Shorebirds of the Eastern Bering Sea

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ABSTRACT

Largely on the basis of work conducted in western Alaska since 1975, we present an overview of the shorebird resources of the region and discuss their relationship to the littoral and supralittoral habitats of the area. Thirty species of shorebirds occur regularly and comprise an important component of the eastern Bering Sea ecosystem. For a third of these species the region supports the main Alaska population—for several species, the main North American population. In winter and spring littoral areas are generally ice-fast and little used by shorebirds. After breeding, there is a pronounced movement of shorebirds to coastal areas throughout the region. Populations regularly swell into the millions, many relying entirely on littoral habitats while undergoing molt and premigratory fat deposition. The extensive intertidal of the Yukon Delta and lagoons of the Alaska Peninsula are used by more species, in greater numbers, and for longer periods than other areas within the region. The timing of fall migration shows considerable variation by area, species, and age. The susceptibility of the most common shorebird species to disturbances from petroleum development is discussed.

INTRODUCTION

The diversity and probably the numbers of shorebirds (Charadrii) occurring in the eastern Bering Sea region are unequalled in Alaska (Pitelka 1979), and possibly even in North America, considered over a comparable area at similar latitudes. Of the 68 species of shorebirds known in Alaska, 52 occur in this region (Kessel and Gibson 1978). Some 15 of these are of Asiatic origin and straggle to Alaska in small numbers each season. The majority, however, figure prominently in the ecology of the region, particularly during the summer and fall, when their numbers swell into the millions over littoral and supralittoral habitats of western Alaska. Furthermore, because Alaska-produced shorebirds are highly migratory, many having migratory paths encompassing several thousands of miles, they become equally important to areas along the Americas, Pacific archipelagoes, and Asia.

Our knowledge of basic shorebird ecology and behavior within Alaska has, until recently, been essentially limited to that obtained on the breeding grounds; little has been known about the requirements of shorebirds after breeding or during migration (Gill and Jorgensen 1979, Pitelka 1979). Since 1975, however, several studies in Alaska have been devoted, wholly or in part, to determining the requirements of shorebirds while they are along coastal areas (Arneson 1978; Connors 1978; Senner and West 1978; Connors et al. 1979; Gill and Jorgensen 1979; Isleib 1979; Schamel et al. 1979; Senner 1979; Shields and Peyton 1979; Gill and Handel, unpublished). These studies, while generally local in scope, have greatly increased our understanding of such aspects of shorebird ecology as seasonal habitat use, food requirements, numbers, and timing and patterns of migration throughout Alaska.

A single systematic treatment of shorebirds in arctic and subarctic environments in Alaska has yet to be developed. We are able now, however, to treat shorebirds on a regional basis. This chapter presents such an overview of the shorebirds of the eastern Bering Sea region.

We have divided the region into four major geographic areas (Fig. 41-1): Bristol Bay, extending from the western tip of Unimak Island east and north to Cape Newenham; the Yukon-Kuskokwim Delta (hereafter called the Yukon Delta), from Cape Newenham to Stuart Island; Norton Sound, from Stuart Island to Cape Prince of Wales; and the large Bering Sea islands, including the Pribilofs, Nunivak, St. Matthew, and St. Lawrence islands.

We have chosen to focus our discussion of shorebirds in this region on their relationship to the littoral

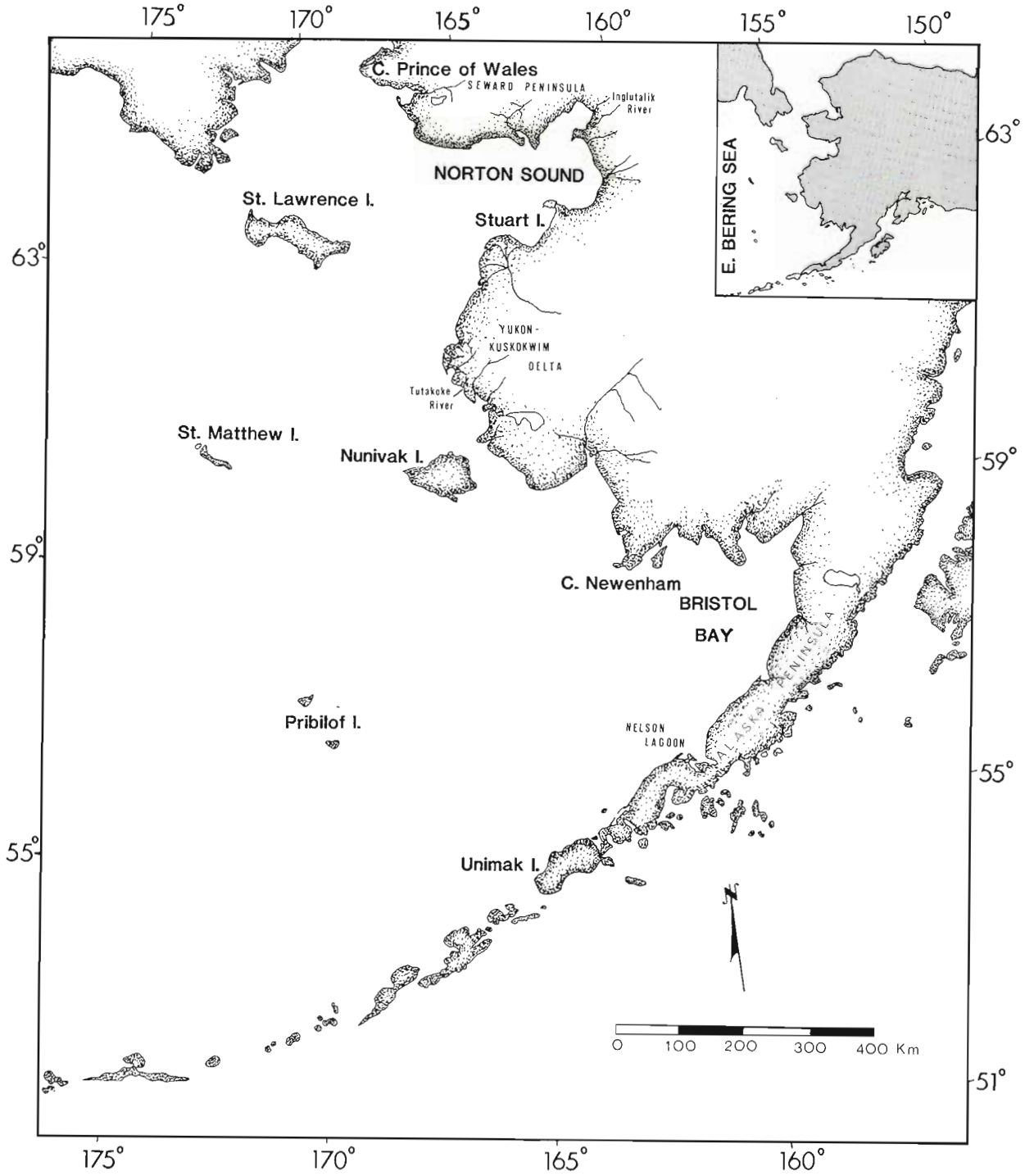

Figure 41-1. Map of the eastern Bering Sea region.

or unvegetated intertidal as well as the vegetated intertidal or supralittoral area affected by storm tides. The amount of intertidal habitat and the number of lagoons within each area are presented in King and Dau (Fig. 42-1, Table 42-1, Chapter 42, this volume). On the Yukon Delta the vegetated intertidal extends inland several kilometers and includes much of the nesting habitat of several species. If there is to be a significant impact on shorebirds from petroleum development in the eastern Bering Sea, it will most likely come as a result of alteration of these critical habitats.

DATA SOURCES

Basic information on shorebird distribution and seasonal occurrence within the eastern Bering Sea region has come primarily from Gabrielson and Lincoln (1959) and Kessel and Gibson (1978). Recent studies throughout the region have provided further details. Within Bristol Bay, information on shorebirds is available for the north central Alaska Peninsula (Gill et al. 1977, 1978; Gill 1979; Gill and Jorgensen 1979), upper Bristol Bay (Arneson 1978), and the Cape Newenham-Peirce area (M. Dick and M. Petersen, Fish and Wildlife Service, unpublished). On the Yukon Delta, studies have been conducted by Holmes (1970, 1971a) and Holmes and Black (1973). Studies by Connors (1978) and Shields and Peyton (1979) and unpublished material from Heinrick Springer, of Nome, Alaska, provide the basis for most information presented for the southern Seward Peninsula and Norton Sound. In addition, we have relied heavily upon our own unpublished material for information on shorebirds of the Yukon Delta and Bristol Bay. Habitat nomenclature for all areas follows that of Kessel (1979).

RESULTS AND DISCUSSION

Habitat use

Probably the most extensive and diverse expanse of intertidal habitat found along the Pacific coast of the Americas occurs within the eastern Bering Sea region. Only in the past few years have we begun to learn the extent to which shorebirds are geographically and temporally restricted in their use of this vast area.

Shorebirds use coastal habitats in the eastern Bering Sea region in distinct seasonal patterns. In spring, beginning in late April (Table 41-1), birds move into the area after migrations which, in many instances, began several thousand miles to the south. Many have come from the Copper River Delta in the northern Gulf of Alaska and from Kachemak Bay in lower Cook Inlet (Isleib 1979, Senner 1979). The intertidal habitats of these areas are generally ice-free in spring and are used as refueling stops by millions of shorebirds before they proceed to nesting grounds in western and northern Alaska.

