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SHOREBIRDS IN WESTERN NORTH AMERICA: LATE 1800s TO LATE 1900s

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Abstract. Only anecdotal information is available to assess whether populations of the 47 shorebird species that breed or winter west of the Rocky Mountains changed in size or distribution during the past century. Unregulated hunting from 1870 to 1927 reduced populations of several species, at least temporarily, and was a factor in bringing the Eskimo Curlew (*Numenius borealis*) close to extinction. Large scale transformation of native grasslands and wetlands for agriculture and other purposes resulted in population declines and nesting range contractions of several temperate-zone breeders. In general, upland species were affected more than wetland species, breeding ranges contracted westward, and alteration of breeding habitat was the factor most responsible for range contractions and population declines. A ranking system assessing shorebird susceptibility to habitat alteration also predicted temperate breeders to be among the most vulnerable species to environmental change. The few estimates for current population sizes of western North American shorebirds range from fewer than 50 Eskimo Curlews to a few million Western Sandpipers (*Calidris mauri*), the most abundant species. Concentrations of at least 1000 shorebirds occur on migration at over 120 western North American sites and of 100,000 to 1,000,000 shorebirds at 18 sites. Whether populations are limited by conditions on breeding, wintering or migration ranges is unknown for most species. Expansion of ongoing programs coupled with economical new census efforts could be useful for monitoring the majority of western North American shorebirds during the next century.

Key Words: Shorebird; status; habitat; population; western North America; twentieth century.

The growth of human population in western North America has been accompanied by significant alteration of wetlands (Dahl 1990) and grasslands (Knopf 1994). Shorebird populations have undoubtedly been affected; however, because assessments of populations have only been initiated within the last 25 years most of what can be reported comes from anecdotal accounts. In this paper we describe western North American shorebird populations by geographical range and habitat preference. We outline the most apparent threats during the past century, and identify species most likely to have been affected. Finally, we summarize available information on their responses to these changes, and identify ongoing or upcoming census programs for measuring future population trends.

WESTERN NORTH AMERICAN SHOREBIRDS

We include all taxa with breeding or wintering populations in the Pacific Flyway (west of Rocky Mountains from Sinaloa, Mexico, north through the Yukon Territory to Alaska). Because this region includes a vast area of arctic and subarctic habitat, links North America to the east-Asian faunal region, and has over 75,000 km of coastline, it supports a large and diverse shorebird fauna (see Table 1 for scientific names). All but 3 of 50 shorebird species that breed regularly in North America occur commonly, and 8 breed only within this portion of the continent (Pitelka 1979).

Among the 47 species of western North American shorebirds, 32 (68%) breed only in arctic and subarctic habitats (Table 1). Eleven species (23%) are temperate breeders and 4 (9%) span both boreal and temperate zones. Wetlands are a key component of the breeding habitat of 11 of the 15 temperate breeders, including the Snowy Plover (*Charadrius alexandrinus*), Wilson's Plover (*C. wilsonia*) and American Oystercatcher (*Haematopus palliatus*), which nest primarily along sandy shores but feed in wetlands. Mountain Plovers (*C. montanus*), Long-billed Curlews (*Numenius americanus*), and Upland Sandpipers (*Bartramia longicauda*) nest primarily on uplands. The Black Oystercatcher (*H. bachmani*) is the only temperate breeder on rocky shores.

TABLE 1. SEASONAL USE OF HABITATS BY WESTERN NORTH AMERICAN SHOREBIRDS

Species	Breeding					Wintering						Habitat score[2]
		Temperate				Interior		Coastal				
	Arctic habitats[1]	Wetlands	Sand shore	Rock shore	Uplands	Wetlands	Uplands	Wetlands	Sand shore	Rock shore	Uplands	
North American wintering group[3]												
Haematopus bachmani				P[4]						P		6
Recurvirostra americana		P				P		P				12
Charadrius alexandrinus		S	P			S		P	P			14
Charadrius montanus					P		P				P	18
Numenius americanus					P		P	P	P		S	7
Limosa fedoa	P	S			P	O		P	P			14
Arenaria melanocephala	P							P	S	P		5
Calidris mauri	P					S		P	S			7
Calidris ptilocnemis	P							S	S	P		4
Calidris alpina pacifica	P					P		P			S	7
Limnodromus scolopaceus	P					P		P				7
Bicontinental wintering group												
Haematopus palliatus		S	P					P	P			4
Pluvialis squatarola	P					P	P	P	P	S	P	4
Charadrius semipalmatus	P					S		P	P			5
Charadrius wilsonia		S	P					P	P			15
Charadrius vociferus		P	S		S	P	P	P	S		P	15
Tringa melanoleuca	P					P		P				4
Tringa flavipes	P					P		P				4
Catoptrophorus semipalmatus		P			S	O		P	P	P		13
Actitis macularia	P	P			S	P		P	S	P		3
Aphriza virgata	P									P		4
Calidris canutus	P							P	P			4
Calidris pusilla	P					S		P	P			5
Calidris minutilla	P					P		P	S			7
Calidris himantopus	P					P		P				6
Limnodromus griseus	P							P	O			7
Gallinago gallinago	P	P				P	S	P			S	12
South American wintering group												
Pluvialis dominica	P					P	P	P	O		P	6
Tringa solitaria	P					P		P				4
Bartramia longicauda	S				P	O	O	P	O		O	11
Numenius borealis	P						P	S				6
Limosa haemastica	P					O		P	S			6
Calidris fuscicollis	P					P	O	P	O			6
Calidris bairdii	P					P		P			O	6
Calidris melanotos	P					P	P	S	O		S	6
Tryngites subruficollis	P					S	P				P	6
Phalaropus tricolor		P				P		S				10
Phalaropus lobatus	P							S	mostly pelagic			5
Phalaropus fulicaria	P							S	mostly pelagic			5
Oceania-Asia wintering group												
Pluvialis fulva	P							P	P	O	P	5
Numenius tahitiensis	P							P	P	P	S	5
Limosa lapponica baueri	P							P	P			5
Calidris alpina articola	P							P	P			5
Bicontinental/Oceania-Asia wintering group												
Himantopus mexicanus		P				P		P				12
Heteroscelus incanus	P							S		P		4
Numenius phaeopus	P							S	P	S		5
Arenaria interpres	P							P	P	P		4
Calidris alba	P					O		P	P	S		4

