REGIONAL PATTERNS IN COASTAL SHOREBIRD COMMUNITIES OF ARCTIC AND SUBARCTIC ALASKA

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As a group, shorebirds (Charadriiformes: charadrii: sandpipers, plovers and their relatives) comprise a prominent and characteristic segment of the avifauna of arctic and subarctic tundra regions throughout the northern hemisphere. At most coastal tundra sites numbers of shorebird species and individuals exceed those of any other avian taxonomic group. shorebirds nest on tundra, but frequently forage along beaches, in saltmarshes and on coastal mudflats, especially during migration. As a group they include many of the world's longest-distance migrants, with several species wintering in the southern hemisphere. The late summer period of heaviest shorebird activity in littoral habitats precedes the energetically demanding southward migration, and probably represents an interlude during which shorebird populations depend critically on resources in these coastal habitats.

studies of shorebird nesting ecology, distribution and population densities have been conducted at many arctic sites in recent decades, and several studies have focused on ecology and movements in the littoral zone (see references by geographic region below). The following discussion will compare shorebird communities in littoral habitats from the western Canadian arctic to northeastern Siberia, extracting those features common to all regions and contrasting different regions in such factors as shorebird species composition, habitat availability, seasonal patterns of habitat use, trophic relationships and timing of movements. This exercise will point up the international nature of arctic shorebird communities and the resources on which they depend.

shorebird communities in the Alaskan arctic and subarctic littoral zone: a general description.

The littoral zone can be defined in different ways, but for this report I shall consider all shoreline areas likely to be inundated by saline or brackish water at least once each year. Along the Beaufort coast normal lunar tides are very small, ranging over less than .25 m in most areas. Wind and atmospheric conditions can produce much larger storm tides, however, flooding low-lying areas. Those habitats subject to storm tides as frequently as every year support characteristic salt-tolerant marsh vegetation, or remain unvegetated. I consider these to be littoral zone habitats in contrast to freshwater tundra habitats above the normal flood zone. The more southern coasts of the Bering Sea have larger lunar tidal amplitudes which create a much wider primary littoral zone, but these coasts also are subject to storm flooding, creating an additional littoral (or near-littoral) zone which is salt-affected.

Shorebird use of arctic littoral habitats contrasts sharply in many respects with that of tundra habitats, where almost all species nest. In areas along the Beaufort coast, many shorelines are frozen and inaccessible to shorebirds in early summer. Activities during this period and throughout the incubation and chick-tending periods are centered on the tundra, where emerging insects, spiders and aquatic plankton provide the food source. A few species (for example, Semipalmated and Western sandpipers) also forage along littoral sloughs and on mudflats near their nesting areas, and some species (semipalmated Plover and occasionally Baird's Sandpiper) nest in near-littoral habitats, such as gravel beaches or gravel margins of sloughs. These exceptions, however, do not alter the general rule of much heavier use of tundra habitats during the early breeding season on the Beaufort coast. AS the season progresses, two factors support a shift in shorebird activity into the littoral zone. Break-up of ice along lagoon and ocean shorelines increases the open littoral habitat, making new food sources available to foraging birds; second, as nesting activities proceed, one or both sexes of breeding birds are released from duties which had required their presence near tundra nest sites. These successful breeders join previously unsuccessful breeders along shorelines, and in late summer they are joined or replaced by fledged juveniles of many species.

The timing and magnitude of this habitat shift can be seen in Figure 1 for census transects near Barrow. The extremely high densities in late summer littoral habitats represent mainly juvenile Red Phalaropes, but a similar plot of all shorebirds except phalaropes shows the same seasonal shift, with August littoral densities approximately double the tundra densities. These patterns for the shorebird community as a whole are composites of many individual species patterns which vary in magnitude, precise timing and degree of the shift to the littoral zone.

Similar habitat shifts occur along subarctic coasts of the Bering Sea, but the season of littoral zone use is much longer, since habitats are used by some species during Spring migration, and the post-breeding period continues up to one month longer than in the arctic. In addition, several species forage to an important extent in near-littoral and littoral habitats during the breeding season in areas such as the Yukon Delta. Nevertheless, the season of heaviest shorebird use of littoral zone habitats is the post-breeding migration period in all the areas addressed in this report.

The principal prey resources in the arctic and subarctic littoral zone can be grouped broadly into two categories. Marine and estuarine zooplankton and epibenthic organisms (copepods, amphipods, euphausiids, decapod larvae, mysids, etc.) are important along ocean and lagoon shorelines, and adult and larval insects (principally fly larvae), small

molluscs, and oligochaete worms provide essential resources in saltmarshes, on mudflats, and along the margins of sloughs. Zooplankton communities and densities are highly variable over time and space, but are frequently abundant, attracting principally Red and Northern Phalaropes and Sanderlings, as well as Ruddy Turnstones, Dunlins and several other shorebird species to a lesser extent. The benthic prey base of coastal mudflats and saltmarshes attracts larger numbers of Long-billed Dowitchers, Western and Semipalmated Sandpipers, and Dunlins, and almost all other species at least occasionally.

Along most of the Alaska Beaufort, Chukchi, and Bering coasts, the preceding description gives a general view of shorebird activity in the littoral zone. Several factors alter details of the picture at specific sites, however. Foremost among these are the distributional changes in local shorebird breeding communities and migratory patterns at different sites across the arctic, since these determine the species mix and relative abundances at each site. Across the Western Canadian and Alaskan arctic, many distributional changes follow a simple latitudinal or longitudinal gradient, but discontinuities in breeding distribution or