Upon their arrival in the eastern Bering Sea area, shorebirds usually find that littoral habitats are ice-fast and little intertidal is available for foraging. Only along the western Alaska Peninsula, portions of Bristol Bay, and the mouths of major rivers to the north are littoral areas usually ice-free in spring. These are used by Rock Sandpipers *(Calidris ptilocnemis)*, Bar-tailed Godwits *(Limosa lapponica)*, Red Knots *(C. canutus)*, American Golden Plovers *(Pluvialis dominica)*, and Black-bellied Plovers *(P. squatarola)* for several days or weeks before they move to their breeding grounds (Gill and Handel, unpublished). It is not known what portion of their respective populations uses these areas in spring. Nearshore waters of the region are also used in spring by Red and Northern Phalaropes *(Phalaropus fulicarius* and *P. lobatus)*. Large rafts of these species form in spring but information on their distribution and movements is fragmentary (Gabrielson and Lincoln 1959).

After spring migration, shorebirds settle on the nesting grounds and make little use of littoral areas from late May through June. Throughout the region the coastal fringe provides important shorebird nesting habitat, particularly for eight species: Semipalmated Plover *(Charadrius semipalmatus)*, Black Turnstone *(Arenaria melanocephala)*, Long- and Short-billed Dowitcher *(Limnodromus scolopaceus* and *L. griseus)*, Red and Northern Phalarope, Semipalmated Sandpiper *(Calidris pusilla)*, and Dunlin *(C. alpina)*. In terms of numbers of birds, the principal shorebird nesting area within the region is the Yukon Delta. Here, the highest shorebird nesting densities are found in low-lying coastal areas, which are flooded by tides occasionally during the nesting season and more regularly in early spring and late fall.

After nesting, shorebirds tend to move to coastal areas, particularly to littoral habitats (Table 41-2). This marked shift has been noted in shorebird populations from Pt. Barrow to the western Alaska Peninsula (Connors 1978, Connors et al. 1979, Gill and Jorgensen 1979, Shields and Peyton 1979). As suggested by Holmes (1970), Myers and Pitelka (MS), and others, this movement may be in response to a deterioration in feeding conditions on the nesting grounds and a corresponding improvement on littoral habitats.

The areas within the region most intensively used for foraging by postbreeding shorebirds include the lagoons along the southern Seward Peninsula and eastern Norton Sound, the extensive intertidal flats of the central Yukon Delta, and the lagoons of the Alaska Peninsula. These key areas, rich in benthic organisms, are adjacent to the nesting areas. Of them, the intertidal of the Yukon Delta is used by more species, in greater numbers, and in higher densities than any other littoral area of the region (Table 41-3, Fig. 41-2). This may, in part, be due to a richer benthos on the delta, or to proximity to a more extensive and productive nesting area. For reasons not yet understood, the expansive intertidal of northern Bristol Bay is not extensively used by shorebirds in fall.

TABLE 41-1

Migration period[1] and numbers of shorebirds using littoral[2] habitats in the eastern Bering Sea region in spring.

Species	Norton Sound	Yukon Delta	Bristol Bay	Bering Sea islands[3]
Semipalmated Plover	Δ	e-l MAY, f 100's	lAPR-eMAY, f 100's	Δ
American Golden Plover	m-l MAY, Δ	Δ	mAPR-mMAY, s 100's	mAPR-lMAY, Δ
Black-bellied Plover	Δ	e-l MAY, Δ	eMAY-eJUN, s 100's	VRM
Hudsonian Godwit	Δ	—	—	—
Bar-tailed Godwit	eMAY-eJUN, f 1,000's	m-l MAY, s 1,000's	m-l MAY, f 1,000's	—
Whimbrel	m-l MAY, Δ	m-l MAY, Δ	—	—
Bristle-thighed Curlew	m-l MAY, RM	l MAY, RM	—	RM
Greater Yellowlegs	—	eMAY-eJUN, Δ	lAPR-lMAY, f 100's	RM
Lesser Yellowlegs	Δ	Δ	Δ	—
Wandering Tattler	Δ	lMAY-eJUN, RM	mMAY-mJUN, f 100's	RM
Ruddy Turnstone	lMAY-eJUN, Δ	m-l MAY, Δ	e-l MAY, Δ	lMAY, Δ
Black Turnstone	Δ	e-l MAY, Δ	e-1MAY, s 100's	—
Northern Phalarope	eMAY-eJUN, UNK*	eMAY-lMAY, Δ	mMAY-lJUN, UNK*	m MAY, UNK*
Red Phalarope	mMAY-eJUN, f 10,000's	m-l MAY, UNK*	mMAY-eJUN, UNK*	e-l MAY, UNK*
Short-billed Dowitcher	—	—	e-l MAY, f 1,000's	—
Long-billed Dowitcher	lMAY-eJUN, Δ	m-l MAY, Δ	RM	Δ
Red Knot	eMAY-eJUN, s 100's	eMAY-eJUN, s 1,000's	—	RM
Sanderling	—	mMAY, RM	e-l MAY, f 100's	—
Semipalmated Sandpiper	eMAY-eJUN, Δ	eMAY-eJUN, Δ	—	—
Western Sandpiper	eMAY-eJUN, f 1,000's	m-l MAY, s 1,000's	e-m MAY, f 1,000's	eMAY-eJUN, f 100's
Least Sandpiper	?	?	m MAY, s 100's	—
Pectoral Sandpiper	Δ	Δ	RM	UCM
Sharp-tailed Sandpiper	VRM	—	—	—
Rock Sandpiper	lAPR-eMAY, f 1,000's	mAPR-eMAY, f 10,000's	eAPR-lMAY, f 10,000's	eAPR-lMAY, s 1,000's
Dunlin	mMAY-mJUN, f 1,000's	e-l MAY, f 10,000's	e-l MAY, f 1,000's	eMAY-eJUN, f 100's

[1] Usual period of first arrival to last departure.

[2] Includes all areas between mean low water and mean high water, including tidally influenced rivers.

[3] See species accounts for specific use of each island.

RM = rare migrant, UCM = uncommon migrant, VRM = very rare migrant. Dash = no migration.

Numbers: f = few, s = several, UNK = unknown.

*Birds primarily using offshore waters.

ΔBirds generally move directly to breeding grounds with little or no use of littoral.

TABLE 41-2

Habitat use by shorebirds in late summer and fall in the eastern Bering Sea region.

Species	Adults				Postfledging juveniles			
	Norton Sound	Yukon Delta	Bristol Bay	Bering Sea Is.	Norton Sound	Yukon Delta	Bristol Bay	Bering Sea I.
American Golden Plover	L+T	T	L	T	L+T	L+C	L	T
Black-bellied Plover	—	T	L	—	—	L+C	L	—
Hudsonian Godwit	T+L	T+L	—	—	T+L	T+L	—	—
Bar-tailed Godwit	T+L	L+T	L	T+L	T+L	L+T	L	T+L
Whimbrel	T+L	T+L	L+C	—	T+L	T+L	L+C	—
Bristle-thighed Curlew	—	C+T	—	—	—	C+T	—	—
Ruddy Turnstone	L	T	L	T+L	L	T+L	L	T+L
Black Turnstone	L+C	L	L	—	L+C	L	L	—
Northern Phalarope	C+L	C+L	L	L+T	C+T	L+C	L	L+T
Red Phalarope	C+L	C+L	L	L+T	L	L	L	L+T
Short-billed Dowitcher	—	—	L	—	—	—	L	—
Long-billed Dowitcher	T+L	C	L	—	L+T	C+L	L	—
Red Knot	L	L	—	—	L	L	—	—
Sanderling	—	—	L	L	L	L	L	L
Semipalmated Sandpiper	L	C	—	—	L+C	C	—	—
Western Sandpiper	L+T	L	L	—	L+T	L	L	—
Least Sandpiper	T	—	L+C	—	T	—	L+C	—
Pectoral Sandpiper	L	—	—	—	L+C	C	—	C
Sharp-tailed Sandpiper	—	—	L	L	L+C	L+C	L	L
Rock Sandpiper	L	L	L	L	L	L	L	L
Dunlin	L	L	L	—	L+C	L+C	L	—

L = littoral, C = coastal wet meadows, T = tundra (dwarf shrub meadows and dwarf shrub mat).
The sequence within a couplet indicates primary and secondary use, although in some instances both are used equally.

Within the eastern Bering Sea region, patterns of seasonal use of littoral areas by shorebirds appear to be similar (Fig. 41-2). These patterns are thought to reflect differences in migrational timing among species as well as between sexes and age groups of particular species (Table 41-2). At Wales, Yukon Delta, and Nelson Lagoon there is a buildup in late July and early August primarily of Western Sandpipers *(C. mauri)*, followed in September by an even greater buildup of Dunlin (Fig. 41-2). Similar peaks reflecting passages of plovers, godwits, dowitchers, and phalaropes occur at each site, but their magnitudes are smaller (Table 41-3, species accounts).