[1] Arctic habitats are as described by Kessel (1979); wetlands include fresh and brackish marsh, estuarine marsh, and intertidal flats [in part modified from Burger (1984), Myers (1980), Myers and Myers (1979), and Morrison and Ross (1989)]; sand and rock shores include those in or adjacent to littoral zone; uplands include pampas, grasslands, and agricultural lands.

Western North American shorebirds exhibit a wide array of wintering patterns (Table 1). Ten species (21%) winter primarily in North America and 12 (26%) in South America; 16 (34%) have bicontinental wintering ranges, 3 (6%) winter only in Oceania or Asia, and 5 (11%) have both bicontinental and Oceanic or Asiatic wintering distributions. The Dunlin (*Calidris alpina*) has discrete populations, one wintering in Asia and the other in North America (Gill and Handel 1990). While many species use a greater variety of habitats in winter than during summer, wetlands are of primary importance in winter to the majority (81%) of species. Rocky shorelines provide the primary winter habitat for 7 species, including Black Oystercatcher, Surfbird (*Aphriza virgata*), Wandering Tattler (*Heteroscelus incanus*) and Rock Sandpiper (*Calidris ptilocnemis*), which generally are not found elsewhere. Uplands provide important wintering habitat for 9 species, particularly Eskimo Curlew (*Numenius borealis*), Mountain Plover and Buff-breasted Sandpiper (*Tryngnites subruficollis*). All species use one or more coastal habitats in winter and 66% of the species also use interior habitats. Fourteen species (30%) are restricted to the coast and 2 species, *Phalaropus lobatus* and *P. fulicaria*, are primarily pelagic.

MAJOR FACTORS INFLUENCING POPULATION SIZE

Hunting

Unregulated hunting between 1870 and 1927 significantly reduced populations of Red Knot (*Calidris canutus*) and species of the genera *Pluvialis, Numenius, Bartramia, Limosa,* and *Limnodromus* in eastern North America (Cooke 1910, Forbush 1912, Wetmore 1926). Faced with concomitant widespread loss of habitat along the spring migratory route some species, including Eskimo Curlew, Hudsonian Godwit (*Limosa haemastica*) and Lesser Golden Plover (*Pluvialis dominica*), have never recovered to their former abundance. All available evidence suggests shorebirds were also hunted heavily throughout the western United States. Whimbrels (*Numenius phaeopus*), Long-billed Curlews, Marbled Godwits (*Limosa fedoa*) and dowitchers (*Limnodromus* spp.) in particular were actively procured for the California markets and declined in numbers (Grinnell et al. 1918).

The unregulated killing of shorebirds in North America declined dramatically with the passage of the Migratory Bird Treaty Act in 1918 and subsequent conventions with Mexico, Japan and Russia. Currently only Woodcock (*Scolopax minor*) and Common Snipe (*Gallinago gallinago*) are legally hunted. About 500,000 of each species are shot annually (Banks 1979); 17% of the snipe are taken in the Pacific Flyway (USFWS, unpubl. data). Indigenous peoples of Alaska take small numbers of shorebirds and their eggs but this is not currently a threat to populations. Subsistence hunting of shorebirds south of the United States, however, may be more serious, but its extent and effects remain undocumented (Senner and Howe 1984).

Habitat Alteration

The alteration of native wetlands and grasslands for agriculture and other purposes has had the most profound effect on shorebirds since North America was settled by Caucasians. Settlement has destroyed 35–89% (median = 48%) of the native wetlands in Great Plains states, including 57% of the pothole wetlands in North and South Dakota (Dahl 1990). West of the Rocky Mountains statewide wetland losses range from

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[2] Higher score (range 3–18) indicates habitats used by species are more vulnerable to alteration or destruction given current conditions. See text for derivation and discussion of scores.
[3] Wintering group designations modified from Boland (1991).
[4] P = principal habitat used, S = secondary use, O = occasional use.