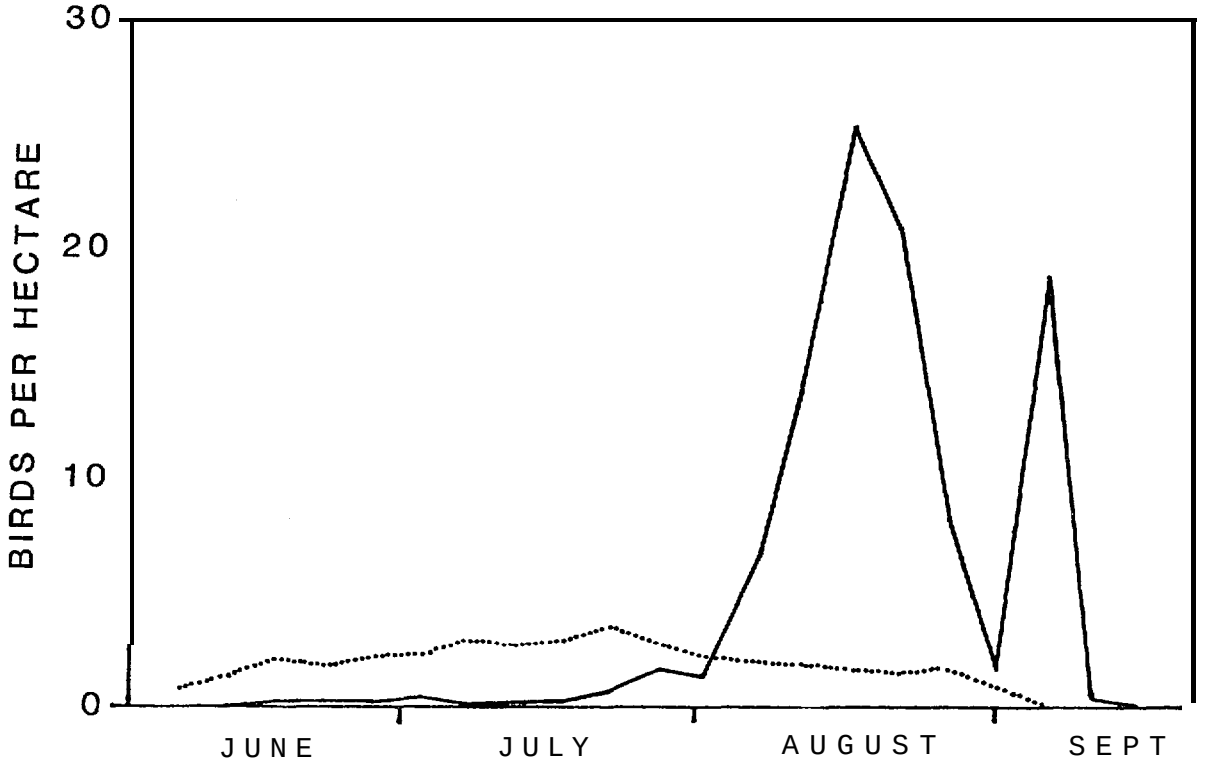

Figure 1. Seasonal changes in habitat use by shorebirds near Barrow, Alaska. Total shorebird densities on tundra (dotted line) compared to densities in littoral zone habitats (solid line). From Connors et al, 1981.

in migration routes complicate this. The mix of local habitats, especially, of different littoral habitats, further affects the relative abundances and absolute numbers of shorebird species at different sites, by determining the availability of different types of prey and of foraging conditions. Finally, the phenology of events such as ice break-up and insect hatches in relation to migratory movements and nesting events determines the availability and attractiveness of littoral habitats in different coastal regions.

The remaining sections of this report summarize the shorebird littoral zone communities for 5 sections of coast from northwestern Canada to northeastern Siberia (see maps, figures 2,3, and 4). Breeding lists and relative abundances of littoral zone shorebirds are based on information in published references cited in each section. In some cases this has been supplemented with descriptions of broader area distribution (see Gabrielson and Lincoln 1959, Godfrey 1966, Kessel and Gibson 1978). In compiling these lists I have omitted all species which occur only rarely in the region addressed. This treatment is not intended to be exhaustive, but rather to summarize the prominent features of avian distribution and habitat use along each coast. Where species distributions are highly patchy I have tried to denote the average status across the region; where status changes markedly from one end of a region to the other, I have indicated the area and status where a species is most common. contrasts or comparisons among sites are emphasized. This exercise is an attempt to define the major differences in shorebird littoral zone communities between areas, but it is unavoidably based on an inconsistent data base, since different studies focus on different topics at each site, and coverage of all coastal sections is neither equal nor continuous.

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Region B: Beaufort and Chukchi Coasts, Prudhoe Bay to Cape Lisburne.

The extensive arctic coastal plain north of the Brooks Range in Alaska reaches its widest and its northernmost point at Pt. Barrow (Figure 2). The Chukchi and Beaufort Sea coasts west and east of that point share many features of general geomorphology which provide similar littoral habitats of importance to shorebird populations. Areas of complex shorelines produced by spits, barrier islands, lagoons, sloughs and river deltas attract the highest density use, here as in other regions. Known concentration areas in late summer (primarily 15 July-5 September) include the islands, spits, mudflats and saltmarshes of Kasegaluk Lagoon, the spits and islands of peard Bay, Point Barrow and the Plover Islands, the mudflats and saltmarshes of Fish Creek and Colville River Deltas, and the Simpson Lagoon area. During migration shorebirds occur in small patches of similar habitats distributed almost continuously along the coastline of the arctic coastal plain, but total numbers at most individual sites remain low compared to the main concentration areas. The principal feature which separates these sites is the total area or distance of suitable habitat available. Except at these locations, and possibly at some unstudied sites such as DeaSe Inlet or smith Bay, areas of mudflat and saltmarsh are restricted in this region compared to areas farther south and west.

The mix of species characteristic of these locations varies in several ways. First, as described earlier, areas of spits and barrier islands typically attract phalaropes, turnstones, and Sanderlings preferentially, while mudflat-saltmarsh habitats support larger numbers of Long-billed Dowitchers, Dunlins, and several other species of sandpipers. (Arctic Terns, Black-legged Kittiwakes and Glaucous, Sabine's, and Ross' Gulls also congregate along spit and island shores.) second, the distribution of breeding shorebirds varies over this region, so the mix of species in littoral habitats varies, primarily on an east-west gradient. Most noticeably, Western Sandpipers are a common breeding species on the coastal plain west of Barrow, and one of the conspicuous members of the littoral zone shorebird community in that area. East of Barrow they are rare or absent as breeders, and uncommon to rare as migrants. Stilt sandpipers have a somewhat complementary distribution, breeding in eastern sections of the Alaska Beaufort coastal plain, but not near Barrow and westward, and occurring fairly commonly as migrants east of Barrow. other species which are more common in eastern areas of this region include Black-bellied Plover and White-rumped Sandpiper. Red-necked Phalaropes are much more common near Prudhoe Bay than at Barrow,