The duration of use and the numbers of shorebirds supported per unit of littoral habitat in the region appear greatest along the Alaska Peninsula and on the Yukon Delta (Table 41-3, Fig. 41-2). To the north, in Norton Sound and along the Chukchi and Beaufort sea coasts, shorebirds tend to use littoral areas for shorter periods (Connors 1978, Connors et al. 1979, Schamel et al. 1979), perhaps in response to the shortness of the seasons. However, recent information (Gill and Handel, unpublished) suggests that for species such as American Golden Plovers, Bar-tailed Godwits, Red Knots, and Dunlin, large segments of the population are leaving or moving through these areas well before the onset of fall. Most appear to move south to the Yukon Delta and lagoons of the Alaska Peninsula. Here they often remain for several weeks before migrating to their respective winter quarters.

Our discussion so far has primarily focused on the importance of littoral areas as foraging areas for postbreeding shorebird populations. Throughout the region littoral and supralittoral habitats are also critical as roosting areas. On the Yukon Delta the larger birds such as Bar-tailed Godwits and Red Knots generally roost 2-5 km inland on dwarf shrub meadow and mat tundra, returning at each low tide to forage on the outermost mudflats (Gill and Handel, unpublished). Occasionally when high tides are particularly low, these species may roost on exposed dry flats.

Table 41-3

Migration period[1] and numbers of shorebirds using littoral[2] habitats of the eastern Bering Sea region after breeding.

Species	Norton Sound	Yukon Delta	Bristol Bay	Bering Sea islands[3]
Semipalmated Plover	UCM	UCM	eJUL-mSEP, s 100's	RM
American Golden Plover	mJUL-mSEP, f 1,000's	eAUG-eSEP, s 1,000's	mAUG-lOCT, f 1,000's	lJUL-lOCT, f 1,000's
Black-bellied Plover	UCM	lJUN-mSEP, s 1,000's	lJUN-mOCT, f 1,000's	RM
Hudsonian Godwit	AUG, f 1,000's, +	mAUG-eSEP, f 100's, +	RM	RM
Bar-tailed Godwit	mAUG-mSEP, s 1,000's	lJUN-mSEP, s 10,000's	eAUG-mOCT, f 10,000's	AUG-SEP, UNK
Whimbrel	mAUG-mSEP, s 100's, +	lJUN-eSEP, f 1,000's, +	lJUN-eSEP, f 1,000's, +	RM
Bristle-thighed Curlew	RM	eJUL-lAUG, +	lJUL-eSEP, +	AUG, RM
Greater Yellowlegs	—	eAUG-lSEP, s 100's, +	eJUL-mOCT, f 1,000's	RM
Lesser Yellowlegs	RM	RM, f 100's	lJUL-eOCT, s 100's	RM
Wandering Tattler	UCM	mAUG-mSEP, f 100's	mJUL-eSEP, s 100's	eJUL-mSEP, f 100's
Ruddy Turnstone	AUG-SEP, UCM	mJUL-mSEP, s 100's	mJUL-lOCT, f 1,000's	mJUL-mOCT, f 10,000's
Black Turnstone	e-l AUG, UCM	eJUL-eSEP, s 1,000's	mJUL-lAUG, f 1,000's	RM
Northern Phalarope	lJUN-lAUG, f 10,000's	lJUN-lSEP, s 10,000's	mJUL-lSEP, s 10,000's	lJUL-eSEP, f 10,000's
Red Phalarope	lJUL-eSEP, s 1,000's	eJUL-lSEP, s 1,000's	mJUL-eOCT, s 10,000's	mJUL-eOCT, f 10,000's
Short-billed Dowitcher	—	—	mJUN-eSEP, f 10,000's	RM
Long-billed Dowitcher	eAUG-mSEP, f 1,000's, +	lJUL-mSEP, s 1,000's, +	eAUG-eOCT, f 1,000's, +	RM
Red Knot	mAUG-eSEP, f 1,000's	lJUN-eSEP, f 10,000's	RM	RM
Sanderling	eAUG-eSEP, s 100's	eSEP-eOCT, s 100's	mAUG-lOCT, f 1,000's	RM
Semipalmated Sandpiper	lJUL-lAUG, f 1,000's, +	lJUL-lAUG, f 1,000's, +	eAUG-mSEP, UCM	RM
Western Sandpiper	eAUG-eSEP, f 10,000's	mJUN-eSEP, s 100,000's	lJUN-eSEP, f 100,000's	lJUL-eSEP, f 1,000's
Least Sandpiper	UCM	RM	lJUN-lAUG, +	RM
Pectoral Sandpiper	eJUL-eSEP, f 1,000's, +	lAUG-lSEP, s 100's, +	RM, +	RM, +
Sharp-tailed Sandpiper	lAUG-eSEP, f 1,000's	lAUG-eOCT, s 1,000's	eSEP-eOCT, s 100's, +	e-l SEP, f 100's
Rock Sandpiper	mJUL-mOCT, f 1,000's	eJUL-lOCT, s 10,000's	eJUL-lOCT, f 10,000's	mJUL-eNOV, s 1,000's
Dunlin	lJUN-mOCT, s 10,000's	lJUN-mOCT, s 100,000's	lJUN-mOCT, f 100,000's	eAUG-eOCT, f 1,000's

[1] Usual period of first arrival to last departure.

[2] Includes all areas between mean low water and mean high water, including tidally influenced rivers.

[3] See species accounts for specific details of each island.

RM = rare migrant, UCM = uncommon migrant, dash = no migration.

Numbers: f = few, s = several, UNK = unknown.

+ = A significantly large portion of the population does not use littoral areas during migration.

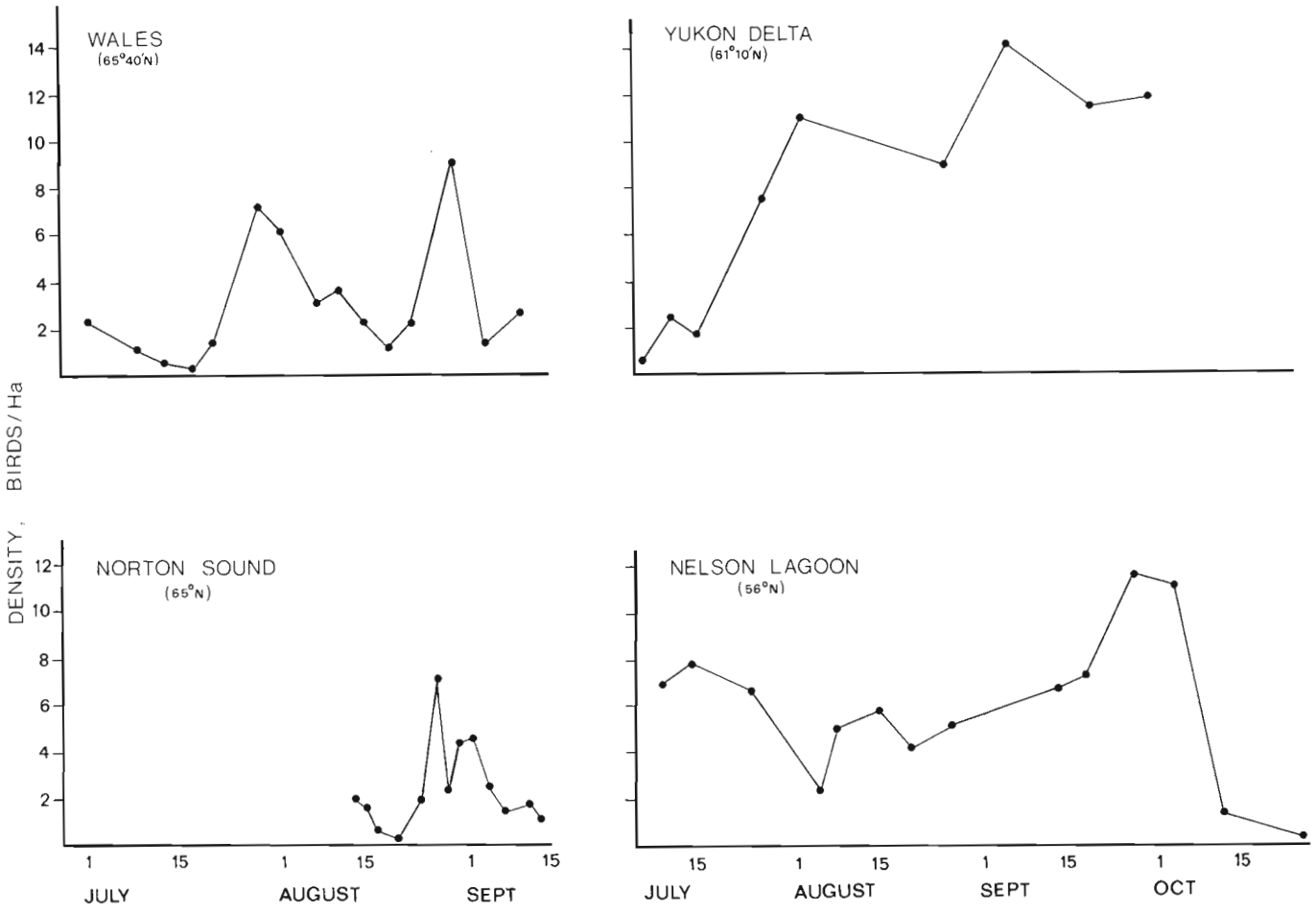

Figure 41-2. Total shorebird densities over littoral habitats at four study sites in the eastern Bering Sea region. Data at Wales from Connors (1978); Norton Sound, Shields and Peyton (1979) and unpublished; Yukon Delta, Gill and Handel, unpublished; and Nelson Lagoon, Gill and Jorgensen (1979) and unpublished.