30–91% (median = 37%), including 51% of the wetlands associated with Pyramid Lake, Winnemucca Lake, and the Carson and Humboldt sinks in Nevada; 60% of the delta marshes and intertidal areas of Puget Sound; 30% of the estuarine flats, marshes and swamps in the Columbia River Estuary; 85% of similar habitats in Coos Bay; and 91% of the wetlands in California (Peters 1989, Dahl 1990). Conversion of native grasslands has been just as extensive (Knopf 1994). By contrast, over 99% of the wetlands in Alaska remain pristine (Dahl 1990).

It is difficult to outline the full response of shorebirds to wetland and grassland modification during the past century because of the complexity of the changes and the paucity of information on shorebird abundance. Many surviving wetlands have been degraded with toxic chemicals or the erection of power lines, which lower reproductive success or increase shorebird mortality. Not all wetland alterations have been detrimental. For example, the conversion of salt marsh to salt ponds has created habitat for phalaropes and stilts in San Francisco Bay (Harvey et al. 1992). Some shorebirds also benefit when uplands are turned into wetlands. In recent decades winter mortality and possibly population sizes of shorebirds may have fluctuated inversely with avian predator populations, which plummeted from the 1950s to 1970s due to organochlorine poisoning and recovered in the 1980s partly in response to conservation efforts (White 1994). A recent change of unknown consequence is the predominance of introduced invertebrates in shorebird diets in some west coast estuaries (Carlton 1979).

POPULATIONS AT RISK

Risk assessments are useful for ranking vulnerability of populations to environmental change. Ranking systems, which differ in variables selected, precision within variables and manner of computation, are often tailored to specific taxonomic or regional requirements (Mace and Lande 1991). Since habitat alteration has had the greatest effect on shorebirds during the last century, we developed a habitat-based ranking system to assess the vulnerability of species.

For each species we first calculated a series of breeding (**B**) and wintering (**W**) area scores for each combination of habitat and region. For breeding areas **B** = **bn** where **b** = breeding region score (Arctic = 1, Temperate = 3) and **n** = breeding habitat score (all arctic habitats = 1; temperate habitats include: uplands = 3, sandy shore = 3, wetlands = 2, rocky shore = 1); for wintering areas **W** = **ws**, where **w** = wintering region score (North America = 3, pelagic = 1, and all other regions = 2); and **s** = wintering habitat score (uplands = 3, wetlands = 2, sandy shore = 2, rocky shore = 1, pelagic = 1). For each species we then calculated an overall habitat ranking score **H** = **B** + **W**, where **B** = average breeding area score and **W** = average wintering area score.

We placed higher values on breeding habitats in temperate latitudes because they have been more altered than arctic habitats. For similar reasons, upland habitats (especially native prairies, grasslands and pampas) were assigned higher values than wetlands. Sandy shore in temperate regions was scored high because of extensive recreational use, particularly along the California coast. Habitat degradation was assumed to have been more extensive in North America than in other wintering regions.

Based on these criteria, habitat vulnerability scores ranged from 18 for the Mountain Plover to 3 for the Spotted Sandpiper (*Actitis macularia,* Table 1). The mean for all species was 7.0 (SD = 3.7). Species wintering in North America had the highest mean score (9.2, SD = 4.5) followed by the bicontinental group (7.0, SD = 4.2), South American group (6.3, SD = 2.2), Americas/Oceania-Asia group (5.8, SD = 3.5) and Oceania-Asia group (5.0, SD = 0.0). Species associated with uplands overall had higher rankings (e.g., Mountain Plover, Killdeer (*Charadrius vociferus*), Marbled Godwit, and Upland Sandpiper). We emphasize that this ranking system is limited to the selection of

breeding and wintering habitats. If other factors were considered, such as extent of breeding and wintering areas, population size, and dependency on limited migratory staging areas, scores for arctic breeders such as the Eskimo Curlew and many of the calidridine sandpipers may have been higher.

CHANGES IN DISTRIBUTION AND ABUNDANCE

Temperate Breeders

There have been notable changes in the abundance and distribution of several temperate breeders during the past 150 years. In general, upland species have been affected more than wetland species and breeding ranges have contracted westward. Alteration of nesting habitat is believed to have been the dominant factor for range contraction and population declines.

Mountain Plover

This species historically nested on short grass prairie where bison (*Bison bison*) and prairie dog (*Cynomys* spp.) activity kept vegetation sparse (F. Knopf, pers. comm.). Plovers were abundant enough to be an important game bird prior to 1900, but by 1914 were reported as declining due to hunting, eradication of bison and prairie dogs, cultivation of the prairies, and degradation of traditional wintering areas (Graul and Webster 1976, Knopf 1992). Mountain Plovers continue to breed in Alberta, Saskatchewan, Colorado, Montana, Wyoming, Kansas, Nebraska, Oklahoma, New Mexico and Texas, but have been extirpated from North and South Dakota. Their range has contracted in Colorado, Kansas and New Mexico, and numbers have declined in Alberta and Saskatchewan (Leachman and Osmundson 1990; Knopf 1992, pers. comm.). In California the decline has been marked by the disappearance of wintering plovers from most valleys of the central coastal ranges and by decreasing numbers on Christmas Bird Counts in the Sacramento Valley, Salton Sea and coastal Orange County (Jurek 1973, Leachman and Osmundson 1990). The continental population, currently between 5000–15,000 birds (F. Knopf, pers. comm.), has declined significantly during the past quarter century due primarily to habitat degradation on the wintering grounds (Knopf 1992, 1994).

