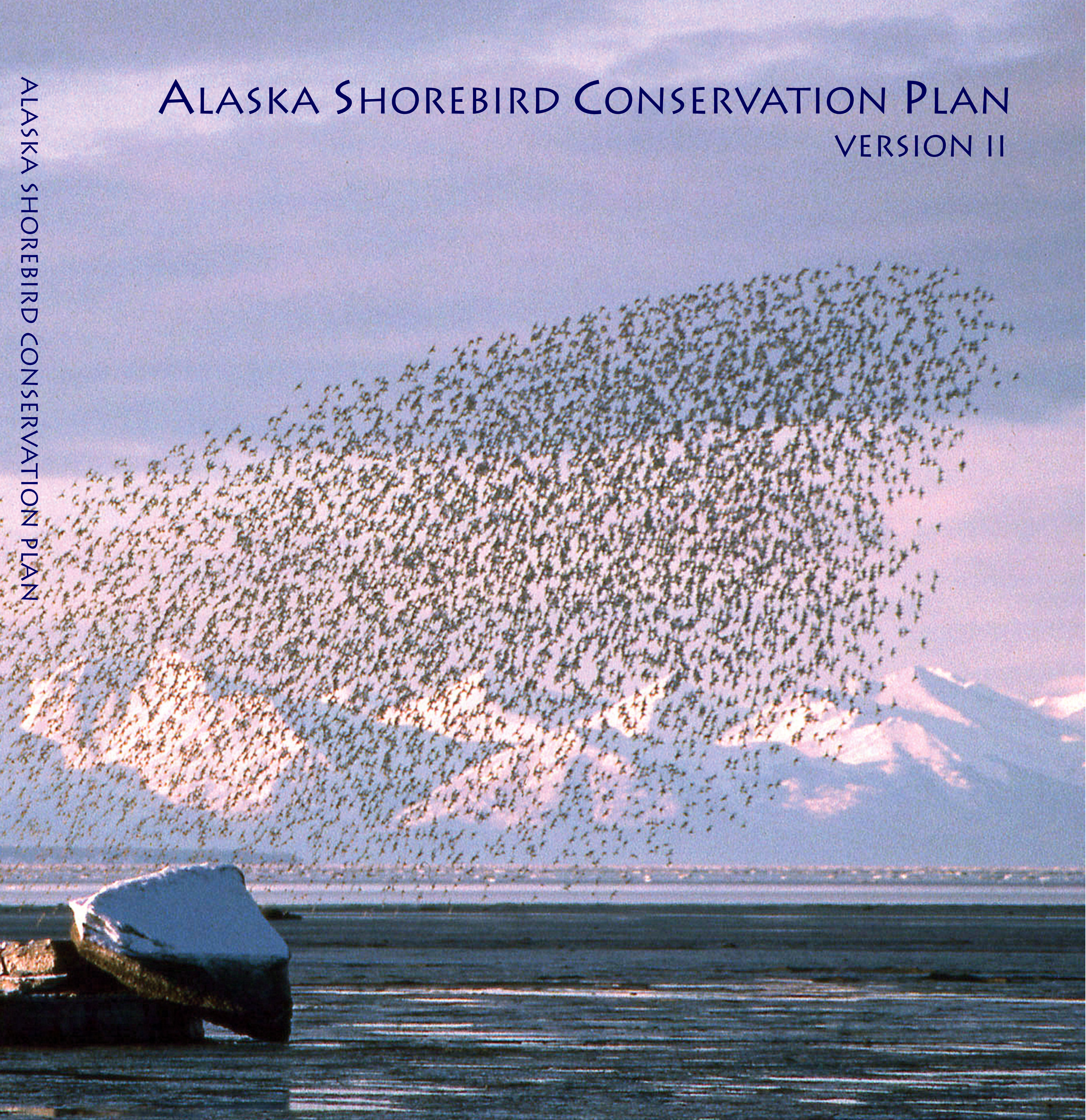
Alaska Shorebird Conservation Plan

Version II



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Alaska Shorebird Group

November 2008

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NOVEMBER 2008

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Alaska Shorebird Group. 2008. Alaska Shorebird Conservation Plan. Version II. Alaska Shorebird Group, Anchorage, AK.

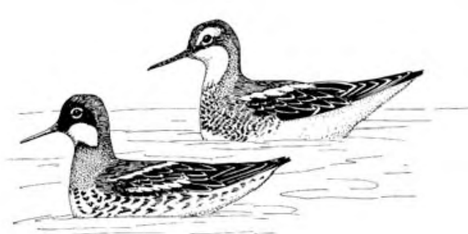
The Alaska Shorebird Conservation Plan and updates can be viewed and downloaded at:
http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm

Cover photo: Rock Sandpipers wintering in Cook Inlet • Robert Gill, Jr.