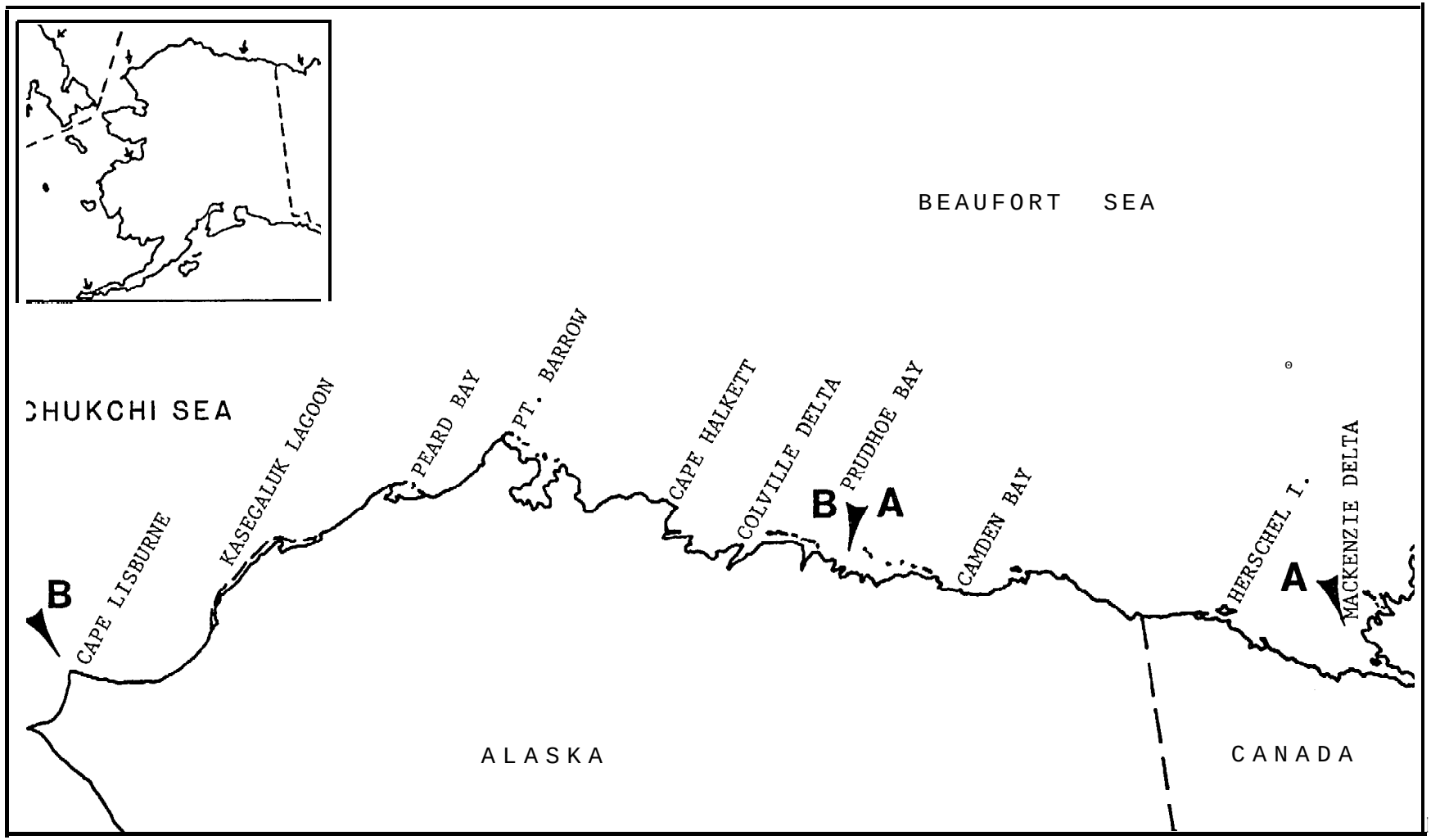

Figure 2. coastal map of Regions A and B, Beaufort and Chukchi Seas.

Table 1. Status of shorebirds occurring regularly along the Region B coast. VC-very common; FC-fairly common; UC-uncommon; R-rare.

species	Breeding June-July	Littoral Zone Migration July-Sept
Black-bellied plover *Pluvialis squatarola*	FC	FC
Lesser Golden Plover *Pluvialis dominica*	Vc	FC
Semipalmated Plover *Charadrius semipalmatus*	UC	Uc
Whimbrel *Numen ius phaeopus*	Uc	R
Bar-tailed Godwit *Limosa lapponica*	R	Uc
Ruddy Turnstone *Arenaria interpres*	Vc	Vc
Red Knot *Calidris canutus*	R west	Uc
Sanderling *Calidris alba*	R	FC
Semipalmated Sandpiper *Calidris pusilla*	Vc	Vc
Western Sandpiper *Calidris mauri*	VC west	VC west
White-rumped Sandpiper *Calidris fuscicollis*	UC east	UC east
Baird's Sandpiper *Calidris bairdii*	FC	FC
Pectoral Sandpiper *Calidris melanotos*	Vc	Vc
Dunlin *Calidris alpina*	Vc	Vc
Stilt Sandpiper *Calidris himantopus*	FC east	FC east
Buff-breasted Sandpiper *Tryngites subruficollis*	FC east	R
Long-billed Dowitcher *Limnodromus scolopaceus*	FC	Vc
Red-necked Phalarope *Phalaropus lobatus*	FC	Vc
Red Phalarope *Phalaropus fulicaria*	Vc	Vc

but they may also occur in large migrant flocks at the western limits of this region, near Cape Lisburne (G. Divoky, pers. comm.). Several species, especially Lesser Golden Plover, Semipalmated, Baird's and Pectoral Sandpipers, Dunlin and Red Phalaropes are common throughout the region, both as breeders and migrants.

Densities of shorebirds nesting on coastal plain tundra or using littoral habitats during migration have been recorded at many sites within this region, as at Icy Cape, Peard Bay, Pt. Barrow, Atkasook, Cooper Island, Fish Creek, Simpson Lagoon, Pt. Storkersen, and prudhoe Bay, as well as at several other sites visited only occasionally. Nesting densities of shorebirds averaged 66 territories per km^2 near Prudhoe Bay (NOrtOn et al. 1975, Troy et al. 1983), 79 per km^2 near Barrow (Myers and Pitelka 1980) and 111 per km^2 near Atkasook, 100 km south of Barrow (Myers and Pitelka 1980). Densities of migrating shorebirds in late summer littoral habitats reach peak values much higher than these (above 100 birds per km of beach near Pt. Barrow (Connors et al. 1979), above 70 birds per km of barrier island beach at Simpson Lagoon (Johnson and Richardson 1981), and above 600 birds per km^2 of saltmarsh and mudflats on Fish Creek Delta (Connors et al. 1981). Mean densities throughout the late summer period are lower than these, however. During migration peaks, flocks of phalaropes, the most numerous shorebirds migrating along shorelines in the region, sometimes number several thousand birds at Point Barrow and at other spits and barrier islands.

The references listed below give a general indication of the effort which has been directed to studies of arctic coastal plain birds, shorebirds in particular, and also indicate the geographic distribution of those studies. The extensive coast has not yet been covered sufficiently to be confident that all important littoral areas and potential concentration areas are known.