Long-billed Curlew

Hunting in the late 19th and early 20th centuries, and cultivation of grasslands, caused the Long-billed Curlew population to decline and the breeding range to shrink (Bent 1929, Palmer 1967, Redmond 1984). Today Long-billed Curlews breed in short grass habitats, especially pastures and uncultivated range lands, from British Columbia to California in the west, and Saskatchewan to Texas in the east. Formerly their range extended farther east into Manitoba, Minnesota, Iowa, Wisconsin and Illinois (DeSante and Pyle 1986) and was more extensive in Saskatchewan (Renaud 1980), North Dakota (Johnsgard 1981), Colorado (McCallum et al. 1977), the Great Basin (Sugden 1933) and Washington (Yocom 1956). Long-billed Curlews ceased breeding in Illinois before 1880 (Bent 1929) and in Minnesota by 1900 (Roberts 1932). According to Palmer (1967), the Long-billed Curlew population was dangerously low for several decades but increased appreciably beginning in the 1950s. Data collected for the U.S. Fish and Wildlife Service Breeding Bird Survey during the past quarter century (credited hereafter as FWS, unpubl. data) suggest a declining population in the eastern portion of the range and an increasing one in the western portion.

Upland Sandpiper

Enormous numbers of Upland Sandpipers once bred on grasslands in the Great Plains. With conversion of forest to agricultural fields their range expanded east to the Atlantic coast (Bent 1929, Palmer 1967). Then extensive hunting in North and South America and cultivation of the prairies during the late 19th and early 20th centuries caused a steep and widespread population

decline (Bent 1929, Roberts 1932, White 1983). Numbers increased after the prohibition of shorebird hunting in North America but expanded cultivation of grasslands probably has prevented full population recovery (Palmer 1967, White 1983). Upland Sandpipers now breed fairly commonly to commonly in the western Great Plains and uncommonly as far east as Maine and Virginia and as far west as Utah and eastern Oregon (DeSante and Pyle 1986). Disjunct populations also breed in Alaska and the Northwest Territories (Johnsgard 1981). In Illinois the population was estimated at 283,000 birds in 1907–1909 and 177,000–208,000 birds in 1957–1958 (Graber and Graber 1963). Stewart and Kantrud (1972) estimated 91,000–183,000 breeding pairs for North Dakota in 1976. Since numbers have increased during the past 25 years (Knopf 1994), and the species is currently a fairly common to common breeder in 10 states or provinces including North Dakota (DeSante and Pyle 1986), the North American population likely numbers between several hundred thousand and a few million birds.

Marbled Godwit

According to Palmer (1967) the Marbled Godwit had a larger breeding range and a much larger population before 1900. It no longer breeds in Wisconsin, Iowa and Nebraska and its range has shrunk in Minnesota (Roberts 1932, DeSante and Pyle 1986). Marbled Godwits now breed chiefly in the prairie pothole country of the U.S. and Canada, and have small isolated populations in Alaska, the Northwest Territories, Ontario and Colorado (Johnsgard 1981). Godwits depend on both grasslands and wetlands for breeding. Fire and grazing, formerly by bison and currently by cattle, are necessary to maintain the short upland vegetation and the open areas at wetland edges they prefer (Ryan et al. 1984). Godwits have suffered from conversion of native grasslands to agricultural crops. Additionally, wildlife management on the northern prairies is directed at producing tall, dense nesting cover for waterfowl and upland game—habitat not favored by nesting godwits (Ryan et al. 1984). Stewart and Kantrud (1972) estimated 37,000 pairs of breeding godwits in 1967 in North Dakota, one of six states or provinces where breeders are categorized as fairly common to common (DeSante and Pyle 1986). Surveys between 1990 and 1992 indicate around 100,000 wintering godwits along the Pacific coast of North America (Table 2). Since Marbled Godwits winter chiefly on the Pacific coast of North America (Palmer 1967, Root 1988), the continental population is probably currently fewer than 200,000 birds. There has been no evidence of a decline in breeding numbers during the past 25 years (FWS, unpubl. data).

Willet

The western subspecies of the Willet (*Catoptrophorus semipalmatus inornatus*) breeds in the prairie pothole and Great Basin regions of western North America (AOU 1983). On the prairies they exploit short, sparse cover in wetlands and grasslands. Their population has declined because of the conversion of wetlands and uplands to small grain and row crops (Ryan and Renken 1987). Willets no longer breed in Minnesota and Iowa (DeSante and Pyle 1986) and their range has shrunk in North Dakota (Ryan and Renken 1987). There were an estimated 41,000 breeding pairs in North Dakota in 1967 (Stewart and Kantrud 1972). The current winter population in the Pacific Flyway is at least 70,000 birds (Table 2). There has been no distinct trend in breeding numbers during the past 25 years (FWS, unpubl. data).