DEDICATION

Doug Schamel
1951–2005

The Alaska Shorebird Conservation Plan is dedicated to Doug Schamel in appreciation for his contributions to shorebird science, education, and conservation over his 20-year career in Alaska. Doug's natural curiosity and enthusiasm for all things zoological were unbounded, but he focused his professional research efforts on shorebirds. Somewhat of a nonconformist himself, it is not surprising that Doug gravitated toward study of the polyandrous social system of phalaropes. Along with his wife, Diane Tracy, he authored a dozen phalarope publications, including the species accounts for the *Birds of North America* series. Doug and Diane turned shorebird research into a family enterprise; along with children Jay and Juliann, they spent many summers at their beloved Cape Espenberg camp immersed in the work of trapping, marking, and observing shorebirds. In later years the Schamel family research program expanded globally to include studies of Temminck's Stints in Finland. Doug was by nature a frugal person, an inclination that was reinforced by the difficulty he encountered in attracting funding for research in shorebird behavioral ecology. He was a master of the low-tech, low-budget approach to research and his accomplishments are a testament to what can be achieved through sheer passion and creativity. Doug was deeply committed to science education at all levels–grade school, undergraduate, graduate, and adult. He played a leading role in connecting the University of Alaska science community with the public at large, and was a gifted and caring teacher. His energy, enthusiasm, and humor (even the bad puns) are greatly missed.

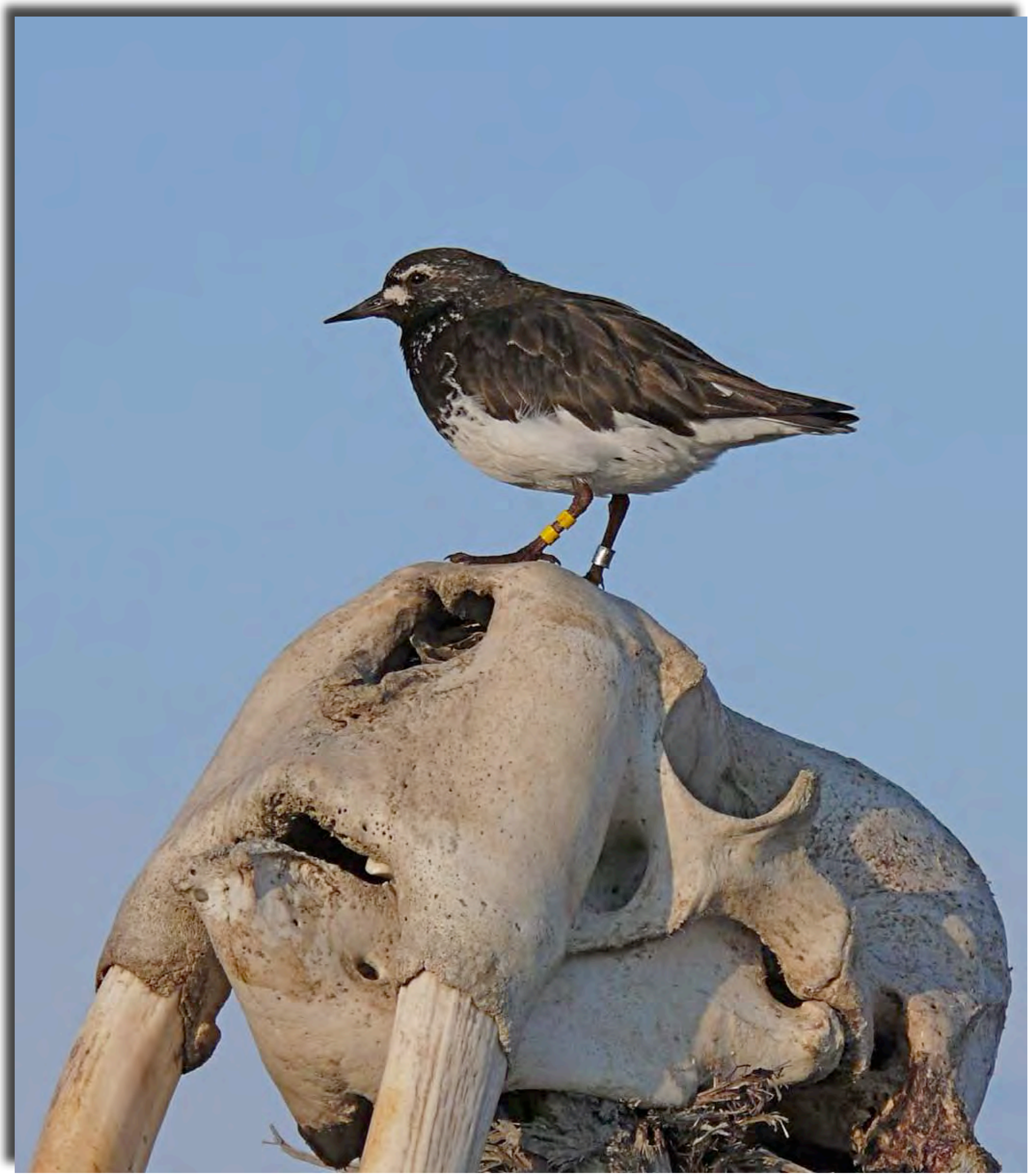


George West

Dunlin • Robert Gill, Jr.

