20 in Alaska (Table 1). Two of the 97 sightings were made east of the Rocky Mountains; one in Kansas and one in Texas (Table 1, Fig. 1). The Kansas record was from a juvenile male Western Sandpiper banded on Sidney Island, BC on 2 August 1990 and last seen there 3 August. It was subsequently captured 2200 km to the southeast at Quivira National Wildlife Refuge, Kansas on 25 August 1990. The Texas record was of a sandpiper banded in Perú and seen near Corpus Christi, Texas on 16 December 1989. The remaining 95 sightings were made west of the Sierra Madre Mountains of México, the Rocky Mountains of the US, and the Coast Range of Canada (Figs. 1, 2).

Western Sandpipers banded in Panamá were seen on the northward and southward migrations only in Pacific Coast states and provinces of North America (Fig. 2). The migration route through the western US and Canada includes many coastal and inland sites along the west side of the Sierras and Cascade Mountains from the Gulf of California to the Strait of Georgia, British Columbia (Fig. 2). Sightings of marked birds away from the coast include Salton Sea, San Leandro and China Lake, California, and Sauvie Island and Salem, Oregon. From southern British Columbia through Alaska, sightings were confined to coastal locations.

At the close of the breeding season, Western Sandpipers gathered in flocks on mudflats near the breeding grounds at Nome where they gained about 3 g of mass prior to departure (B. Sandercock, unpubl. data). An adult female and two juvenile sandpipers of unknown gender that were equipped with radio-transmitters were detected on the Fraser River delta 28, 23 and 29 days after release, respectively. The respective average speeds of these individuals over the 4000 km distance between Nome and the Fraser River delta were 142, 173, and 137km/d, respectively. These records coupled with sightings of flag-banded birds, indicate that Western Sandpipers from at least as far north as Nome, Alaska, migrate south along the Pacific Coast.

DISCUSSION

Many species of shorebirds use different migratory routes in spring and autumn (Morrison 1984, Alerstam 1990, Gratto-Trevor 1994). Censuses of shorebirds in the western US indicate that nine sites hold over 100,000 Western Sandpipers on a single day during spring migration. They are San Francisco Bay and Humboldt Bay, California, Grays Harbor, Washington, the Fraser River delta, British Columbia, and the Stikine, Copper river deltas, Redoubt Bay, Kachemak Bay, Alaska (G. W. Page, W. D. Shuford, J. E. Kjelson, and L. E. Stenzel, unpubl. data). On the southward migration, flocks are much smaller at all sites and most notably in south-central and southeast Alaska, which is largely avoided by Western Sandpipers (Senner 1977; R. Gill, C. Iverson, and M. A. Bishop, pers. comm.; this study). This contrasts with sites in southern British Columbia and many western states in the US where many more sites are used in autumn than in spring migration (Paulson 1993).

The migration of the Western Sandpiper is more compressed in time and space in spring than in fall. Many of the large mudflats along the Pacific Coast of North America support larger numbers of Western Sandpipers on the northward migration than on the southward migration (Page et al. 1979; Butler 1994; Senner 1977; G. West, pers. comm.), and many small mudflats avoided in spring are used by southbound migrants. As a result, population censuses on large mudflats are greater during the northward migration than the southward migration. This phenomenon confounds our understanding of the southward migration. Gill (1979) reported two sightings of Western Sandpipers marked at Nelson Lagoon in the northern Gulf of Alaska and Prince William Sound and two sightings of birds marked on the Yukon River delta at Nelson Lagoon. He proposed that the migration route of juvenile Western Sandpipers was south along the Alaska and British Columbia coast. However, some Western Sandpipers might also make a trans-Pacific flight from western and southern

Alaska that bypasses southeast Alaska and makes landfall in southern British Columbia. Large numbers of post-breeding Western Sandpipers gather on intertidal mudflats near their breeding grounds in western Alaska and on the Alaskan Peninsula (Gill and Jorgenson 1979, Connors 1984, Gill and Handel 1990, this study). Individuals caught at this time near Nome were about 3 g heavier than their breeding masses (B. Sandercock, unpubl. data), and mass gains occurred among post-breeding Western Sandpipers on the Alaskan Peninsula (R. E. Gill, Jr., pers. comm.), suggesting they were preparing for a long flight. Banded individuals on the southward migration were seen in southern Alaska and on the Alaskan Peninsula but not southeastern Alaska (Gill 1979; Figs. 1, 2). The species occurs in very small numbers in southeast Alaska at this time (M. A. Bishop, R. E. Gill, C. Iverson, pers. comm.). Maximum single day censuses of adults and juveniles using the Fraser River delta during their southward migration were about 21,000 and 45,000 birds, respectively, which is far below the 500,000 individuals counted in spring (Butler 1994), but many other coastal and interior sites are also used mostly only during the southward migration.