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Region A. Beaufort coast from prudhoe Bay to the Mackenzie Delta.

The arctic coastal plain is narrower in this region compared with Region B, and the closer approach of the Brooks Range to the Beaufort Sea produces well-drained tundra with generally lower nesting densities of the shorebirds which are most abundant nearer BarrOw. Deltas of numerous small rivers, spits, barrier islands, occasional areas of saltmarsh or flooded tundra provide littoral habitats used by migrating birds. Study coverage is patchy, but reports are available for several sites on both the Alaskan and Canadian portions of this region (Figure 2).

The geographic trends in bird distribution evident in Table 1 are continued in Table 2, with Western Sandpipers present only as rare migrants, and eastern species (Stilt sandpiper, Buff-breasted Sandpiper) fairly common. Northern Phalaropes are common nesting species in this region in contrast to their scarcity in the western Beaufort, and they are abundant coastal migrants. Red Phalaropes continue as common breeders near the coast throughout both regions, but with densities declining in the east. AS migrants, however, they are much more common in the west. This shift in relative abundance is apparent in the ratios of the two species counted at several points along the Beaufort coast (Table 3). Dunlins, one of the consistently common breeding species along the Alaskan coast from the Bering Sea north and east along most of the Alaskan Beaufort coast, is absent or rare as a breeder near Demarcation Point and along the Yukon coast, although it occurs in these areas uncommonly as a migrant.

Locations of site studies for area A are mentioned below in the list of references. Concentration areas of late summer migrant shorebirds probably correspond with areas of the more extensive littoral wetlands, spits, and barrier islands. Herschel Island is of particular significance for phalaropes (Vermeer and Anweiler 1975).

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Table 2. Status of shorebirds occurring regularly along the coast of Region A. Symbols as in Table 1.

Species	Breeding June-July	Littoral Zone Migration July-Sept
Black-bellied Plover	UC	FC
LeSser Golden Plover	VC	FC
Semipalmated Plover	Uc	Uc
Whimbrel	--	Uc
Ruddy Turnstone	FC	FC
Sanderling	--	FC
Semipalmated Sandpiper	VC	Vc
Western sandpiper	--	UC west
White-rumped Sandpiper	UC west	UC west
Baird's Sandpiper	FC	FC
Pectoral Sandpiper	Vc	FC
Dunlin	FC west	FC west
Stilt Sandpiper	FC	FC
Buff-breasted Sandpiper	FC	Uc
Long-billed Dowitcher	Uc	Vc
common Snipe *Gallinago gallinago*	UC east	R
Red-necked Phalarope	Vc	Vc
Red Phalarope	Vc	FC

Table 3. Ratios of Red Phalaropes: Red-necked Phalaropes in late summer migrant foraging flocks along the Beaufort coast.

Barrow, Alaska 156°30'W	30:1	Connors et al. (1981)
Simpson Lagoon, Alaska 149°30'W	4:1	Johnson and Richardson (1981)
Nunaluk Spit, Canada 139°40'W	1:20	Salter et al. (1980)
Herschel Island, Canada 139°10'W	1:40	Vermeer and Anweiler (1975)

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Region C: Bering and Chukchi coasts, Cape Lisburne to NOrtOn Sound.

This coastal region is more varied in shoreline environments than is the Beaufort coast because of the greater latitudinal range, variation in coastal topography from rocky cliff headlands to coastal plains and lagoons, and the much greater range of summer ice conditions (Figure 3). Mainland rock cliffs, especially at Cape Lisburne and Cape Thompson, provide nesting habitats for large numbers of seabirds but the resultant lack of coastal wetlands in these areas makes them underutilized by shorebirds. Coastal lowland tundra nesting areas are not as extensive as on the North slope arctic coastal plain, and the more prevalent upland tundra supports generally lower shorebird nesting densities. At some sites with wet tundra areas, however, densities are high. Shorebird nesting densities have been measured at only 47 nests/km^2 at Cape Krusenstern (Connors and Connors, 1978), but at 62 to 336 nests/km^2 at Cape Espenberg (Schamel et. al. 1979), 129 nests/km^2 near Shishmaref (Wright 1979), 100 nests/km^2 at wales (Hirsch and Woodby 1978), and 109 to 160 nests/ km near the Akulik-Inglutalik river delta in Norton Sound (Shields and peyton 1979). High nesting densities have also been recorded in other areas of coastal wetlands around Norton Sound (Woodby and Divoky 1983). The most common species at most of these sites are Red-necked Phalarope, Western and Semipalmated sandpipers, and Dunlin.

spits and barrier islands are less prominent and less heavily used by post-breeding phalaropes, Sanderlings, and Ruddy Turnstones in this region compared with the Beaufort coast. Mudflat and saltmarsh habitats are much more extensive here, however, and large numbers of several species of shorebirds, especially Semipalmated, Western and pectoral Sandpipers, Dunlin and Long- billed Dowitchers forage in these areas in late summer. Major areas of these littoral habitats occur in Kotzebue Sound, especially the Noatak Delta, on the north shore of Seward Peninsula, and in inner NOrtOn Sound. Densities of migrant shorebirds on 10 coastal wetlands around Norton Sound averaged over 250 birds/km^2, with migration peaks of individual species totaling much higher (Woodby and Divoky 1983). Between these important wetlands, however, coastal beaches backed by well-drained tundra are little used by post-breeding shorebirds (Connors and Connors 1982, Woodby and Divoky 1983).

Species distributions in RegiOn C show several contrasts with the two northern regions (Table 4). Several species seldom seen on the arctic coastal plain are regular breeders or migrants in this region, occurring over wide areas or only locally (Black Turnstone, Sharp-tailed sandpiper, Common Snipe, Rock sandpiper, Hudsonian Godwit, Lesser Yellowlegs). A few of the most common arctic species are local or much less common here (Ruddy Turnstone, Red Phalarope, breeding Pectoral Sandpiper). The more