Snowy Plover

The subspecies west of the Rockies, *Charadrius alexandrinus nivosus,* breeds along coastal beaches and at interior saline and alkaline wetlands (Page et al. 1991). Surveys of Washington, California, Oregon and Nevada from 1977–1980 indicated 10,200 breeders; about 2300 were on the coast (Page

TABLE 2. POPULATIONS OF SELECTED SPECIES OF SHOREBIRDS FOR WHICH CURRENT ESTIMATES ARE AVAILABLE

Species	Population size[1]	Season	Area[2]	Source[3]
Charadrius montanus	5000–15,000	breeding	Continental	F. Knopf (pers. comm.)
C. alexandrinus nivosus	18,500	breeding	Western U.S.	Page et al. (1991), Paton and Edwards (1992)
Haemantopus bachmani	7600	breeding	Pacific Flyway	Carter et al. (1992), *in* Campbell et al. (1990)
Himantopus mexicanus	25,000	winter	Pacific Flyway	Page et al. (1992), Morrison et al. (1992), PRBO (unpubl. data), MBO (unpubl. data)
H. m. knudseni	1100	resident	Hawaiian Is.	HDFW (unpubl. data), Engilis and Pratt (1993)
Recurvirostra americana	100,000	winter	Pacific Flyway	Page et al. (1992), Morrison et al. (1992), PRBO (unpubl. data), MBO (unpubl. data)
Catoptrophorus semipalmatus	70,000+	winter	Pacific Flyway	Page et al. (1992), Morrison et al. (1992), PRBO (unpubl. data), MBO (unpubl. data)
Numenius borealis	25–50	breeding	Continental	*in* Alexander et al. (1991), Gollop (1988)
N. tahitiensis	7000	breeding	Alaska	Gill and Redmond (1992), C. Handel and R. Gill (unpubl. data)
Limosa lapponica	25,000–40,000	breeding	Alaska	Gill and Jorgensen (1979), Gill and Handel (1990), B. McCaffery (unpubl. data)
L. fedoa	100,000	winter	Pacific Flyway	Page et al. (1992), Morrison et al. (1992), PRBO (unpubl. data), MBO (unpubl. data)
Arenaria melanocephala	61,000–99,000	breeding	Alaska	Handel and Gill (1992)
Aphriza virgata	50,000–70,000	spring	Alaska	Norton et al. (1990), P. Martin (unpubl. data)
Calidris alpina pacifica	450,000–600,000	winter	Pacific Flyway	Page et al. (1992), Morrison et al. (1992), PRBO (unpubl. data), MBO (unpubl. data)
Phalaropus tricolor	1,500,000	autumn	Continental	Jehl (1988)

[1] Population size = estimated number of individual birds.
[2] Pacific Flyway as depicted on Figure 1, this report. Continental = North America.
[3] HDFW = Hawaii Division of Forestry and Wildlife, MBO = Manomet Bird Observatory, Manomet, Massachusetts, PRBO = Point Reyes Bird Observatory, Stinson Beach, California.

et al. 1991). Breeders were absent at 33 of 53 California coastal sites with records prior to 1970 (Page and Stenzel 1981). Christmas Bird Counts from the early 1960s to the mid-1980s also indicated declining numbers in winter along the southern California coast (Page et al. 1986, Butcher and Lowe 1990). The situation in the interior was unclear since breeding habitat had been lost at some locations, especially in the Central Valley, but gained elsewhere such as the Salton Sea (Page and Stenzel 1981). A repeat breeding season survey in the same states during 1988–1989 indicated only 7900 Snowy Plovers, a 20% decline from a decade earlier both on the coast and in the interior (Page et al. 1991). By 1990 the number of historical coastal breeding sites had declined from 29 to 6 in Oregon (C. Bruce, pers. comm.) and from 6 to 2 in Washington (E. Cummins, pers. comm.). Plants introduced to stabilize dunes, expanding recreational use of beaches, and heavy nest predation by feral foxes (*Vulpes vulpes*) threaten to reduce coastal nesting populations even further. The discovery of up to 10,000 breeding Snowy Plovers at Great Salt Lake in 1992 would put the current U.S. population west of the Rockies at about 18,500 birds (Page et al. 1991, Paton and Edwards 1992).