Senner and Martinez (1982) proposed that most Western Sandpipers used a Pacific Coast route to and from the breeding grounds in western Alaska. Our study confirms their hypothesis for the Pacific route and extends it over 8000 km south of California to Perú (Table 1, Figs. 1, 2). Western Sandpipers banded in Perú, Panamá, and northern México were sighted along the Pacific Coast of the Americas from northern México to southwestern Alaska (Figs. 1, 2).

Evidence for the existence of a Great Plains route beginning in northern Alaska (Senner and Martinez 1982) is less convincing than the Pacific Coast route. Individuals banded near Nome and Kotzebue, Alaska have been sighted and recovered along the Pacific Coast (Fig. 1; D. Schamel, pers. comm.), but the route taken by populations that breed along the North Slope of Alaska are unknown. The species is considered as a rare breeding species in northern Alaska (Johnson and Herter 1989, Wilson 1994), and small numbers of Western Sandpipers have been seen in spring and fall migration on the northeast coast of Alaska and western Canadian arctic (Martell et al. 1984, Johnson and Herter 1989). The species is rarely seen in Alberta. Birdwatchers there recorded an individual on 20 May 1990, four individuals on 2 July 1993, and one individual on 6 May 1995 at Beaverhill Lake Bird Observatory near Edmonton between 1986 and 1995 (G. Holroyd and D. Ross, pers. comm.). None has been caught in James Bay, the Canadian Prairies, or North Dakota despite extensive banding there (D. Lank, R. I. G. Morrison, C. L. Gratto-Trevor and G. Beyersbergen, pers. comm.). This evidence suggests that the Canadian

prairies and adjacent parts of the US are north of the main migration route across the North American continent or that Western Sandpipers fly over the Great Plains on their way to and from northern Alaska.

A diagonal migration across the North American continent proposed by Senner and Martinez (1982) is the most plausible route for populations that spend the winter along the Atlantic and Caribbean coasts. This route was supported by recoveries and from sightings of banded sandpipers in this study. The most probable migration route occurs along a wide front from southern Alaska and the north Pacific Coast through continental US. The Western Sandpiper is an abundant autumn shorebird species on the south coast and in the southern interior of British Columbia, but it is uncommon farther north in the interior of the province (Campbell et al. 1990). In Idaho, the species is widespread in fall but not in spring (Oring 1962, Taylor et al. 1992), and it is abundant in mid-western US (Martinez 1979, Neil 1992, Skagen and Knopf 1993). The species is a regular winter resident on the southern Atlantic Coast of the USA and in the Caribbean (Wilson 1994, Rice 1995).

The migration routes of Western Sandpipers through Central America and northern South America are poorly known. Hundreds of thousands of Western Sandpipers spend the winter on the Pacific coasts of México (Morrison et al. 1992, 1994) and Panamá (Butler et al. 1992b). We assume that the migration route south of México follows the Pacific Coast but records are lacking. The sighting of a Peruvian banded bird in Texas in December is enigmatic, given that the species exhibits strong winter site fidelity (Smith and Stiles 1979, Rice 1995).

Evidence to support Wilson's (1994) contention that migration is more leisurely in fall than in spring is equivocal. Fifty-eight adult spring migrants carrying 0.8 g mass radio transmitters flew the 3200 km distance between San Francisco Bay and Copper River delta at an average speed of 422 km/d (Iverson et al. 1996). This is 1.3–3.0 times faster than the speed we found for autumn migrants flying 4000 km between Nome and the Fraser River delta. However, some of this time might have been spent accumulating mass in preparation for migration. Once migration was underway, individuals appeared to travel at similar speeds: the length of stay at Pacific Coast staging sites is about three days in spring and autumn (Butler et al. 1987, Iverson et al. 1996).

The trans-Pacific flight of the Western Sandpiper likely evolved during the last glacial period about 15,000 BP. During the height of glaciation, sea level along the Pacific Coast was about 100 m lower than today. Much of the present day continental shelf off Washington, Oregon, and California was not covered by water. In Alaska, Beringia extended over 1000 km wide in places, providing tundra habitats for many shorebirds. Be-

tween the breeding grounds in Beringia and the beaches of continental US lay an immense sheet of ice requiring flights of about 3000 km by shorebirds migrating to winter quarters in Central and South America. The river deltas in British Columbia and Alaska are less than 9000 years old, and so their use by Western Sandpipers is a relatively recent phenomenon. It is unclear why shorebirds use these deltas in spring but not fall but the answer may lie in the nature of favorable winds for migration. In spring, winds along the British Columbia and Alaska coasts are frequently from the southeast and in the direction of the migration, whereas late summer winds are generally out of the northwest (Favorite et al. 1976). We hypothesize that Western Sandpipers migrate northward along the coast and southward across the Pacific to take advantage of favorable winds.

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