

THE ABUNDANCE AND MIGRATION OF SHOREBIRDS AT TWO PUGET SOUND ESTUARIES

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The timing and magnitude of shorebird migration has been documented at several areas along the Pacific coast of North America, primarily California (Recher 1966, Page et al. 1979) and Washington (Widrig 1979, Herman and Bulger 1981). Few studies in this region have been conducted away from the outer coast. In Washington, only Van Velzen (1973) has described shorebird migration at noncoastal sites. Because of the dearth of information on shorebird abundance and migration in this region (but see seasonal summaries in *American Birds*), I here provide information on the year-round abundance and migration timing of shorebirds at two small estuaries in the south Puget Sound of western Washington.

STUDY AREA AND METHODS

The two study sites, Eld Inlet and Totten Inlet (Kennedy Creek delta), are adjacent inlets 7 km apart at the south end of Puget Sound in western Washington (Figure 1). Both inlets are relatively small, having tidal flats of ca. 600 ha exposed at Mean Lower Low Water. A small salt marsh (ca. 3 ha) is present at Totten Inlet, but salt marsh is virtually absent at Eld Inlet, where the largest contiguous salt marsh covers only 30 m². The tidal flats at Eld Inlet are deeply cut by distributary and creek channels, whereas the tidal flats at Totten Inlet exhibit less relief. Whether this difference produces differences in the mobility of sediment or in the stratification of grain sizes sufficient to influence the distribution and abundance of invertebrates is unknown (see Ferns 1983, Hicklin and Smith 1984). Brennan et al. (1985) and Buchanan (in press) described the sites further.

I visited Eld Inlet on 293 days between July 1980 and March 1983, Totten Inlet on 196 days between April 1980 and March 1988. A summary of my field effort at each site is presented in Table 1. Shorebirds were counted immediately before or after roosting periods, increasing the likelihood of accurate counts. When shorebirds were abundant (>1000 birds), their numbers were estimated by hundreds; otherwise, birds were estimated by tens or counted individually.

SPECIES ACCOUNTS

Black-bellied Plover (*Pluvialis squatarola*). This species was noted only twice at Eld Inlet (Table 2). It was common at Totten Inlet (Table 3), where populations each winter remained fairly stable, although there was considerable variation in numbers from year to year (Table 4; see Discussion below). Spring migrants began to arrive in the third week of March, and the peak of spring passage occurred late in April. Small numbers of birds were occasionally observed during summer; birds in winter plumage present in

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June and early July presumably spent the summer south of the breeding grounds (see Loftin 1962). There was no distinct peak in the fall migration, and numbers in fall were never higher than the eventual winter population. Widrig (1979), reporting on shorebird migration at Leadbetter Point on the outer coast of Washington, noted a distinct peak in autumn migration (early August) but not in spring migration. Similarly, Herman and Bulger (1981) did not detect any peaks between 25 April and 14 May at Grays Harbor, Washington.

Semipalmated Plover (*Charadrius semipalmatus*). This was an uncommon species at the two study sites, neither of which has the sandy tide flats this species seems to prefer. Spring migrants were noted between 26 April and 13 May. Autumn migration spanned the period 18 July through 13 September.

Killdeer (*C. vociferus*). This locally nesting species was recorded in all months. The high number of birds recorded in late summer at both sites

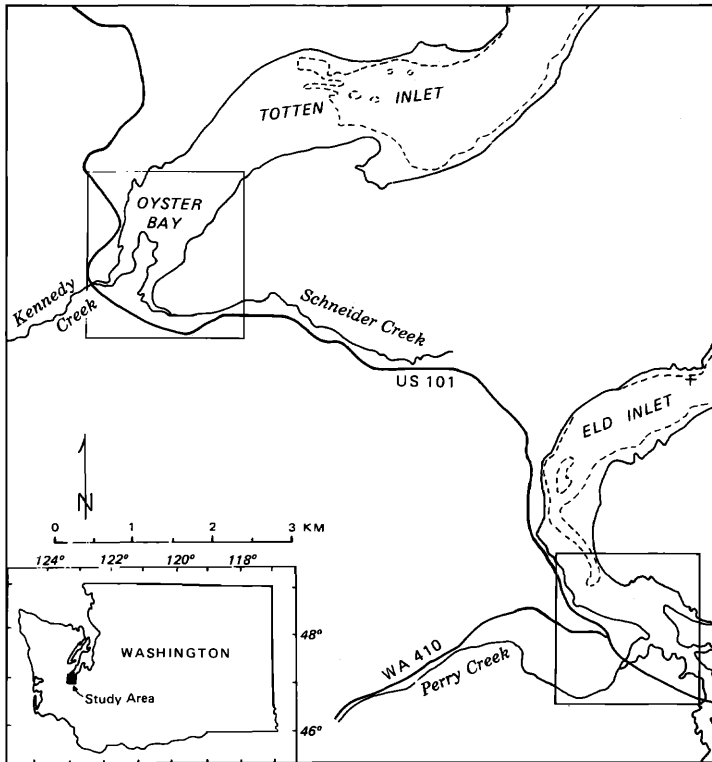


Figure 1. Location of the two study sites in western Washington.