ACKNOWLEDGMENTS

Audrey Taylor, Chair of the Alaska Shorebird Group, extends appreciation and sincere thanks to all members who contributed their time and expertise to produce this plan. Their hard work and dedication have made this very important endeavor possible. Many thanks are also due to all agencies and organizations that cooperated in this effort: Alaska Department of Fish and Game (ADF&G), Audubon Alaska, Bureau of Land Management (BLM), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), US Forest Service, USGS Alaska Science Center, and Wildlife Conservation Society. Maksim Dementyev graciously provided the artwork (unless otherwise noted), and Milo Burcham (http://www.milosphotos.com), Brian Guzzetti (http://www.fromthefarcorners.com), Ron Niebrugge (http://www.wildnatureimages.com), Joel Sartore (http://www.joelsartore.com), Ted Swem, and many members of the Alaska Shorebird Group shared their fantastic shorebird images that bring this document to life. Special thanks are due to Julie Morse, Jim Johnson, and Dan Ruthrauff for producing this final document, and Robert Gill, Colleen Handel, Rick Lanctot, Joe Liebezeit, Brian McCaffery, and Lee Tibbitts for their tireless work and dedication over many years. The combined efforts of these enthusiastic Alaska Shorebird Plan devotees made completion of this project finally possible in 2008.



Black Turnstone • Adrian Riegen

EXECUTIVE SUMMARY

Alaska's immense size and northerly position make it a critical region for breeding and migrating shorebirds. In fact, Alaska provides breeding habitat for more shorebird species than any other state in the U.S. Seventy-three species of shorebirds have occurred in Alaska; 37 of them, including several unique Beringian species and Old World subspecies, regularly breed in the region. Most of these species migrate south of the U.S.-Mexico border and one-third migrate to South America or Oceania. Concentrations of shorebirds at several coastal staging and migratory stopover sites exceed one million birds; on the Copper River Delta alone, five to eight million shorebirds stop to forage and rest each spring.

Shorebirds worldwide have suffered dramatic population declines in the last decade. Using the species prioritization process developed for the U.S. National Shorebird Plan, we incorporated new population estimates, updated threats, and identified 20 taxa of shorebirds of high conservation concern in Alaska. All species of concern tend to have small global population sizes or limited breeding distributions. Seasonal occurrence of priority species was examined within the geographic context of Alaska's five Bird Conservation Regions (BCRs). Most priority species, particularly breeding species, occur in the Western Alaska and Arctic Coastal Plain BCRs. Southern regions of the Northwest Interior Forest and the Northern Pacific Rainforest BCRs are primarily used by shorebirds during migration and winter. The Aleutian/Bering Sea Islands BCR is also an important wintering area for shorebirds.

Around the world, loss of wetland habitat represents the greatest threat to shorebird populations. Nonbreeding and migratory stopover areas outside of Alaska that are important to the state's shorebirds are being altered by humans at an immense scale, primarily through drainage and reclamation of coastal wetlands. Critical shorebird habitats are further threatened worldwide by changes predicted to occur through ancillary effects of global climate change, particularly rising of sea level and drying of continental wetlands. Shorebird habitats in Alaska are still relatively intact, but interior wetlands important for breeding are already showing evidence of drying, and coastal areas are being altered by increasingly intense storms. Shorebird habitats in Alaska face other, more local threats, particularly from energy and mining development in the Cook Inlet, Northern Pacific Rainforest, and Arctic Coastal Plain regions.

The Alaska Shorebird Conservation Plan is one of eleven regional plans associated with the U.S. Shorebird Conservation Plan. This document is the second iteration for Alaska, and contains updated conservation objectives and priorities based on the latest information. Important changes in this version include updated species conservation scores, revised population estimates, updated descriptions of conservation threats in Alaska, and a new framework for building a conservation strategy within a landscape context. This document is formatted in two sections: Part I presents an overview of the conservation plan for Alaskan shorebirds, descriptions of priority species, and threats to shorebirds throughout Alaska; Part II describes a conservation strategy specific for each Bird Conservation Region in Alaska. There are four major components to the conservation strategy adopted in this plan: (i) research, (ii) population monitoring, (iii) habitat management, and (iv) education and outreach. The overall goal of this plan is to keep shorebirds and their habitats well distributed not only across the Alaska landscape, but also throughout regions used by these populations during other phases of their annual cycle. Updates to this plan can be found at http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.