Black-necked Stilt (Himantopus mexicanus)

Stilts breed at ephemeral fresh to brackish water pools, salt meadows, rice fields, agricultural waste water ponds, coastal lagoons, and salt evaporation ponds (Johnsgard 1981). Their western North American range includes the western Great Plains, the Great Basin, California's Central Valley, the central and southern California coast, the Texas coast, Mexico, and the Hawaiian Islands (AOU 1983). During the last two decades stilts have expanded their western range, at least temporarily, northward into Washington, Montana, Alberta and Saskatchewan, in response to drought in their traditional range (Rohwer et al. 1979, Salisbury and Salisbury 1989). Within the last century stilts have colonized the salt evaporation ponds of San Francisco Bay (Shuford et al. 1989) and the Salton Sea. The degree to which these gains offset losses in the Central Valley, where over 90% of the historic wetland habitat has been destroyed (Frayer et al. 1989), is unknown. Numbers of stilts breeding on the North American continent are probably much reduced over former times, based on the amount of wetland habitat lost during the past 200 years in western states where they currently breed (range for 11 states 27–91%; median = 38%; Dahl 1990). The population wintering in the Pacific Flyway has recently been estimated at about 25,000 birds (Table 2). Hunting and loss of lowland wetland habitat caused the Hawaiian population of stilts to decline to possibly as few as 200 birds in 1944 (Monroe 1976). Stilts were protected in 1939 following a prohibition on hunting. By 1949 the population had rebounded to 1000 birds (Swartz and Swartz 1949) and currently fluctuates around 1000 birds (Engilis and Pratt 1993).

American Avocet (Recurvirostra americana)

Avocets breed at alkaline lakes and ponds, coastal lagoons, and salt and waste water evaporation ponds over a range including the western Great Plains; the intermountain region of the U.S. west of the Rockies; California's Central Valley and central and southern coast; and Mexico (AOU 1983). Historically they bred farther north through Alberta to the Northwest Territories (AOU 1983). Wetland loss has been extensive during the past 200 years in states where avocets currently breed (range 27–91%; median = 42%; Dahl 1990). Such losses must have caused a shrinkage of population size (Grinnell and Miller 1944) despite habitat gains such as creation of the salt ponds in San Francisco Bay and the Salton Sea. Currently, about 100,000 avocets winter in the Pa-

cific Flyway (Table 2). Unless there are substantially more avocets throughout the remainder of the winter range in southern Texas and Mexico (Palmer 1967, Root 1988), the continental population must be in the low hundreds of thousands. Although breeding bird surveys indicate a decline in the western breeding population during the past 10 years (FWS, unpubl. data), lower numbers may only reflect fluctuations in response to a recent widespread drought in the west (Alberico 1993).

*Wilson's Phalarope (*Phalaropus tricolor*)*

Wilson's Phalaropes breed abundantly in ephemeral wetlands and are able to respond to droughts with large population shifts (M. Colwell, pers. comm.). Because of the high rate of wetland loss during the past two centuries on the phalarope's Great Plains and Great Basin breeding grounds (Dahl 1990), the continental population most likely has declined. During the past 50 years, however, the breeding range has expanded north into the Yukon Territory; south into Arizona, New Mexico, Oklahoma and Texas; and east into the Canadian maritime provinces and Maine (Jehl 1988, McAlpine et al. 1988). An abundant breeder in Minnesota prior to 1900, the Wilson's Phalarope inexplicably nearly disappeared for 20 years beginning in 1900. Although numbers increased steadily thereafter, by 1930 it was still not nearly as abundant as in the pre-1900s (Roberts 1932). Wilson's Phalaropes are now described as fairly common breeders in Minnesota (DeSante and Pyle 1986). Jehl (1988) makes a gross estimate of 1.5 million birds for the current size of the continental population in fall. Breeding bird surveys indicate a decline in numbers in the Great Plains over the past 10 years, a period too short to reveal much about population trends (FWS, unpubl. data). Jehl (pers. comm.) has not noted any overall decline in Wilson's Phalarope numbers at major fall staging areas during the past decade, although local reductions have been large at some localities.

Other temperate breeders

Little has been reported on other temperate breeders to indicate a change in population size or breeding range. The Common Snipe likely has lost breeding habitat and declined in the west because its breeding range includes the Great Plains and Great Basin, where there have been significant wetland losses. The continental population showed a decline over the last 10 years but not over the past 25 years of breeding bird surveys (FWS, unpubl. data). Spotted Sandpipers and Killdeers are likely to have been less affected by change on their breeding grounds than most other temperate breeders because of their broad ranges, diverse nesting habitats and affinity for altered habitats (Grinnell et al. 1918, Johnsgard 1981). Spotted Sandpipers have shown no evidence of decline over the past 25 years in the central or western portions of their U.S. breeding range. Killdeers, in contrast, have declined over the past 25 years in the western range and over the past 10 years in the western and central range (FWS, unpubl. data). The range of the Black Oystercatcher is restricted to the rocky shoreline of the Pacific coast, where there is minimal human impact. The only other temperate breeders in western North America are the American Oystercatcher and Wilson's Plover, which nest in the extreme southern part of the Pacific Flyway. The beaches and wetlands that they use are likely little altered and disturbed compared to those farther north.