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reflected the presence of large numbers of juveniles. I noted little evidence of spring migration at either site; however, fall migration peaked in October.

American Avocet (*Recurvirostra americana*). On 24 August 1981 a male (sex determination based on bill shape; see Prater et al. 1977) still showing a tinge of rust on its head and neck was observed at Eld Inlet. This was probably the same bird observed at Totten Inlet on 3 September 1981 (M. Finger pers. comm.). This species is rare in western Washington.

Greater Yellowlegs (*Tringa melanoleuca*). This species was common and conspicuous in autumn, winter, and spring at both sites. Peaks in both spring and autumn migration were noted, with peak numbers occurring in April and September (see Buchanan in press). Individuals occasionally seen during June presumably spent the summer months south of the breeding grounds. Winter populations varied from year to year (Table 4).

Lesser Yellowlegs (*T. flavipes*). This species was rarely encountered, and all records except one are from autumn. The single spring sighting was of an individual at Eld Inlet on 11 April 1981. At Eld Inlet a single bird was observed on 3 August 1981, and I saw up to 4 birds in late September 1980. Two birds were present from 14 August to 13 September in 1986 at Totten Inlet.

Spotted Sandpiper (*Actitis macularia*). Seen in all months except June at Eld Inlet, where it was uncommon but regular; rarely seen at Totten Inlet between May and November. No distinct migratory peaks were noted, although the species was most common from September through January at Eld Inlet. The Spotted Sandpiper nests in western Washington (Jewett et al. 1953).

Whimbrel (*Numenius phaeopus*). A single bird observed on 21 May 1982 on oyster beds at Eld Inlet was the only one recorded during this study. This species is uncommon in south Puget Sound.

Ruddy Turnstone (*Arenaria interpres*). Three birds on 6 May and one on 9 May 1987 at Totten Inlet are this study's only records and apparently the first of this species west of Tacoma in south Puget Sound (W. Tweit pers. comm.).

Western Sandpiper (*Calidris mauri*). An uncommon winter resident and abundant migrant at Totten Inlet (see Tables 3 and 4). It was absent during two of three winters at Eld Inlet. The peak of spring migration occurred late in

Table 1 Average Number of Visits Each Month to Eld Inlet, 1980-1983, and to Totten Inlet, 1980-1988

Month	Eld Inlet	Totten Inlet	Month	Eld Inlet	Totten Inlet
Jan	8.3	2.8	Jul	9.0	2.0
Feb	7.7	2.5	Aug	9.3	2.3
Mar	12.7	3.0	Sep	8.0	1.5
Apr	13.0	3.4	Oct	6.7	1.5
May	7.0	1.4	Nov	11.7	1.8
Jun	2.5	1.0	Dec	9.3	1.5

Table 2 Maximum Monthly Counts of Shorebirds at Eld Inlet, Washington, 1980-1983

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black-bellied Plover				1							2	
Semipalmated Plover					4		2	3				
Killdeer	7	5	3	4	1	3	6	10	11	16	2	7
American Avocet								1				
Greater Yellowlegs	32	35	35	39	3	2	14	24	38	28	27	19
Lesser Yellowlegs				1				1	4			
Spotted Sandpiper	5	1	2	2	2		2	2	4	5	4	5
Whimbrel					1							
Western Sandpiper	25	10	4	400	364		62	510	415	51	100	5
Least Sandpiper				9			11	30				
Dunlin	1230	1500	1500	1500	766				540	540	2100	1200
Stilt Sandpiper										1		
Short-billed Dowitcher				3								
Common Snipe										1		
Red-necked Phalarope					7							
Red Phalarope										2		

Table 3 Maximum Monthly Counts of Shorebirds at Totten Inlet, Washington, 1980-1988