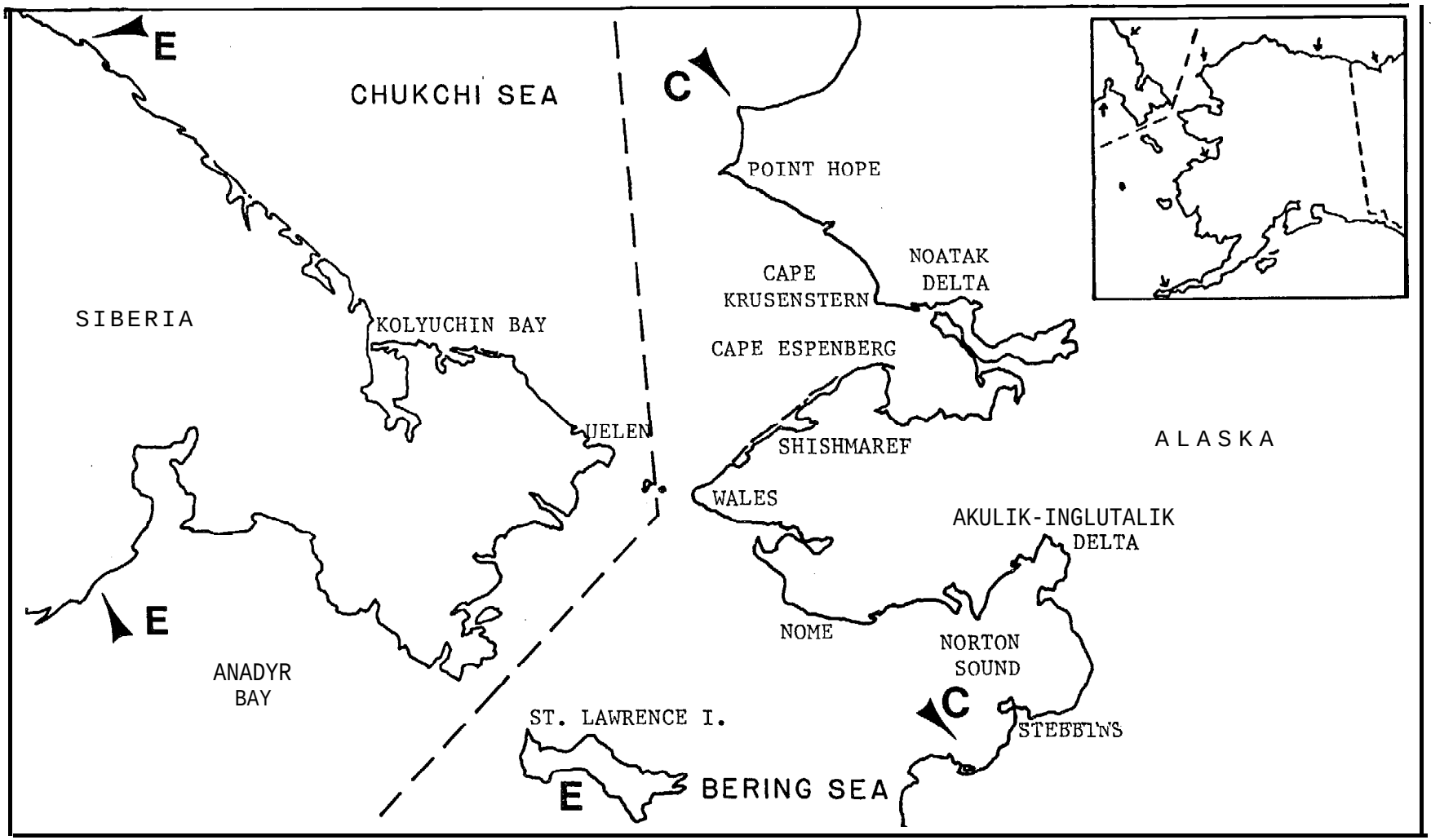

Figure 3. Coastal map of Regions c and E, Bering and Chukchi seas.

Table 4. status of shorebirds occurring regularly along the coast of Region C. symbols as in Table 1.

Species	Breeding June-July	Littoral Zone Migration July-Sept
Black-bellied Plover	UC	UC
Lesser Golden Plover	VC	Vc
Semipalmated plover	UC	UC
LeSSer Yellowlegs *Tringa flavipes*	R south	UC south
Whimbrel	UC	UC
Hudsonian Godwit *Limosa haemastica*	*	UC south
Bar-tailed Godwit	UC	FC
Ruddy TurnStone	UC	UC
Black Turnstone *Arenaria melanocephala*	FC south	FC south
Red Knot	R	UC
Sanderling	--	UC
Semipalmated sandpiper	VC	VC
Western Sandpiper	Vc	Vc
Baird's Sandpiper	UC	UC
Pectoral Sandpiper	UC	FC
Sharp-tailed Sandpiper *Calidris acuminata*	--	UC south
Rock Sandpiper *Calidris ptilocnemis*	UC south	UC south
Dunlin	Vc	Vc
Long-billed Dowitcher	FC	Vc
Common Snipe	FC	UC
Red-necked Phalarope	VC	Vc
Red Phalarope	FC	FC

* Breeding status uncertain

eastern arctic species (Whit e-rumped Sandpiper and Stilt Sandpiper) are rarely seen. Western sandpipers, however, are one of the most common nesting species throughout the region, as are Red-necked Phalaropes in suitable habitat. Finally, whereas almost all golden plovers on the arctic coastal plain are the American form (Pluvialis dominica dominica), the Pacific form (P. d. fulva) is somewhat more common as a nesting species in this region and is much more common as a littoral zone migrant (Connors 1983). Some of the juvenile Pacific Golden Plovers foraging in littoral areas of this region in August may have been produced in Siberia, as is certainly the case for the Sharp-tailed sandpipers seen fairly commonly during late summer.

Several concentration areas have been identified for post-breeding migrant shorebirds. These include the mudflats and saltmarshes of Kotzebue sound (Noatak Delta and Cape Espenberg), the 160 km long lagoon system on the north shore of Seward Peninsula, and several Norton Sound wetlands, especially those at Stebbins and Safety Lagoon. some areas, such as southern Kotzebue sound and Pt. Hope have not been studied sufficiently to judge their importance.

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Region D: Bering Sea Coast, Yukon Delta to Alaska Peninsula.

In terms of total numbers of shorebirds using arctic or subarctic littoral habitats in Alaska, the Yukon Delta and southern Bering Sea coast (Figure 4) inarguably comprise the region of highest activity. Shorebird numbers total in the millions in these areas, distinguishing this region on a global as well as Alaskan perspective. The extensive littoral habitats of the Yukon River delta stand out in importance, as well as the lagoons of the Alaska Peninsula. The entire area has been discussed comprehensively by Gill and Handel (1981), and their work will be only summarized here.