The smaller sandpipers, particularly Dunlin, Western Sandpipers, and Rock Sandpipers, generally roost along the littoral-vegetation interface, usually flying from 1 to 3 km to feeding areas. Species of both groups appear to remain faithful to both feeding and roosting areas, at least well into molt and early stages of fat deposition, and probably until migration (Gill and Handel, unpublished). On the Alaska Peninsula, most shorebirds roost in littoral or supralittoral areas (Gill, unpublished).

In winter there is little use of the eastern Bering Sea region by shorebirds because littoral areas become ice-fast and unavailable for foraging. Only in Bristol Bay, along the ice-free western Alaska Peninsula, can wintering shorebirds be found regularly. Here relatively low numbers of Rock Sandpipers occur on rocky shores and gravelly beaches, and Sanderlings *(Calidris alba)* on sand and mud-sand substrates.

Migration

The shorebirds of the eastern Bering Sea engage in some of the most varied and highly specialized migrations among birds, many involving sex- and age-related differences, both in timing and in the routes used. Shorebird migration over western Alaska is a pronounced seasonal phenomenon: the spring migration is distinctly different from that in fall. Spring migration can be characterized as short and direct, often occurring during a period of a few weeks, usually in mid- to late May. Once along west and north coastal Alaska, most species move directly to the breeding grounds. In several of the calidridine sandpipers, and probably in many other species, males generally precede females to the nesting areas, but seldom by more than a few days (Holmes 1966, 1971a; Ashkenazie and Safriel 1979; Gill and Handel, unpublished).

Fall migration is more protracted, often beginning in late June and continuing through September and into October for some species (Table 41-3). Shorebirds nesting in the eastern Bering Sea region usually follow one of two general fall migration patterns: in the first, both adults and juveniles quickly leave the nesting grounds. They may then proceed on a very rapid migration, like Semipalmated Sandpipers, which seldom frequent intertidal areas of the region; or they may leisurely move south, like Western Sandpipers and Black Turnstones, which move to intertidal areas but do not remain in the region to molt (Holmes 1972; Gill and Handel, unpublished).

The second basic pattern is typical of most species of the region. Both adults and juveniles move to coastal areas for prolonged periods, generally building lipid stores necessary for extended migrations. Many also complete their prebasic molt before departing for wintering grounds. We do not know what portions of the large numbers of post-breeding birds using Bering Sea coastal areas are from adjacent nesting grounds, and what portion come from further north. In Bristol Bay, large numbers of several species stage on lagoons of the north central Alaska Peninsula (Gill and Jorgensen 1979), well south of their breeding range. These include the Bar-tailed Godwit, Whimbrel *(Numenius phaeopus)*, Ruddy Turnstone *(Arenaria interpres)*, and Long-billed Dowitcher, which breed on the Yukon Delta and north. In coastal areas of the Yukon Delta and Norton Sound, birds from more northern breeding grounds may be mixing with those from local populations.

Within a species, timing of migration may vary by sex and by age. For example, female Western Sandpipers and Black Turnstones depart slightly before males (Gill and Jorgensen 1979; Gill and Handel, unpublished), but male Pectoral Sandpipers *(C. melanotos)* depart before females (Pitelka 1959). Such differences in timing of migration are thought to be linked to differences in social systems (Pitelka et al. 1974).

Age-related differences in migrational timing are often much more pronounced. Juveniles of species such as the plovers, turnstones, phalaropes, and Western, Least *(C. minutilla)*, and Pectoral Sandpipers often depart several weeks later than adults (Pitelka 1959; Holmes 1972; Gill and Handel, unpublished). In species which remain to molt, such as Dunlin and Rock Sandpipers, most adults and juveniles leave together (Gill and Jorgensen 1979; Gill and Handel, unpublished). Bar-tailed Godwits staging on the Alaska Peninsula appear to depart as family groups (Gill and Jorgensen 1979).

Perhaps the most interesting case of age-segregated migration is that of the Sharp-tailed Sandpiper *(C. acuminata)*, which nests in Siberia and winters in the South Pacific. Large populations occur along the eastern Bering Sea coast each fall, but they are almost exclusively juveniles (Gill and Handel, unpublished). The reasons for this striking segregation are not yet understood.

Feeding

Among arctic and subarctic nesting birds, food is probably the single most important factor regulating population numbers, timing of breeding, and habitat use. Holmes (1970, 1971a) addressed these relationships for Dunlin and Western Sandpipers on the Yukon Delta during the nesting period. There is little published information, however, on the feeding ecology of shorebirds during their use of Bering Sea coastal areas before or after nesting. What little is available is about shorebirds on the Pribilof Islands in late summer (Preble and McAtee 1923, Thompson 1973).

Senner and West (1978) have demonstrated the nutritional significance of littoral habitats for shorebirds migrating through the north Gulf of Alaska in spring, particularly as these areas relate to levels of lipid and mineral intake thought necessary to initiate breeding activities. This phenomenon of nutritional "recharging" probably accounts in part for shorebird use of Bering Sea intertidal habitats in spring. Indeed, most of the species which use these areas in spring have completed very extensive, energy-demanding, nonstop migrations (see species accounts).

During nesting, it appears that dipteran larvae of the families Chironomidae, Tipulidae, and Muscidae are the staples in the diets of most shorebirds breeding in coastal fringe habitats (Holmes 1970; Gill and Handel, unpublished). Feeding requirements of shorebirds after breeding are not well known, but the bivalve *Macoma balthica* figures prominently in the diets of several species throughout the region (Gill and Handel, unpublished). Also important, especially on the Yukon Delta, are dipteran larvae of the family Ephydridae (Gill and Handel, unpublished).

SPECIES ACCOUNTS

We present here annotated accounts of the 30 most common shorebird species occurring in the eastern Bering Sea region. In each account, we discuss, as data permit, the occurrence, habitat use, and migrational timing of that species over the four geographic areas of the region.

Semipalmated Plover *(Charadrius semipalmatus)*

This small plover occurs along the coast of the eastern Bering Sea region during the breeding season and in migration. It generally nests in small numbers in the supralittoral zone on sand beaches, dunes, or bars (Gabrielson and Lincoln 1959, Holmes and Black 1973, Gill and Jorgensen 1979). In Bristol Bay, where it is a common breeder, nests have also been found in wet and dwarf shrub meadows (M. Dick, unpublished). There are breeding records for this species on all large Bering Sea islands except the Pribilofs (Gabrielson and Lincoln 1959, Thompson 1967, DeGange and Sowls 1978).

In migration, the Semipalmated Plover forages singly or in small flocks along sandy beaches and mudflats throughout the region. At the head of Norton Sound, it also frequents wet and dwarf shrub meadows (Gabrielson and Lincoln 1959, Shields and Peyton 1979). Spring migrants move through the region from late April to mid-May, with most settling directly on their nesting areas (Gabrielson and Lincoln 1959; Gill and Jorgensen 1979; M. Dick, unpublished; Gill and Handel, unpublished). Fall migrants spend more time on littoral areas, particularly in Bristol Bay, with adults moving through in July and juveniles from early August through mid-September (Gill and Jorgensen 1979; M. Dick, unpublished). One fall record exists from St. Paul Island (Gabrielson and Lincoln 1959).

American Golden Plover *(Pluvialis dominica)*

This bird nests on drier tundra of the eastern Bering Sea region from Cape Prince of Wales south to the Kuskokwim River area, as well as on St. Lawrence and Nunivak islands (Gabrielson and Lincoln 1959).

Spring migration is fairly rapid and direct through the eastern Bering Sea region, with some birds stopping on the Pribilof Islands (Gabrielson and Lincoln 1959) and a few throughout Bristol Bay (Gill and Jorgensen 1979; M. Dick, unpublished). Spring migrants use both intertidal flats and tundra, but appear to favor tundra. During fall migration, large concentrations of both adults and juveniles occur along coastal mudflats, intertidal sloughs, and rivers throughout the region, although an unknown percentage remains on wet meadows. Fall movement through the northern Bering Sea area persists from July through September, peaking in early September (Fay and Cade 1959, Connors 1978, Shields and Peyton 1979). From the Yukon Delta south, a wave of migrants passes through progressively later, with the last birds gone from the Alaska Peninsula and the Pribilofs by late October (Gabrielson and Lincoln 1959; Gill et al. 1977, 1978; Gill and Jorgensen 1979). The first fall migrants have been noted in wintering areas in the central Pacific in late July (Johnston and McFarlane 1967). Adults appear to precede juveniles in this migration.

Black-bellied Plover *(Pluvialis squatarola)*

This plover nests over dwarf shrub meadows of the major river deltas along the arctic coast and south to the Yukon Delta (Gabrielson and Lincoln 1959). During both spring and fall migration, it is found along the coast, frequenting mudflats and wet meadows. In spring, Black-bellied Plovers are fairly common along upper Bristol Bay (Arneson 1978; M. Dick, unpublished). However, the fact that they are uncommon farther out along the Alaska Peninsula (Gill and Jorgensen 1979) indicates that their migration route may take them across the base of the peninsula from the Gulf of Alaska. North of Bristol Bay there is little use of littoral areas by this species in spring.