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black-bellied Plover	98	104	132	185	66	2	15	34	38	57	68	94
Semipalmated Plover				5	1		5	5	2			
Killdeer	10	6	3	4	2	18	35	23	15	31	9	7
American Avocet	25	13	19	43	5	4	9	1	17	17	20	22
Greater Yellowlegs								2	2			
Lesser Yellowlegs					1	1	4	2	1		1	
Spotted Sandpiper					3							
Ruddy Turnstone	145	120	150	6600	2600		87	1910	1750	305	200	200
Western Sandpiper				4	12		14	35	20			
Least Sandpiper	4400	4400	4500	5100	1400					1050	3800	4130
Dunlin				50	6							
Short-billed Dowitcher							10	9	2	1	1	1
Long-billed Dowitcher	1		2							2		2
Common Snipe												
Red-necked Phalarope					32			6				

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April and was brief; I have no records after 13 May. This pattern of abundance during spring in Washington has been noted by others (Van Velzen 1973, Widrig 1979, Herman and Bulger 1981). My earliest record for autumn migrants was on 2 July 1986. Autumn migration typically exhibited two peaks, the first in mid to late August and the second in mid to late September. This is similar to the pattern noted by Widrig (1979), although at Leadbetter Point, Widrig observed a substantial peak of postbreeding adults in late June and early July. Most fall migrants in Puget Sound are juveniles. In south Puget Sound the autumn migration of Western Sandpipers occurs during a period of relatively low diurnal low tides and is largely completed one month before the first large flocks of Dunlins arrive. This migration timing is probably dictated largely by differing breeding schedules and seasonal availability of prey in the Arctic (Holmes 1972), although the availability of habitat and prey during migration (Schneider and Harrington 1981) and reduced competition with other sandpipers (Recher 1966) have been suggested as timing mechanisms.

Least Sandpiper (*C. minutilla*). This species was more common in autumn than in spring and appeared to be slightly more common at Totten Inlet. Spring migrants were observed between 24 April and 7 May, while autumn migration spanned a much greater period (6 July-22 September).

Dunlin (*C. alpina*). Except during early fall and briefly in spring, this was the most abundant species at both study sites. During winter this species constituted >95% of all shorebirds, regardless of the yearly variation in its population (Table 4; see Discussion below). Populations generally fluctuated very little within a single winter. If a gradual northward movement of birds from California occurs during winter, as suggested by Holmes (1966) and Widrig (1979), it is not evident in south Puget Sound until after mid-March.

Table 4 Yearly variation in Peak Winter^a Counts of Black-bellied Plovers, Greater Yellowlegs, Western Sandpipers, and Dunlins at Totten Inlet, 1980-1988

	Black-bellied Plover	Greater Yellowlegs	Western Sandpiper	Dunlin
1980-81	68	16	132	2400
1981-82	65	12	100	4100
1982-83	67	19	87	2450
1983-84	68	7	50	2030
1984-85	104	13	110	4400
1985-86	103	8	8	2550
1986-87	99	15	120	2650
1987-88	102	19	180	4130
c.v. (%) ^b	22.2	33.2	53.0	30.7

^aDecember, January, February.

^bCoefficient of variation = standard deviation/mean.

Table 5 Comparison of Species Richness at Eld Inlet, Totten Inlet, and Leadbetter Point^a

Month	Eld Inlet	Totten Inlet	Leadbetter Point
Jan	5	6	8
Feb	5	5	8
Mar	5	6	10
Apr	9	8	19
May	8	11	22
Jun	2	4	16
Jul	6	8	20
Aug	8	11	26
Sep	5	9	27
Oct	8	8	17
Nov	6	7	11
Dec	5	7	10

^aFrom Widrig (1979).

The peak of spring migration occurred late in April in all years, and passage was completed by 8 May. This timing has been documented by others (Van Velzen 1973, Widrig 1979, Herman and Bulger 1981). A protracted southward movement of juveniles on the outer coast during November has been hypothesized (Buchanan et al. 1986). A brief passage of up to 2100 birds during November 1982 at Eld Inlet suggests an occasional late autumn movement through Puget Sound. The earliest autumn migrants were observed on 17 October in 1982 and 1983. This is in contrast to arrival dates at Leadbetter Point, where Widrig (1979) recorded this species throughout summer and early fall; however, the timing at my study sites coincides with the arrival of the first large Dunlin flocks at Leadbetter Point.

Stilt Sandpiper (*Micropalama himantopus*). A juvenile was observed at Eld Inlet on 6 October 1980, for the only record during this study. This species is rare in western Washington.

Short-billed Dowitcher (*Limnodromus griseus*). Because of the problems in distinguishing between *L. griseus* and *L. scolopaceus* in the field (see Wilds and Newlon 1983), the information presented here is restricted to birds identified by their call notes. This species was detected only during spring migration (12 April-9 May), and, after the departure of a few *L. scolopaceus*, which occasionally wintered locally, this was the only dowitcher present during the peak of spring migration.