This region differs importantly from more northern regions in several respects. First, as already mentioned, it differs strikingly by the sheer area of favored littoral habitats and the vast numbers of shorebirds using them. Densities of post-breeding shorebirds in Yukon Delta littoral habitats average appreciably higher in late summer than at other sites (Table 5), but the total area of littoral habitat probably differs by a much greater factor. The resultant difference in population size may be an order of magnitude for many common species (Gill and Handel 1981). Only the lagoon habitats of the north shore of Seward Peninsula, because of their relatively high shorebird densities and large area, can begin to compare with the Yukon Delta from this viewpoint (Connors and Connors 1982). second, the season of shorebird activity in littoral habitats is greater than along the Beaufort and Chukchi coasts largely because of differences in seasonal ice conditions. Shoreline habitats are more widely available and therefore more frequently used by spring migrant shorebirds in this region. Although much of the area is still ice-bound in May, shoreline areas of Bristol Bay and the mouths of rivers are open to migrants of several species, and open nearshore waters are used by phalaropes (Gill and Handel 1981). During the nesting season, littoral habitats are used to a limited extent by shorebirds nesting on the low-lying coastal tundra. some of this nesting tundra is near-littoral, occasionally flooded by storm tides during the late summer and fall. After nesting, adults and juveniles of many species shift to littoral habitats here as elsewhere in the arctic and subarctic, but the period of post-breeding staging lasts considerably longer than at more northern sites. From Canada to Bering Strait, the main shorebird littoral zone season extends from mid or late July to late August or early September, but "at the Yukon Delta and Nelson Lagoon it begins at the same time but lasts at least one month longer (Table 5). This implies longer residency by individual birds during migration, and probably an increased dependence of the Alaska population on fewer sites during the late period. For some sites within Region D, the shorebird littoral zone season even

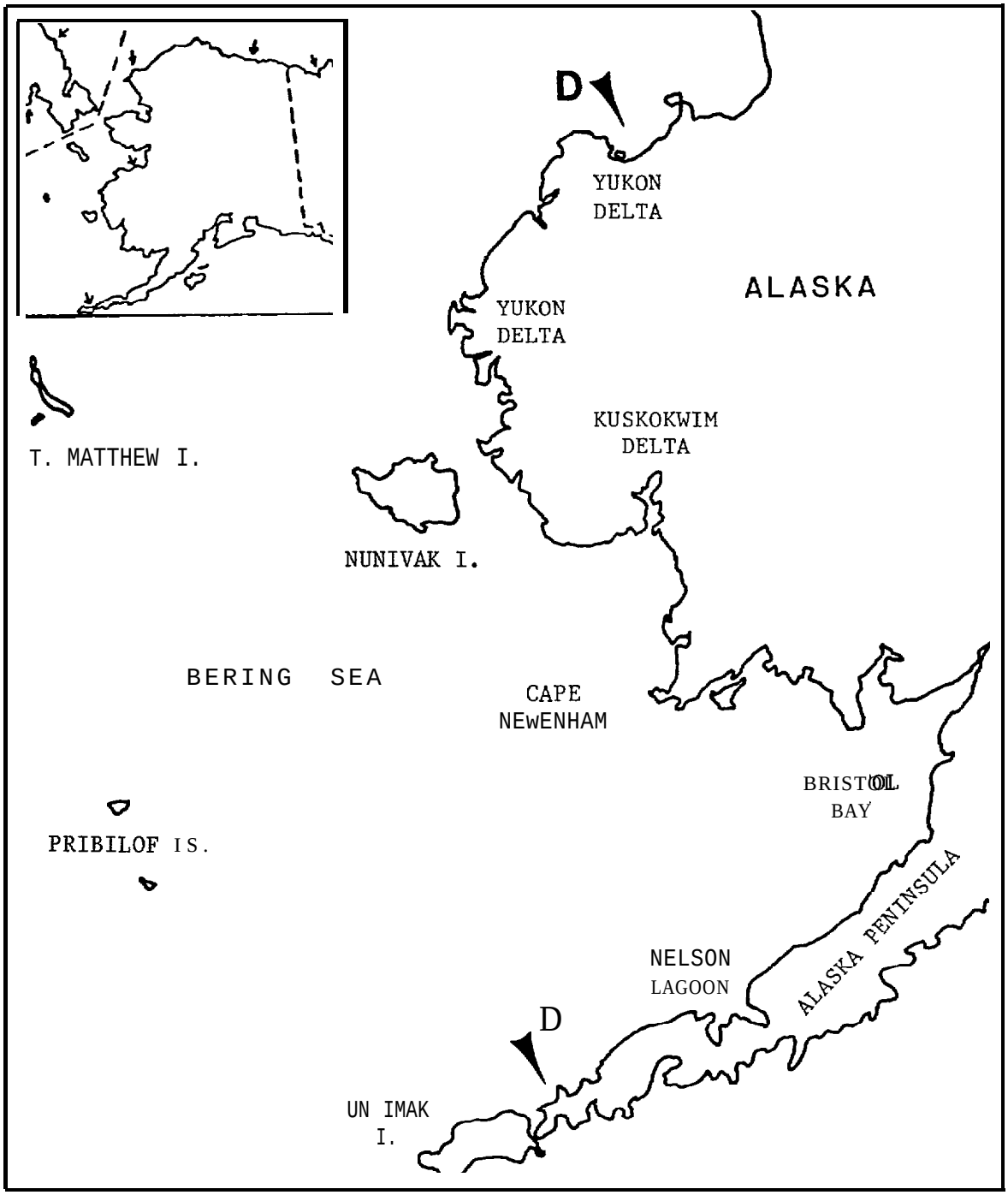

Figure 4. Coastal map of Region D, Bering Sea.

Table 5. Mean densities of post-breeding shorebirds using littoral habitats at several Alaskan sites.

Location	Major Post-breeding Period	Mean Density, Birds/ha	Reference
Canning River Delta, Region A	late July to early Sept	1.6	Martin and Moiteret 1981
Barrow, Region B	late July to early Sept	9.8*	Connors et al. 1979
Cape Krusenstern, Region C	mid July to late August	3*1	Connors and Connors 1982
Wales, Region C	late July to early Sept	3.3	Connors and Connors 1982
Yukon River Delta, Region D	late July to early oct	10.6	Gill and Handel 1981
Nelson Lagoon, Region D	mid July to early Ott	6.6	Gill and Handel 1981

* 88% of counted shorebirds were phalaropes; density of all other shorebirds was only 1 .2 birds per ha.

Table 6. status of shorebirds occurring regularly along the coast of Region D. Symbols as in Table 1.