Beginning in late summer, adults and juveniles move to intertidal mudflats throughout most of the region. In Norton Sound, Black-bellied Plovers are uncommon on mudflats of eastern Norton Bay (Shields and Peyton 1979) and seldom use lagoons along the southern Seward Peninsula (H. Springer, personal communication). On the Yukon Delta, however, thousands of adults pass through from late June to early August, with even larger numbers of juveniles appearing from early August through mid-September (Gill and Handel, unpublished). In upper Bristol Bay, passage occurs slightly later, with adults moving through from late June to early September and juveniles from late August to late September (M. Dick, unpublished). Along the Alaska Peninsula, this species is again uncommon, seen primarily in October in small numbers, but occasionally in flocks of 30-50 birds (Gill et al. 1977, 1978; Gill and Jorgensen 1979). The Black-bellied Plover is a very rare migrant to the Pribilof Islands and St. Lawrence Island in both spring and fall (Kessel and Gibson 1978).

Hudsonian Godwit *(Limosa haemastica)*

During most of its stay in Alaska, this species is generally associated with inland habitats (Gabrielson and Lincoln 1959, Kessel and Gibson 1978), although in the northern part of the region, small numbers regularly use littoral habitats during fall migration. Within the Norton Sound area, this bird apparently prefers dwarf shrub meadows (Shields and Peyton 1979), but it has been recorded on mudflats at Koyuk and Buckland (B. Kessel, Univ. of Alaska, personal communication). Jones and Kirchhoff (Fish and Wildlife Service, unpublished) report that *haemastica* are

abundant on the tide flats on the north Yukon Delta, in July. Records of Hudsonian Godwits along the coast become increasingly scarce farther south (Kessel and Gibson 1978). On the southern Yukon Delta, there appears to be a regular but comparatively small movement of birds from late June through August, but birds are seldom found near the coast (C. Dau, FWS, unpublished; Gill and Handel, unpublished).

Bar-tailed Godwit *(Limosa lapponica)*

This godwit is the most abundant of the large shorebirds breeding in or migrating over western Alaska. The main nesting concentration occurs on the Yukon Delta, but the species breeds north to the Colville Delta (Gabrielson and Lincoln 1959). The Bar-tailed Godwit winters primarily in the southwest Pacific.

In spring, birds arrive along the west coast of Alaska beginning in early May. Most probably move directly to the nesting grounds, although in years of heavy snow cover, a substantial number of godwits linger on adjacent intertidal areas before moving inland. Use of the littoral zone in spring is more pronounced at Norton Sound (H. Springer, personal communication) and on the Yukon Delta (C. Dau, unpublished; Gill and Handel, unpublished) than at Bristol Bay (Arneson 1978, Gill and Jorgensen 1979).

Beginning in late June, the Bar-tailed Godwit becomes one of the more conspicuous shorebirds on the mudflats of the Yukon Delta. Adults generally precede juveniles in their movement to the coast after breeding (Gill and Handel, unpublished). In Norton Sound, birds reach peak populations in mid-August and maintain their numbers into early September (Shields and Peyton 1979; H. Springer, personal communication). On the Yukon Delta, populations of adults peak in late July, but juveniles are most abundant in late August (Dau, unpublished; Gill and Handel, unpublished). By mid-September, most of the godwits have left the delta. On the Alaska Peninsula, this species does not begin to build in numbers until early September, reaching a peak in mid-September. Birds have usually departed from the lagoons by late September (Gill et al., 1977, 1978; Gill and Jorgensen 1979). It is likely that these birds have molted on the Yukon Delta or elsewhere and then moved to the lagoons of the peninsula to fatten before migration. The comparatively low numbers of godwits seen in fall on the Bering Sea islands (Gabrielson and Lincoln 1959) and in the Aleutians (Byrd et al. 1974) suggest that most depart directly from the mainland of western Alaska, probably from the Yukon Delta and Alaska Peninsula (Gill and Jorgensen 1979), to fly directly overseas to the southwest Pacific.

Whimbrel *(Numenius phaeopus)*

According to Gabrielson and Lincoln (1959), the Whimbrel probably breeds from the mouth of the Kuskokwim River, both along the coast and over the interior, north to the Canadian Arctic. There are no breeding records from the Alaska Peninsula or Bering Sea islands.

Spring migrants moving into Alaska generally proceed directly to the nesting grounds. During the summer and fall, Whimbrels rely on littoral areas to varying degrees. In eastern Norton Sound, Whimbrels were found to favor intertidal areas over adjacent tundra habitats (Shields and Peyton 1979, unpublished). Along the southern Seward Peninsula, Whimbrels in flocks of 200 or more have been seen roosting on mudflats of Safety Lagoon in September (H. Springer, personal communication). On the Yukon Delta, *phaeopus* commonly occur along the intertidal of rivers and sloughs as well as on the extensive mudflats, where they often associate with Bar-tailed Godwits (Dau, unpublished; Gill and Handel, unpublished). But the majority of the birds prefer to remain inland on wet and dwarf shrub meadows. In northern Bristol Bay at Nanvak Bay, Whimbrels occur regularly in fall in flocks of 20-30 birds, many using mudflats and rocky shores (M. Dick, unpublished). On the Alaska Peninsula, Whimbrels occur in unusually large flocks. At Naknek, a flock of over 500 was seen in early July 1969 (D. Gibson, Univ. of Alaska, personal communication); and at Nelson Lagoon, from late June through August, flocks of as many as 1,000 birds have been observed foraging on the mudflats (Gill et al. 1977, Gill and Jorgensen 1979).

Bristle-thighed Curlew *(Numenius tahitiensis)*

This species is unique among Alaska shorebirds because its breeding range remains an enigma. Only two nests have been found, these in 1948 on bare tundra in the Nulato Hills (Allen 1948, Allen and Kyllingstad 1949). Other reports (H. Springer, personal communication) suggest that the highlands of the Seward Peninsula are also used for nesting.

The comparatively few spring records along coastal Alaska suggest that this species moves directly to its breeding grounds from wintering areas on islands in the south central Pacific. These birds appear on coastal wet and dwarf shrub meadows on the Yukon Delta in early July (Gill and Handel, unpublished), and fatten preparatory to their fall transoceanic migration. These curlews rarely use littoral areas on the delta, and they remain scattered in flocks seldom

exceeding 20 birds. Away from the Yukon Delta, this species is uncommon in fall. There are reports of Bristle-thighed Curlews with Whimbrels at Cape Newenham (M. Dick, unpublished) and of occasional flocks in upper Bristol Bay and on the Bering Sea islands (Gabrielson and Lincoln 1959). Birds are generally gone from western Alaska by late August.

Greater Yellowlegs *(Tringa melanoleuca)*

This wader breeds in wet inland bogs of south central and southeastern Alaska, and perhaps sparingly on the eastern Alaska Peninsula (Gabrielson and Lincoln 1959; D. Gibson, personal communication). During migration, the Greater Yellowlegs can be found in coastal areas on the Yukon Delta and Bristol Bay, frequenting wet meadows and sometimes mudflats. Spring migration through this area extends from late April to late May, with small numbers passing through upper Bristol Bay and a very few along the Yukon Delta (Gabrielson and Lincoln 1959; M. Dick, unpublished; Gill and Handel, unpublished). There are two spring records for this species from the Pribilof Islands (D. Gibson, personal communication). During fall migration, numbers increase both on the delta and throughout Bristol Bay, with birds sometimes making extensive use of mudflats, particularly on the Alaska Peninsula (Gill and Jorgensen 1979; Gill, unpublished). Along coastal Yukon Delta, Greater Yellowlegs occur regularly, usually as single birds, from early August to late September (Gill and Handel, unpublished). Throughout Bristol Bay they become fairly common, occurring in small flocks from early July to mid-October (Gill and Jorgensen 1979; M. Dick, unpublished). There is one historical record of this species on the Pribilof Islands in fall (Gabrielson and Lincoln 1959).

Lesser Yellowlegs *(Tringa flavipes)*

This smaller yellowlegs also breeds in bogs of interior Alaska, but is much less common than the Greater Yellowlegs along the coast of the eastern Bering Sea. The Lesser Yellowlegs apparently moves directly to the breeding grounds in spring without using littoral areas in this region. In the fall, it is a rare migrant in Norton Sound, frequenting brackish ponds, mudflats, and dwarf shrub meadows (Shields and Peyton 1979). Farther south it is seen more frequently as a regular and common migrant over wet meadows along the north Alaska Peninsula from mid-July to early October (Gill and Jorgensen 1979). It is a rare fall straggler to the Pribilofs (Kenyon and Phillips 1965) and St. Lawrence Island (Thompson 1967).

Wandering Tattler *(Heteroscelus incanus)*

This shorebird has been found breeding along gravelly streams in mountainous areas throughout southcoastal, central, and western Alaska (Gabrielson and Lincoln 1959, Kessel and Gibson 1978). In migration, however, it prefers rocky shores and steeply cut riverbanks along the coast. The small numbers of tattlers found in littoral areas during migration are probably from suitable nesting areas in adjacent habitat. In spring, Wandering Tattlers occur on the Yukon Delta in late May (Gill and Handel, unpublished) and in northern Bristol Bay between mid-May and mid-June (M. Dick, unpublished). In fall, they become more widespread, but remain uncommon throughout the region from mid-July through late September (Gabrielson and Lincoln 1959, Kessel and Gibson 1978). There are many records of this species on the Bering Sea islands in fall, but only one in spring, on St. Paul Island.