Long-billed Dowitcher (*L. scolopaceus*). This was the only dowitcher species identified during autumn (11 July-8 October) or winter (Table 2). These findings are much different from those reported from the outer coast by Widrig (1979), who found that both dowitcher species were common during spring and autumn migrations but that this species was not present in autumn until early September.

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Common Snipe (*Gallinago gallinago*). I saw this species only once at Eld Inlet, on 21 October 1980. I observed it during October and December at Totten Inlet but never later, probably because it is shot by waterfowl hunters, whose season begins in October.

Red-necked Phalarope (*Phalaropus lobatus*). This species was recorded three times: 32 on 7 May 1982 at Totten Inlet, 7 on 8 May 1982 at Eld Inlet, and 6 on 18 August 1985 at Totten Inlet.

Red Phalarope (*P. fulicaria*). Two birds were present at Eld Inlet 27-30 October 1982. This species was recorded from several other interior localities in Washington and Oregon in fall 1982 (Hunn and Mattocks 1983).

DISCUSSION

Eighteen species were observed during this study (Tables 2 and 3). At least 12 other species [Lesser Golden-Plover (*Pluvialis dominica*), Black-necked Stilt (*Himantopus mexicanus*), Solitary Sandpiper (*Tringa solitaria*), Black Turnstone (*Arenaria melanocephala*), Red Knot (*Calidris canutus*), Sanderling (*C. alba*), Semipalmated Sandpiper (*C. pusilla*), Baird's Sandpiper (*C. bairdii*), Pectoral Sandpiper (*C. melanotos*), Sharp-tailed Sandpiper (*C. acuminata*), Buff-breasted Sandpiper (*Tryngites subruficollis*), and Wilson's Phalarope (*Phalaropus tricolor*)] have been recorded from southern Puget Sound (W. Tweit pers. comm.), but they are either rare or use habitats not found at my study sites. Because I did not observe these species during my study I will not consider them further.

Sixteen species were observed at Eld Inlet during the study period, while 15 species were observed at Totten Inlet. Spring and autumn were the periods of highest cumulative species richness. I regularly saw between 5 and 7 species during winter (Tables 2 and 3). This pattern of species richness is similar to that noted by Widrig (1979) at Leadbetter Point (Table 5), although I recorded a much lower diversity and abundance during all months at my sites. In addition to the slight seasonal differences in species richness at my two sites, there were distinct differences in species composition.

Black-bellied Plovers and dowitchers were regularly encountered at Totten Inlet but were rare at Eld Inlet (two and one records, respectively). Least Sandpipers were observed less often and in fewer months at Eld Inlet than at Totten Inlet, probably because salt marsh, a preferred habitat, is virtually absent at Eld Inlet. Dunlins and Western Sandpipers were far less common at Eld Inlet. These differences in abundance may be related to differences in prey availability (Goss-Custard 1970, O'Connor and Brown 1977, Evans and Dugan 1984).

The four most abundant species at Totten Inlet during winter were the Black-bellied Plover, Greater Yellowlegs, Dunlin, and Western Sandpiper. In the 8 winters of this study, these species varied considerably in numbers from year to year (Table 4). The degree of variation, as indicated by values of the coefficient of variation, was similar for three species (a temporary influx of 19 Greater Yellowlegs in mid-winter 1982-1983, which increased the site's population from 19 to 38, is not included in Table 4 because these birds remained for only a short period; see Buchanan in press). Yearly variation in each species was clearly independent of the abundance of other species.

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These findings are similar to those reported by Page et al. (1979), who, in a 5-year study in California, found considerable variation in winter populations of these species. The patterns of variation in winter abundance exhibited by Black-bellied Plovers and Dunlins appear cyclical. It is unknown whether these fluctuations at Totten Inlet reflect fluctuations in breeding success, postbreeding survival rates, or the carrying capacity of the site. Summers et al. (1987) presented evidence that cyclic variations in the abundance of first-year Sanderlings in southern Africa result from cyclic variations in predation pressures in arctic nesting areas. Changes in the abundance of Dunlins wintering at Eld Inlet (580 birds in 1980-81, 1230 in 1981-82, and 220 in 1982-83) were similar to those at Totten Inlet, indicating that variables away from the wintering grounds (e. g., breeding success or survival rates) may influence this species' annual pattern of abundance.

The results of this study illustrate variation in shorebird abundance from year to year and between sites, and they indicate the need for and the importance of long-term studies. Also, because of between-site differences, studies of shorebirds should include several areas or subareas (e. g., Page et al. 1979, Herman and Bulger 1981) to provide a more complete understanding of local populations and habitat use.

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