Arctic Breeders

Our ability to assess change in arctic and subarctic shorebird populations is extremely limited. Remoteness of breeding areas, broad distributions, and limited life history observations have resulted in a paucity of information on which to assess population trends, with one notable exception, the Eskimo Curlew. As of 1989 the Eskimo Curlew population was thought to be about two dozen individuals (Alexander et al. 1991). There have been no authenticated sightings

in North America since 1989 or in South America since 1939 (Wetmore 1939). Eskimo Curlews formerly nested in the McKenzie District, Northwest Territories eastward to Hudson Bay and possibly westward throughout northern Alaska (Banks 1977, Gollop et al. 1986, Houston 1994). Aside from reference to the species as a common spring and fall migrant in western Alaska (Nelson 1883, Murdoch 1885, McLenegan 1887), there are no records west of the Rocky Mountains (Gollop et al. 1986).

Although anecdotal accounts suggest a historic population of millions of Eskimo Curlews (Gollop et al. 1986), numbers may not have exceeded hundreds of thousands of birds (Gollop 1989). Although the curlew's decline was dramatic and well documented, the causes are still uncertain (Banks 1977, Gollop et al. 1986). Market hunting from 1880–1890 on both the South American wintering grounds and on migration staging areas in North America is frequently mentioned as the most important factor. Concomitantly, however, there was widespread conversion of curlew habitat from native grasslands to croplands and pasture. Banks (1977) speculated that a combination of factors was responsible for the decline including: hunting, habitat alteration, mortality during autumn migration caused by severe Atlantic storms in the 1880s, and volcanic eruptions between 1883 and 1907, which produced extensive atmospheric dust and prolonged winter conditions on the breeding grounds. Still lacking, however, is an explanation for why other species such as Lesser Golden Plover and Hudsonian Godwit, which nested at the same latitudes, shared the same migration routes and wintering areas, and were excessively hunted, rebounded from suppressed population levels whereas the curlew did not.

Changes in populations of other arctic breeders during the past century are not readily apparent because of the absence of data on historical abundance. Fortunately, recent studies are beginning to generate baseline information on population sizes. The population of Black Turnstones (*Arenaria melanocephala*) breeding in Alaska was estimated at about 95,000 birds in the early 1980s (Handel and Gill 1992) and the Bristle-thighed Curlew (*Numenius tahitiensis*) population in the early 1990s was estimated at about 7000 breeding birds (Gill and Redmond 1992; C. Handel and R. Gill, unpubl. data). Less precise information has also been obtained for the Surfbird. The 50,000–70,000 birds that stage in western Prince William Sound, Alaska, during spring migration are suspected to include the majority of the continental population (Norton et al. 1990). Studies on a more regional level include those of Troy (1992), who has amassed a 10-year data set on population trends of breeding shorebirds on the arctic coastal plain of Alaska; Connors and Risebrough (1978), who studied shorebird dependency on littoral habitats in Alaska; and Gill and Handel (1981, 1990) and Woodby and Divoky (1983), who studied postbreeding shorebird concentrations along the coast of western Alaska.

POPULATION SIZES AND LIMITING FACTORS

The few crude population estimates available for North American shorebirds range widely in size from a handful of Eskimo Curlews to 1.5 million Wilson's Phalaropes (Table 2). Probably the most abundant western North American species is the Western Sandpiper (*Calidris mauri*). Over 6 million reportedly passed through the Copper River Delta during the 1973 spring migration (Isleib 1979), but this estimate may be too high since it assumed complete population turnover every three tidal cycles. About 1.3 million were counted in Pacific Flyway wetlands south of Alaska over a week-long period at the peak of spring migration in late April 1991 (PRBO, unpubl. data).

Very little is known about the factors that have affected population size in shorebirds. The anecdotal information on temperate breeders suggests the amount and quality of available breeding habitat may have been the most important limiting factor in the