Ruddy Turnstone *(Arenaria interpres)*

This bird is a common breeder in the dwarf shrub meadows along the Bering Sea coast as far south as the Yukon Delta and on St. Lawrence Island (Gabrielson and Lincoln 1959). A few historical breeding records exist for St. Matthew and St. Paul islands. During spring migration, there is little use of littoral areas along the western Alaska coast. Small numbers trickle through Bristol Bay and the Yukon Delta throughout May; there is no significant movement through Norton Sound or on the Bering Sea islands (Gabrielson and Lincoln 1959; Gill and Jorgensen 1979; M. Dick, unpublished; Gill and Handel, unpublished).

Fall movements extend from mid-July to early October through western Alaska, with adults preceding juveniles. On the Pribilof Islands, spectacular concentrations of tens of thousands of migrant turnstones are found in late summer and fall. At least some of these birds are coming from breeding grounds in Siberia and St. Lawrence Island (Thompson 1973). After staging on the Pribilofs, they depart on a transoceanic route, which takes them through the central Pacific in fall, returning to the breeding grounds in spring along the western Pacific via Japan and perhaps the Commander Islands (Thompson 1973). It is not known if *interpres* that breed on the north and west coasts of mainland Alaska follow this route or if they winter along the Pacific coast of the Americas.

Nowhere on the mainland of western Alaska do *interpres* occur in numbers similar to those on the

Pribilofs. In the Norton Sound area, they are uncommon fall migrants at Cape Prince of Wales (Connors 1978), are widespread but uncommon at Safety Lagoon (H. Springer, personal communication), but apparently do not occur at the head of Norton Bay (Shields and Peyton 1979). Along the Yukon Delta small flocks of turnstones occur regularly on upper tidal flats from mid-July through mid-September (Gill and Handel, unpublished). South of the Yukon Delta they are uncommon fall migrants in north Bristol Bay (M. Dick, unpublished), but become common along the rocky shores and mudflats of the north central Alaska Peninsula (Gill and Jorgensen 1979; Gill, unpublished). On the peninsula, turnstones first appear in mid-July and populations peak in late August. Most have passed through the area by early October. The Ruddy Turnstone is a fairly common fall migrant on St. Lawrence and St. Matthew islands (Fay and Cade 1959, Gabrielson and Lincoln 1959, DeGange and Sowls 1978).

Black Turnstone *(Arenaria melanocephala)*

The Black Turnstone is primarily a bird of the Yukon Delta, yet occurs as a regular breeding species north to Cape Prince of Wales and south through Bristol Bay and along the Alaska Peninsula (Murie 1959, Kessel et al. 1964, Harris 1966, Holmes and Black 1973, Gill and Jorgensen 1979). In spring, birds move directly to the breeding grounds, usually in early May. On the Yukon Delta, nests are concentrated on coastal wet and salt grass meadows and are subject to occasional flooding from storm-driven tides (Gill and Handel, unpublished).

After the young hatch, usually from early to mid-June, adults begin to shift their foraging from vegetated areas to the adjacent intertidal zone. As young fledge, adults begin flocking on the mudflats and, by mid-July, most have left the delta. Adults presumably migrate directly to areas in the Gulf of Alaska and southeast Alaska, where they probably molt before flying to wintering areas. Juvenile turnstones appear in small groups on the mudflats of the Yukon Delta beginning in early August and are present into early September. In Norton Sound and Bristol Bay, juveniles appear in late August, but usually as single birds (Gill and Jorgensen 1979; H. Springer, personal communication; M. Dick, unpublished).

Northern Phalarope *(Phalaropus lobatus)*

The breeding range of this shorebird is probably more extensive than any other within Alaska (Gabrielson and Lincoln 1959). It breeds throughout the eastern Bering Sea region, including St. Lawrence and St. Matthew islands. Birds generally arrive throughout western Alaska from mid- to late May and, depending on ice and snow conditions, may move directly to the nesting grounds. In late springs, particularly in Norton Sound, large rafts of *lobatus* frequently congregate along open ice leads (H. Springer, personal communication). In summer, birds begin flocking in Norton Sound in early July, and usually pass through the area by late August (Shields and Peyton 1979). On the Yukon Delta, adults occur in large numbers on nearshore waters, mudflats, and salt grass meadows during mid-July. The peak passage of juveniles occurs from mid-August through mid-September (Gill and Handel, unpublished). Northern Phalaropes exhibit similar timing in their movements through Bristol Bay and along the Alaska Peninsula (Gill et al. 1977, 1978; Gill and Jorgensen 1979; M. Dick, unpublished).

Red Phalarope *(Phalaropus fulicarius)*

The Red Phalarope nests throughout the region from northern Bristol Bay to Norton Sound, including St. Lawrence Island (Gabrielson and Lincoln 1959). In Norton Sound, it occurs regularly in late May, sometimes in rafts of several thousands (H. Springer, personal communication). On the Yukon Delta and on St. Paul and St. Matthew islands, birds generally arrive from mid- to late May (Gabrielson and Lincoln 1959; Dau, unpublished; Gill and Handel, unpublished). In these areas, large numbers of birds are often present in littoral habitats until early June before settling onto the nesting grounds. Throughout Bristol Bay this species is an uncommon spring migrant, occurring at Cape Newenham from mid- to late May (M. Dick and M. Petersen, FWS, unpublished) and along the Alaska Peninsula in mid-May (Gill and Jorgensen 1979).

In Norton Sound, Red Phalaropes make little use of littoral areas after breeding or during fall migration (Connors 1978; Shields and Peyton 1979; H. Springer, personal communication). Over the Hooper/Hazen Bay segment of the Yukon Delta, Gabrielson and Lincoln (1959) reported the Red Phalarope abundant in early August. However, in 1978 and 1979, only small, scattered flocks consisting mainly of juveniles were seen over this same area, and only during July and early September were movements noted (Gill and Handel, unpublished). In Bristol Bay, birds have been reported from late June through late October. Here, Bartonek and Gibson (1972) found many small flocks scattered at sea in July. At Nelson Lagoon, numbers of adults peaked in mid-July, never exceeding 50 birds (Gill et al. 1977, Gill and Jorgensen 1979).

Common Snipe *(Gallinago gallinago)*

The Common Snipe breeds throughout western Alaska, but generally away from littoral areas, and usually in very low densities (Gabrielson and Lincoln 1959). This species is one of the earliest spring migrants: birds appear in late April over much of the Norton Sound, Yukon Delta, and Bristol Bay. In fall, birds generally migrate directly from the breeding grounds.

Short-billed Dowitcher *(Limnodromus griseus)*

Of the two species of dowitcher breeding in the eastern Bering Sea region, *griseus* has the more restricted nesting distribution, being limited to the Alaska Peninsula and upper Bristol Bay, perhaps occurring as far north as Goodnews Bay (Gabrielson and Lincoln 1959, Gill et al. 1977, Gill and Jorgensen 1979). In spring, birds arrive in the region in mid-May and move directly to the breeding grounds. Postbreeding flocking begins in late June, as birds move from wet meadows to adjacent intertidal areas. Flocks gradually increase in size, often comprising several thousand birds, and generally remain through early August (Gill and Jorgensen 1979). The Short-billed Dowitcher is usually gone from western Alaska by mid-September.

Long-billed Dowitcher *(Limnodromus scolopaceus)*

The more common of the two dowitchers in Alaska, *scolopaceus* breeds from the mouth of the Kuskokwim River north along the coast and inland to the Yukon Territory (Gabrielson and Lincoln 1959). Among the Bering Sea islands, only St. Lawrence is known as a breeding site (Fay and Cade 1959). The species also breeds across the Bering Strait on the Chukotsk Peninsula (Dementyev and Gladkov 1951).

Long-billed Dowitchers move directly to the breeding grounds in spring, and are considered to be among the latest migrants of western Alaska shorebirds. They generally do not arrive in the Norton Sound area until early June (H. Springer, personal communication) and not until late May on the Yukon Delta (Holmes and Black 1973; Dau, unpublished; Gill and Handel, unpublished). In summer, adults, followed by juveniles, begin using littoral habitats, mostly along major rivers. The majority of the population, however, remains inland until fall migration (Shields and Peyton 1979; Gill and Handel, unpublished). Postbreeding birds peak in number in Norton Sound and on the Yukon Delta in early September. Beginning mid-August, there is an influx of *scolopaceus* at Nelson Lagoon and probably other estuaries along the Alaska Peninsula (Gill and Jorgensen 1979; Gill, unpublished). These birds generally do not peak in numbers until early October, well after numbers have begun to decline farther north, suggesting that the Alaska Peninsula is used as part of the regular fall migration route.

Surfbird *(Aphriza virgata)*

This species is a rare spring and fall migrant along the coast of the eastern Bering Sea. The few breeding records available indicate that it probably nests in most of the mountainous areas of mainland Alaska, concentrating in the ranges of the interior (Gabrielson and Lincoln 1959, Kessel and Gibson 1978). The few Surfbirds using littoral areas of the region probably nest in suitable adjacent habitat, e.g., the mountains surrounding Norton Sound, the Kilbuck Mountains of northern Bristol Bay, and the Aleutian Range of the Alaska Peninsula.