Species	Breeding June-July	Littoral Zone Migration July-Sept
Black-bellied Plover	FC	FC
Lesser Golden Plover	FC	FC
Semipalmated plover	Uc	Uc
Greater Yellowlegs *Tringa melanoleuca*	*	FC south
Lesser Yellowlegs	*	Uc
Wandering Tattler *Heteroscelus incanus*	*	Uc
Whimbrel	UC	Uc
Bristle-thighed curlew *Numenius tahitiensis*	*	R
Hudsonian Godwit	--	Uc
Bar-tailed Godwit	FC	VC
Ruddy Turnstone	Uc	FC
Red KnOt	--	VC north
Sanderling	--	FC
Semipalmated sandpiper	Fc north	FC north
Western sandpiper	Vc	Vc
Least Sandpiper *Calidris minutilla*	*	Uc
Pectoral Sandpiper	Uc	UC
Sharp-tailed sandpiper	--	FC
Rock Sandpiper	Uc	Vc
Dunlin	Vc	Vc
short-billed Dowitcher *Limnodromus griseus*	UC south	VC south
Long-billed Dowitcher	UC north	FC
Common Snipe	FC	R
Red-necked Phalarope	FC	Vc
Red Phalarope	FC	Vc

* Breeding status uncertain

extends through the winter, clearly distinguishing this situation from areas farther north. Such shorebird use is not extensive however, being limited to occasional Rock sandpipers and Sanderlings in ice-free areas of Bristol Bay (Gill and Handel 1981).

Another difference in the shorebird littoral zone community concerns the diversity of species involved, several of which are regular migrants at sites within this region, but rare or absent at sites farther north and east (Table 6). A few of the most abundant species (Dunlin, Western Sandpiper, Northern Phalarope) are also common in other regions; several (Hudsonian Godwit, Black Turnstone, Red Knot, Sharp-tailed Sandpiper, Rock Sandpiper) only occur regularly in one of the previously discussed regions, or are much more common in this region; a few (Greater Yellowlegs, wandering Tattler, LeaSt Sandpiper, Short-billed Dowitcher) are not sufficiently regular to be mentioned in discussions of other regions. The net result is a total species list which is longer for Region D than for the other Alaskan regions discussed.

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Region E: Northeastern Siberia, Bering and Chukchi Coasts.

Much less information is available to describe the littoral zone activities of migrant shorebirds along Siberian coasts. In particular, assessments of the relative importance of different coastal sites are difficult to make, but it is possible to compile a list of all common species breeding along the coasts of northeastern Siberia, together with estimates of the degree of their use of littoral zone habitats in late summer (Table 7). This information was taken principally from portenko (1972), supplemented with other references listed below.

Published descriptions indicate, not surprisingly, that breeding and post-breeding habitats in Siberia are similar to the habitats used by each species in Alaska. Phenology of nesting and migration staging is also quite similar to that of Alaska, especially of Region C.

Table 7 clearly establishes one central fact: much of the Siberian shorebird community is continuous with the communities of western and northern Alaska. A few distinctly Siberian species (Common Ringed Plover, Rufous-necked Stint, Spoonbill Sandpiper) are rare or absent on Alaskan shores, but all other common breeders in Siberia occur regularly in Alaska. Furthermore, several species breed on one continent in populations which migrate along the shore of the other continent, as discussed further in the final section of this report.

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Table 7. status of shorebirds occurring regularly along the coast of Region E. symbols as in Table 1.

Species	Breeding June-July	Littoral Zone Migration July-Sept
Black-bellied Plover	FC	*
Lesser Golden Plover	FC	FC
Mongolian Plover *Charadrius mongolus*	UC	*
Common Ringed Plover *Charadrius hiaticula*	FC	FC
Eurasian Dotterel *Charadrius morinellus*	UC	*
Wandering Tattler	UC	UC
Bar-tailed Godwit	*	UC
Ruddy Turnstone	FC	FC
Red Knot	--	UC
Western Sandpiper	FC	FC
Rufous-necked Stint *Calidris ruficollis*	FC	*
Temminck's Stint *Calidris temminckii*	UC	*
Baird's sandpiper	UC	*
Pectoral Sandpiper	FC	FC
Sharp-tailed Sandpiper	--	UC
Rock Sandpiper	FC	FC
Dunlin	Vc	Vc
Spoonbill Sandpiper *Eurynorhynchus pygmeus*	FC	*
Long-billed Dowitcher	FC	*
Common Snipe	FC	*
Red-necked Phalarope	FC	Vc
Red Phalarope	FC	VC

* Status uncertain

This presentation of Alaskan, Canadian, and Siberian shorebird communities has spanned a range from 136° West to 180° west longitude and from 55° North to almost 72° North latitude, including shores of the Bering, Chukchi and Beaufort Seas. Such an enormous range forces our discussion to gloss over details, often ignoring smaller scale distinctions in order to search for the major trends and patterns. Several of these patterns have emerged, a number of which deal with geographic distributions of shorebird species.

First, and not surprisingly, shorebird communities vary across the regions as individual species abundances change. Species breeding distributions range from those wholly contained within part of these regions (for example, Black Turnstone) to those breeding only in the south (short-billed Dowitcher), north (Sanderling), east (Stilt sandpiper) or west (Spoonbill Sandpiper), but many species have distributions which include all the regions considered (for example, Lesser Golden Plover and Pectoral Sandpiper) and several species are circumpolar in distribution (Black-bellied Plover, Sanderling, both phalaropes).

Migrational distributions often overlap the more limited breeding distributions, but a similar range of littoral zone migrant distributions can be discerned, which likewise combine to produce regional differences in the potential littoral zone shorebird communities. Superimposed on these distributional limitations are species habitat preferences which determine the degree to which a species present within a region actually uses the littoral zone. Phenology of breeding and of migratory movements also plays an important role, since some species or cohorts of species either leave breeding grounds early, before chicks hatch (for example, adult female phalaropes) or migrate suddenly after breeding (Baird's Sandpipers). This limits the species' involvement in littoral habitats in two ways, by removing birds from the arctic while northern shoreline habitats are still ice-bound and by reducing the period of littoral zone occupancy when these habitats are available. some species, in contrast, migrate very slowly (for example, Dunlin) remaining in arctic littoral habitats until early September and in subarctic areas into October.