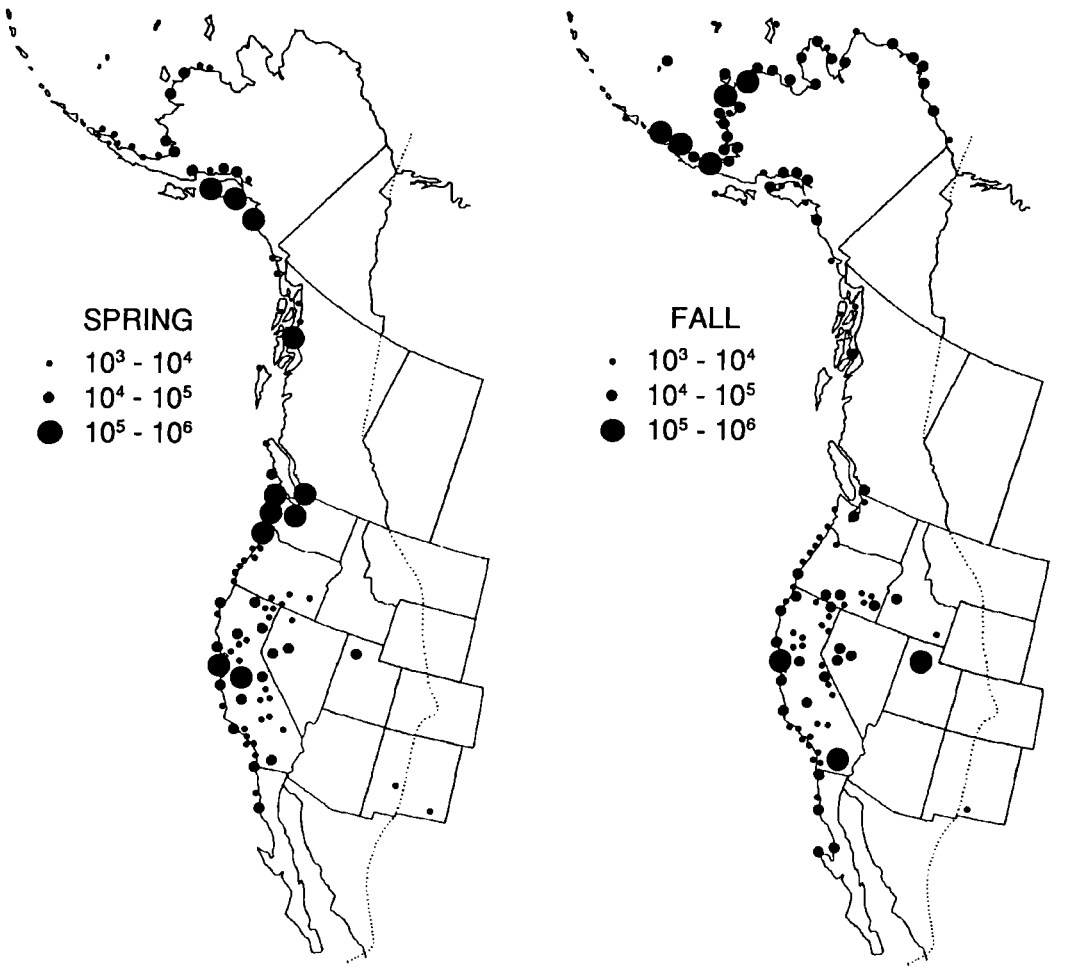

FIGURE 1. Sites of concentrations of shorebirds in spring and fall throughout the Pacific Flyway. Numbers represent total birds of all species (after Page et al. 1992; Morrison et al. 1992; Gill, unpubl. data).

recent past. Ranges have shrunk and populations have declined as grasslands and wetlands have been converted to croplands, or as beaches have been engulfed by urban and recreational development. Mountain Plover populations are believed to be declining now, however, due to deteriorating conditions on their wintering grounds (Knopf 1994). Eskimo Curlews have not been able to recover from the excessive hunting and habitat alteration around the turn of the century. Whether other arctic breeders are limited by conditions on their breeding, staging or wintering grounds is unknown. Information emerging from long-term studies in Europe suggests that some arctic species may be limited by conditions on the wintering grounds and others by conditions on the breeding grounds (Goss-Custard and Moser 1988, Moser 1988).

CAPACITY TO DETECT FUTURE POPULATION CHANGE

While there is little precise information on changes in western North American shorebird populations during the past century, expansion of ongoing programs, coupled with new efforts, could provide the information needed to monitor some populations during the next century (Table

TABLE 3. MONITORING SCHEMES BEST SUITED FOR DETECTING TRENDS IN POPULATION OF SELECTED SPECIES OF SHOREBIRDS DURING THE NEXT CENTURY

Species	Monitoring scheme[1]			
	BBS	CBC	ISS	SSS
Pluvialis squatarola			x (W[2], S)	
Charadrius alexandrinus		x		x
C. semipalmatus			x (F, S)	
C. vociferus	x	x		
C. montanus	x			x
Haematopus bachmani		x		x
Himantopus mexicanus	x		x (F)	
Recurvirostra americana	x		x (F, W)	
Catoptrophorus semipalmatus	x		x (F, W)	
Actitis macularia	x			
Bartramia longicauda	x			
Numenius phaeopus			x (S)	
N. tahitiensis				x
N. americanus	x		x (F, W)	
Limosa fedoa	x		x (W, S)	
Arenaria melanocephala		x		x
Aphriza virgata				x
Calidris alba		x		
C. mauri			x (W, S)	
C. minutilla			x (F, W)	
C. alpina			x (W, S)	
Limnodromus griseus			x (S)	
Gallinago gallinago	x	x		
Phalaropus tricolor			x (F)	

[1] BBS = U.S. Fish and Wildlife Service Breeding Bird Survey, CBC = National Audubon Society Christmas Bird Count, ISS = International Shorebird Survey (Howe et al. 1989), SSS = Species Specific Survey.
[2] S = spring, F = fall, W = winter.

3). The Breeding Bird Survey of the U.S. Fish and Wildlife Service could prove useful for identifying future population trends of 10 temperate breeders. Christmas Bird Counts of the National Audubon Society could be used for wintering populations of at least six species. Recently completed species-specific breeding season surveys could be periodically replicated for six species. At least eight additional species that breed in the arctic could be monitored by adapting the methods of the International Shorebird Survey (Howe et al. 1989) to the Pacific Flyway. New information on the key staging and wintering areas for shorebirds in western North America (Fig. 1) could be used to identify monitoring sites that would be representative of the total Pacific Flyway population. Work still needs to be done to develop economical monitoring methods for the remaining species.

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