Red Knot *(Calidris canutus)*

The habits of this large sandpiper in Alaska are poorly known. There are relatively few breeding records, and its migration routes are not well known (Gabrielson and Lincoln 1959, Kessel and Gibson 1978). The most recent information indicates that within Alaska *canutus* breeds in the mountainous regions of the Seward Peninsula, over the western Brooks Range, and near Barrow.

In early to mid-May, as many as 100,000 Red Knots are estimated to stage on the Copper River Delta (Isleib 1979) and from there apparently fly directly to breeding grounds in northwest Alaska and possibly Siberia (Kessel and Gibson 1978). Recent observations (Dau, unpublished; Gill and Handel, unpublished) indicate that between early and late May the Yukon Delta supports a substantial segment of the northbound population. Beginning the first week of May in 1978 and 1979, large flocks of Red Knots were seen approaching the coast from a south-southwest direction. During mid-May in both years, several thousands and perhaps a few tens of thousands of this species fed daily on the exposed tide flats and flew inland to roost during high tides. Most were generally gone from the area by early June (Gill and Handel, unpublished). To the north in Norton Sound, the intertidal zone is also used by knots each spring, but not in the numbers found on the Yukon Delta (H. Springer, personal communication). There are few spring records of *canutus* from the Bering Sea islands and none from the Alaska Peninsula (Kessel and Gibson 1978).

In fall, knots show little preference for the intertidal areas of Norton Sound (Shields and Peyton 1979; H. Springer, personal communication). Those

birds using the area move through in mid-August. The bird is similarly scarce in north Bristol Bay and along the Alaska Peninsula (Gill et al. 1977; Kessel and Gibson 1978; M. Dick, unpublished). On the Yukon Delta, however, adults begin using the mudflats in late June, and several thousand can be found along the coast of the central delta by mid-July. Juveniles do not appear until late July, but most remain into early September. Red Knots fly daily between feeding and roosting areas, just as they do in spring. In fall, however, they often associate, especially at roosts, with Bar-tailed Godwits (Gill and Handel, unpublished).

Sanderling *(Calidris alba)*

The Sanderling is not known to breed in the eastern Bering Sea region (Kessel and Gibson 1978). Away from the breeding grounds, this is a bird of open coasts, usually sandy beaches and mudflats. During spring migration, usually from mid- to late May, Sanderlings are scarce in Norton Sound, but are regularly found on the Yukon Delta, in upper Bristol Bay, and along the Alaska Peninsula. They occur in large numbers only at Izembek Lagoon (R.D. Jones, FWS, personal communication). The birds that are here have probably wintered in the Aleutians and are moving east along the chain before dispersing to northern breeding grounds.

In fall, Sanderlings move through Norton Sound in August and early September, over the Yukon Delta from early September through early October, and along the Alaska Peninsula from mid-August through October (Connors 1978; Gill et al. 1978; Gill and Jorgensen 1979; Shields and Peyton 1979; Gill and Handel, unpublished). There are few fall records of Sanderlings from the Bering Sea islands (Kessel and Gibson 1978). Sanderlings regularly winter in the Aleutians and, depending on ice conditions, can be found as far east as the central Alaska Peninsula between November and March (Gill, unpublished).

Semipalmated Sandpiper *(Calidris pusilla)*

The Semipalmated Sandpiper is the most common nesting "peep" of northwest Alaska. Its principal breeding grounds are north of the Yukon Delta (Gabrielson and Lincoln 1959, Ashkenazie and Safriel 1979, Shields and Peyton 1979), but nesting does occur south to at least the mouth of the Kuskokwim River (Gill and Handel, unpublished). This species arrives on the breeding grounds in early to late May. Over much of the Yukon Delta and portions of Norton Sound, the nesting habitat of *pusilla* is frequently flooded by storm-driven tides in early spring and occasionally during the nesting season.

The Semipalmated Sandpiper, unlike its congeners the Dunlin and Western Sandpiper, makes little use of littoral areas in this region after nesting (cf. Connors 1978, Connors et al. 1979, for Chukchi Sea coast). Instead, *pusilla* generally remains on coastal wet meadows and departs directly from these areas by early August.

Western Sandpiper *(Calidris mauri)*

This species is an abundant nester over dwarf shrub meadows throughout the eastern Bering Sea region, including the Alaska Peninsula and Nunivak, St. Matthew, and St. Lawrence islands (Gabrielson and Lincoln 1959, Holmes 1971a, Gill et al. 1977, Gill and Jorgensen 1979). The Yukon Delta supports most of the Alaska breeding population but substantial numbers breed as far north as the Seward Peninsula. Western Sandpipers arrive on the nesting grounds in mid-May. Most have come from staging areas in the north Gulf of Alaska (Connors 1978, Senner 1979).

After breeding, adult females are the first to move to the coast. Throughout the region, this movement occurs in early to mid-July (Holmes 1971a, 1972; Gill and Jorgensen 1979; Shields and Peyton 1979; Gill and Handel, unpublished). Adult males follow soon, usually accompanying the first volant juveniles. In Norton Sound, migration peaks in mid- to late August. On the Yukon Delta, adults usually depart by late July, but juveniles are present into early September. Western Sandpipers exhibit similar timing in their use of lagoons on the Alaska Peninsula.

Rufous-necked Sandpiper *(Calidris ruficollis)*

This small Beringian sandpiper is known to nest in western Alaska along the Seward Peninsula coast and probably on St. Lawrence Island (Kessel and Gibson 1978). Reports of nesting birds are usually of separate pairs. During spring and fall migration, *ruficollis* is most frequently reported flocking with the very similar Western Sandpiper.

Least Sandpiper *(Calidris minutilla)*

The Least Sandpiper nests commonly in coastal wet and salt grass meadows along Bristol Bay, and perhaps rarely on the Yukon Delta and in Norton Sound (Gabrielson and Lincoln 1959; Shields and Peyton 1979; H. Springer, personal communication). *Minutilla* makes little use of littoral habitats in the region during spring migration; however, in fall, fair numbers can be found throughout Bristol Bay in salt grass meadows and occasionally on mudflats and along flowing waters of major drainages (Gill and

Jorgensen 1979; M. Dick, unpublished; Gill, unpublished). Postbreeding adults are present from late June through mid-July, and juveniles are present into late August. *Minutilla* is probably a rare but regular visitant to the Pribilof Islands (D. Gibson, personal communication).

Baird's Sandpiper *(Calidris bairdii)*

Baird's Sandpipers breed sparingly within the eastern Bering Sea region from the Yukon Delta to Cape Prince of Wales, including St. Lawrence Island (Gabrielson and Lincoln 1959). During migration they occur throughout the region, usually as singles or in small groups mixed with Western Sandpipers.

Pectoral Sandpiper *(Calidris melanotos)*

The principal nesting grounds of the Pectoral Sandpiper occur north of the Yukon Delta, although this species has been found nesting as far south as Bristol Bay, and possibly breeds on St. Lawrence Island (Kessel and Cade 1958, Fay and Cade 1959, Gabrielson and Lincoln 1959, Pitelka 1959).

Pectoral Sandpipers seldom use littoral areas in western Alaska in spring, flying instead directly to the breeding grounds. In Norton Sound and areas farther north, postbreeding birds use both littoral areas and coastal wet meadows, peaking in numbers in late August and early September (Connors 1978; Shields and Peyton 1979; H. Springer, personal communication). On the Yukon Delta comparatively few adults occur along the coast or immediately inland (Gill and Handel, unpublished; C. P. Dau, personal communication), suggesting that adults migrate in fall through the interior. Juveniles, however, move to the vegetated supralittoral of the central delta, where they occur by the thousands. They often associate with juvenile American Golden Plovers and, to a lesser extent, with Sharp-tailed Sandpipers (Gill and Handel, unpublished). In Bristol Bay and along the Alaska Peninsula, *melanotos* is uncommon in fall (Gill and Jorgensen 1979; Dick and Petersen, unpublished). This species is a rare fall migrant on St. Lawrence Island, but occurs regularly on the Pribilofs (Preble and McAtee 1923, Fay and Cade 1959, Gabrielson and Lincoln 1959).

Sharp-tailed Sandpiper *(Calidris acuminata)*

This species, unlike the very similar Pectoral Sandpiper, is not known to nest in Alaska (Kessel and Gibson 1978). Instead, it occurs as a regular late summer and fall visitor from breeding grounds along the coastal fringe of northeast Siberia (A.A. Kistchinski, The Ringing Center, Moscow, personal communication). Almost all fall records are of juveniles (Kessel and Gibson 1978).

Within Alaska, most Sharp-taileds occur from Cape Lisburne south, the majority congregating on the Yukon Delta (Connors 1978; Schamel et al. 1979; Shields and Peyton 1979; Gill and Handel, unpublished). On the delta, beginning in late August, birds appear in thousands and probably tens of thousands. By mid-September, flocks of 100 birds are common and occasionally flocks of 200 or more are seen. Most of these are found over the extensive intertidal of the central delta, including the littoral area of several major rivers, where they most often associate with juvenile Dunlin and juvenile American Golden Plovers. Less commonly *acuminata* also use adjacent wet meadows in association with Pectoral Sandpipers.