Except for small numbers of two species which remain in the southern Bering Sea, all shorebirds migrate from these regions before winter begins. AS a group, shorebirds are the longest-distance migrants among the world's birds. Of the species which occur commonly in the Alaskan arctic and subarctic each summer (Tables 1,2,4,6), 21 (of 25 species total) include the southern hemisphere as a major part of their wintering ranges; 15 of 25 regularly winter as far south as southern South America or Australia. only one species (Rock sandpiper) winters

exclusively north of Mexico. Furthermore, these migrations are not confined to the western hemisphere. At least four species are known to migrate from Alaska to wintering areas in Asia, Australia, or the central Pacific Islands, and several species with widespread breeding and wintering areas may include populations which move westward as they migrate southward. The clearest examples of westward migrations between hemispheres consist of species or subspecies whose winter ranges do not include North or South America. Bar-tailed Godwits, the Pacific form of Lesser Golden Plover (Pluvialis dominica fulva) and the Siberian subspecies of Dunlin (Calidris alpina sakhalina) all breed in Alaska but winter only west of the Americas. Sharp-tailed Sandpipers perform an even stranger trans-Bering Sea migration, with juveniles born in Siberia foraging along Alaskan coasts in regions C and D before crossing back to winter in Micronesia and Australia. The explanation for this surprising pathway may lie in a greater availability of rich littoral zone feeding areas in Alaska compared with Siberian shores, but detailed habitat descriptions for the Siberian sea coasts are lacking. A few shorebird species (as well as Snow Geese and Sandhill Cranes) are known to perform an alternative migration across the Bering Strait area. Long-billed Dowitchers, Western Sandpipers, Baird's Sandpipers and Pectoral Sandpipers all nest in western Siberia but winter only in the Americas. This annual shifting of shorebird populations between hemispheres, east and west, north and south, creates a global aspect to questions of evolution, and a broad international aspect to questions of conservation or management of Alaska's shorebirds.

Examining these distributional patterns among the five regions we have been discussing, we can make several comparisons. The largest number of species occurring regularly in littoral zone habitats is to be found in Region D, with 26 species, compared with 18 to 22 species in other regions. The additional species are the more southerly birds which do not occur in the arctic; most arctic species also occur here, at least in migration. we can explore the similarity among regional shorebird littoral zone communities by comparing lists of core species, those species listed as Fairly Common or very Common across each region. These core species lists can be constructed from Tables 1, 2, 4, 6, and 7, with some uncertainty for species of questionable status in Table 7. Similarities between regional lists of core species (number of species occurring on both lists divided by total number of species in two regions) are presented in Table 8. These similarity values can be placed in three groups. The only high similarity (>.70) pair is regions A and B, at similar latitude along the Beaufort coast. The three Chukchi coast regions (BC, BE, and CE pairs) form a moderate similarity group, and the remaining pairs, consisting of the southern Bering region D with A, B, C,

Table 8. Similarity coefficients between regions in shorebird littoral zone core species lists.

Region	A	B	C	D	E
A	1.0	.77	.43	.37	.33-.41
B	----	1.0	.57	.50	.50-.56
C	----	----	1*0	.41	.50-.55
D	----	----	----	1.0	.41-.47
E	----	----	----	----	1.0
Mean similarity with other regions	.49	.59	.49	.43	.47

and E and the eastern Beaufort region A with C, D, and E form the lowest similarity group. Region B has the highest average similarity and Region D has the lowest. The main trends seem to be the general similarity of migrant shorebird communities across large expanses of arctic coast, even across Bering Strait, and the somewhat lower similarity as new species are introduced in subarctic regions.

In all Alaska regions some species are more common as littoral zone migrants than they are as tundra breeders within the region. Likewise there are more species listed as fairly common or very common in the littoral zone than as fairly common or very common breeders in each of the Alaska regions. This difference is greatest in Region D, the Bering Sea coast, with 15 common migrants and only 10 common breeding species. Such a pattern emphasizes the potential for widespread effects on bird populations arising from localized disturbances. It is one of the reasons that the population effects of littoral zone disturbances are more difficult to estimate than the effects of disturbances on breeding areas. Another reason arises from the transient nature of migration use of littoral habitats. Censuses of migrant shorebirds in the littoral zone at dozens of Alaska coastal sites have been obtained over the last decade, but in almost no cases do we know the turnover rates associated with birds foraging in these areas. If individual birds remain for only short periods at a site, the total number of birds migrating through an area over a period of several weeks can be much greater than the population censused at any one time. Neither do we know the number of sites at which an individual bird may stop as it migrates from the arctic southward to wintering grounds. Both these factors have an important bearing on the problem of estimating population effects of habitat disturbances in the littoral zone. A correlary question concerns the amount of redundancy required in the location of foraging habitats within a region. How flexible are migrant shorebirds about finding alternative foraging areas when a favored area is unavailable? This question opens complex issues of food limitation, competition, energetic of migration, and relative habitat values, and is not an easy one to answer. We cannot, however, assume that all birds will be lost if habitat used by those birds is lost, and neither can we assume that such mobile animals can always go somewhere else to feed.

The shorebird community at any site is composed of species which differ in the several factors which determine a species' sensitivity to oil development effects. They range from phalaropes, which swim on the water's surface, vulnerable to spilled oil films, to upland foraging species like Bristle-thighed Curlew and Buff-breasted sandpiper, and from localized world populations (Black Turnstone, Bristle-thighed curlew) to

species with circumpolar distributions (Black-bellied Plover, Sanderling). Factors which affect the individual's sensitivity revolve around habitat use, seasonality of movements, trophies, and foraging behaviors. These have been discussed elsewhere (Connors et. al 1979), and have been used to assign relative sensitivities of Barrow shorebirds to oil development. Additional factors which govern population vulnerability concern the numbers of birds exposed at a site compared with local, regional and worldwide populations. These factors have been included in an assessment of relative susceptibility of Bering seacoast shorebirds by Gill and Handel (1981).

This report has described the major shorebird littoral zone concentration areas within each region. Viewing the entire Bering, Chukchi and Beaufort coasts of Alaska, the outstanding area in terms of total numbers of shorebirds supported is undoubtedly the Yukon Delta. Other prime areas include Nelson Lagoon, Stebbins and Safety Lagoon in the Bering Sea, Kasegaluk Lagoon and the barrier island-lagoon system east and west of Shishmaref in the Chukchi Sea, and the Pt. Barrow-Plover Islands area in the Beaufort Sea. Along each of these coastlines, however, some areas of potential importance remain unstudied, and shorebirds are widespread in migration, occurring in many less extensive areas in high densities.

A final trend across regions can be garnered from the list of prime shorebird concentration areas just presented. Along the Beaufort and Northern Chukchi coasts, major shorebird concentrations invariably involve large numbers of phalaropes, usually near spits and barrier islands, where a major component of the prey base consists of planktonic or epibenthic organisms such as amphipods, copepods, euphausiids, and mysids. Farther south along the Southern Chukchi and Bering coasts many of the phalaropes have probably moved offshore to feed on similar prey, and the large littoral zone shorebird concentrations involve several species of sandpipers most prominently. The habitats used are principally mudflats and saltmarsh areas, and the prey are mainly benthic, especially insect larvae and small molluscs. Of course, both arctic and subarctic areas involve a similar, full range of shorebird species, habitats, and invertebrate prey, but the dominant themes in the major concentration areas show this geographic shift. It is of interest in management because the sensitivity of local avifauna to oil or other development impacts changes with shifts in shorebird communities, their trophies and their habitats.

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