In Bristol Bay and on the Bering Sea islands, *acuminata* are seen less frequently and in smaller numbers than to the north (Gill and Jorgensen 1979; M. Dick, unpublished). Away from the eastern Bering Sea region, Sharp-taileds are reported regularly in fall in the Aleutians (Byrd et al. 1974; Kessel and Gibson 1978; G. V. Byrd, personal communication).

The number of Sharp-tailed Sandpipers occurring on the Yukon Delta and the Seward Peninsula suggests that western Alaska is part of a regular, age-specific fall migration route for this species from Siberia. Birds from the delta and other areas probably move across the eastern Bering Sea and along the Aleutian and Komandorsky islands to wintering areas in the southwest Pacific.

Rock Sandpiper *(Calidris ptilocnemis)*

The Rock Sandpiper is truly a shorebird of Beringia. Three distinct races breed in the region, and a fourth is known from the Commander Islands (see Conover 1944, Gabrielson and Lincoln 1959). Many birds winter in ice-free areas of the Bering Sea, although most move to rocky coastlines in the Gulf of Alaska and south to central California (Conover 1944, Gill 1979).

As early as mid-April, birds begin moving to the breeding grounds, often while the nearshore intertidal is still ice-fast. Here they congregate in large flocks and forage extensively over the ice-free outer flats of the Yukon Delta and Alaska Peninsula (Gill et al. 1977, 1978; Gill and Jorgensen 1979; Gill and Handel, unpublished). Birds continue to use the littoral into early June. After breeding, usually by early July, the first adults return to the tidal flats, followed by juveniles in late July and early August. Flocks gradually build until peak numbers are reached in early September; once formed, flocks become relatively sedentary and faithful to daily roosting and

feeding sites (Gill and Handel, unpublished). On the Yukon Delta, roost sites are typically cut banks adjacent to the intertidal (Gill and Handel, unpublished), but rocky points and shores are more commonly used on the Bering Sea islands, Norton Sound, and Alaska Peninsula (Gabrielson and Lincoln 1959). Rock Sandpipers and Dunlin, which remain to complete prebasic molt, are often the last shorebirds to leave the northeastern Bering Sea region in fall, with some birds remaining into November on several Bering Sea islands.

Dunlin *(Calidris alpina)*

This species is the most abundant shorebird using littoral areas along the west coast of Alaska, and the principal breeding species throughout the coastal fringe (Holmes 1971b, Gill and Jorgensen 1979). In spring, Dunlin generally move directly to the breeding grounds from staging areas on the Copper River Delta (Isleib 1979, Senner 1979). However, on the Yukon Delta during years of late snow-melt, birds congregate and feed on adjacent ice-free intertidal until nesting areas become available (Gill and Handel, unpublished).

Postbreeding Dunlin move from nesting areas to adjacent intertidal habitat beginning in mid-June, where they undergo molt and usually remain to build fat reserves for fall migration. Their use of the littoral is among the most protracted of all shorebirds in western Alaska, with both adults and juveniles remaining along the coast into early October (Gill and Jorgensen 1979; Gill and Handel, unpublished; H. Springer, personal communication). These birds appear to be highly faithful to roosting as well as feeding areas, and often associate with Rock Sandpipers at both sites. Individual roosts on the Yukon Delta often comprise several thousands of birds and, occasionally, several tens of thousands. Roosting sites are generally adjacent to major feeding areas and are often within the upper littoral zone.

Within western Alaska, there appear to be two or possibly three distinct populations of Dunlin of the race *pacifica*, whose nesting is restricted to the eastern Bering Sea region (MacLean and Holmes 1971, Browning 1977, Gill and Jorgensen 1979). The two major populations, in the Yukon Delta and Alaska Peninsula, appear to winter in the Pacific northwest and in central and northern California respectively (Gill et al. 1978, Gill 1979). Dunlin from Norton Sound appear to represent a third, albeit much smaller, population, but little information exists on its postbreeding movements or migration. The Yukon Delta also hosts, beginning in August, several tens of thousands of Dunlin of the race *sakhalina*, which breeds in arctic Alaska and northeastern Siberia. In 1979, large flocks mainly of adults staged on the delta before departing in late September or early October. Band recovery data and sightings of color-marked birds from this population indicate that these *sakhalina* winter in Japan and Korea (Gill and Handel, unpublished).

Buff-breasted Sandpiper *(Tryngites subruficollis)*

This species is not known to nest within the eastern Bering Sea region, nor does it occur regularly or in numbers during migration (Kessel and Gibson 1978). There are, however, several records of its occurrence along coastal areas of western Alaska, including the Pribilof Islands, Norton Sound, Yukon Delta, and Alaska Peninsula (M. Petersen, unpublished).

CONCLUSIONS

The shorebird resources of the eastern Bering Sea region have global significance. For a third of the species discussed, the area supports at some time the main Alaska population and, in many instances, the main North American population (Table 41-4). In addition, major segments of populations of more northern breeders move into the area during or preparatory to fall migration. Combined, these populations represent several million birds. But while there can be little question of the importance of the region to these shorebird populations, we are less certain why it is important and how this resource may be affected by environmental changes.

Connors et al. (1979) indicate several biological factors which partly determine the susceptibility of a species to environmental disturbance in arctic Alaska. These include distribution, habitat use, trophic relationships, and social systems and behavior. For the most part the same issues are applicable to shorebird populations in subarctic environs. The aspects of these which must be addressed for each species in the region are: What is the size of the population and are there discrete subpopulations? What is the origin of the population? How important is an area to the welfare of a species? What are the food requirements of a species, both on the breeding grounds and over littoral habitats? What food resources are available, and how do shorebirds respond to changes in their availability? How mobile are populations which depend on littoral areas after breeding? And by what routes do birds migrate and where do they winter?

Until these questions are answered, only a preliminary assessment can be made of the vulnerability of these shorebirds to environmental disturbances. As

TABLE 41-4

Shorebird species whose main Alaska (*) or North America (+) breeding or postbreeding populations occur in the eastern Bering Sea region.

Breeding	Postbreeding
+Black Turnstone *(Arenaria melanocephala)*	*American Golden Plover *(Pluvialis dominica)*
+Western Sandpiper *(Calidris mauri)*	+Bar-tailed Godwit *(Limosa lapponica)*
+Rock Sandpiper *(Calidris ptilocnemis)*	*Whimbrel *(Numenius phaeopus)*
+Dunlin *(Calidris alpina pacifica)*	*Red Knot *(Calidris canutus)*
+Bristle-thighed Curlew *(Numenius tahitiensis)*	[1] Sharp-tailed Sandpiper *(Calidris acuminata)*

[1] Breeds in northeastern Siberia. A large but unknown segment of the annual juvenile population moves to coastal western Alaska each September.

habitat use within the region changes dramatically with the seasons, the susceptibility of a species also changes. In winter and spring, very few species are associated with littoral or supralittoral habitats. During the breeding season, those species nesting in numbers along the coastal fringe, particularly Black Turnstones, Dunlin, and Semipalmated Sandpipers, are most vulnerable, especially to changes in their nesting habitat or food resources.

By far the greatest numbers of shorebirds are present in the coastal areas of the region after breeding, from mid-July through late September. During this period, many species become entirely dependent upon littoral and supralittoral habitats for premigratory fattening and often through molt. For each of the most common shorebirds of the region we present in Table 41-5 an estimate of its relative susceptibility to littoral zone disturbances. We have assigned each species to a category based primarily on its dependence upon littoral habitats, including the magnitude of this use in relation to the total population, and the duration of dependence upon the habitat. For example,

TABLE 41-5

Relative susceptibility of common shorebirds to littoral zone disturbances.

Area	High	Moderate	Low
Norton Sound	Northern Phalarope Red Phalarope Western Sandpiper Dunlin	American Golden Plover Bar-tailed Godwit Long-billed Dowitcher Sanderling Semipalmated Sandpiper	Hudsonian Godwit Whimbrel Pectoral Sandpiper
Yukon Delta	Bar-tailed Godwit Black Turnstone Western Sandpiper Rock Sandpiper Dunlin	American Golden Plover Black-bellied Plover Whimbrel Northern Phalarope Red Knot Sharp-tailed Sandpiper	Hudsonian Godwit Bristle-thighed Curlew Ruddy Turnstone Long-billed Dowitcher Pectoral Sandpiper
Bristol Bay	Bar-tailed Godwit Short-billed Dowitcher Western Sandpiper Rock Sandpiper Dunlin	Whimbrel Ruddy Turnstone Northern Phalarope Red Phalarope Long-billed Dowitcher Sanderling	Greater Yellowlegs Lesser Yellowlegs Least Sandpiper
Bering Sea islands	Northern Phalarope Red Phalarope Rock Sandpiper	Ruddy Turnstone	American Golden Plover

Dunlin and Western and Rock Sandpipers are considered highly susceptible because essentially the entire population of adults and juveniles moves to littoral areas and remains there until fall migration. We consider species such as American Golden Plover and Long- and Short-billed Dowitchers to be less susceptible because large segments of the population remain inland or move out of the region after breeding. Even these, however, could become more susceptible if an event such as an oil spill were coupled with a storm surge in the early fall: the inland habitats could become polluted—a situation easily realized over the low-lying portions of the Yukon Delta and Norton Sound. Until we better understand the dynamics of shorebird populations in relation to the coastal habitats, we will not be able to determine the extent of the effects of environmental stress, whether it be the result of man's activities or of natural causes.

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