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Sharp-tailed Sandpiper • Robert Gill, Jr.

INTRODUCTION

Shorebirds are among the world's most impressive avian migrants. Some species that nest in remote, high-arctic regions undertake annual, one-way migrations of over 15,000 kilometers. To complete these long-distance flights, most species rely on sites along the way where they stop to rest and replenish reserves to fuel the next leg of their migration. At many of these sites, particularly coastal ones, shorebirds can be found in concentrations that number in the millions of individuals. The fact that many species fly such distances only to spend a few short months nesting and raising their young in inaccessible and often harsh northern regions only adds to the human fascination with this group of birds.

Shorebirds as a group are generally associated with water, and probably no other cover type in the world has been and continues to be affected more by human perturbations than wetlands. The landscape of North America has been markedly altered through the loss of large expanses of estuarine, brackish, and freshwater wetlands. Not surprising then, is the finding that shorebird populations throughout much of North America are in decline. Indeed, of the 72 species and subspecies of shorebirds addressed in the U.S. and Canada National Shorebird Plans, almost half (49%) appear to have experienced population declines since 1970 (Donaldson et al. 2000, Brown et al. 2001); for half of these taxa (n = 17) the declines are severe enough to be statistically significant (Morrison et al. 2001). For many of these species, outright loss of habitat is the cause of their population decline; for others, it is less clear what factors are responsible. What is known is that any adversity shorebirds face during one phase of their annual cycle will likely manifest itself during subsequent phases of that cycle. Therefore, the ability to identify and assess changes in shorebird populations, especially among those species migrating throughout the Western Hemisphere, requires well-coordinated national and international efforts.

The impetus for the U.S. Shorebird Conservation Plan came from heightened awareness of problems facing migratory birds in general and from several national and international conservation initiatives focusing on migratory songbirds and waterfowl. Although shorebirds have long been afforded protection under North American laws and treaties, such strictures have largely been ineffective in preventing declines in their populations brought about primarily through loss of habitat. Greater efforts are needed to conserve habitat and increase knowledge of shorebird biology. Such active conservation will help halt the decline of many species and keep common species common. The vision of the U.S. Shorebird Conservation Plan, therefore, is to ensure that stable and self-sustaining populations of all shorebirds are distributed throughout their range and among a diversity of habitats across the Western Hemisphere.

To be effective, the U.S. Shorebird Conservation Plan must address shorebird conservation needs across each species' range and throughout the annual cycle. To accomplish this goal, the U.S. Shorebird Conservation Plan has been developed around 11 geographical units, the same units used for other migratory bird conservation plans throughout North America. Alaska constitutes one of these 11 units. Working with the national component of the U.S. Shorebird Conservation Plan, each of the 11 regional working groups was charged with compiling information and making conservation recommendations for its region. The Alaska Shorebird Plan is further drafted within the context of biogeographical regions; specific plans are presented here for the five Bird Conservation Regions in Alaska. These recommendations, though based on regional needs, are expected to reflect annual cycle needs of species and as such will involve conservation actions across regions, countries, and in many cases, hemispheres.

Academic and private researchers, federal and state agency staff, conservation organizations, and shorebird enthusiasts have accumulated data about Alaska's shorebirds for more than half a century. These individuals formed the Alaska Shorebird Group (ASG) in 1997 with the goal of raising awareness about shorebirds in Alaska, developing conservation actions, and exchanging information on issues and research findings (Alaska Shorebird Group 2003). The Alaska Shorebird Conservation Plan was first published in 2000 and is based on that wealth of information. It provides the framework and background for conservation planning in Alaska (Alaska Shorebird Working Group 2000). In addition to regularly updating this conservation plan, the ASG meets annually and produces an annual report of the activities of ASG members (for information, contact Richard_Lanctot@fws.gov). As new information becomes available, it will be incorporated into periodic revisions of this plan (visit http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm for updates).

SHOREBIRDS IN ALASKA

Seventy-three species of shorebirds have been recorded in Alaska (Appendix 1), representing fully one-third of the world's shorebird species. Population sizes of migrant and breeding shorebirds in Alaska range from a few thousand to several million (Table 1). The highest densities of breeding shorebirds in North America occur in Alaska, with premier breeding grounds on the expansive Yukon-Kuskokwim Delta and Arctic Coastal Plain. The shorebird fauna of Alaska is also remarkably diverse, primarily as a result of the region's proximity to Asia and its paleogeographic history (Kessel and Gibson 1978). More than 80% of Alaska's landmass is north of 60° N, where tundra and taiga habitats dominate the landscape. Shorebirds, more so than any other group of birds, have evolved in and radiated across these landscapes. The same processes operating in Alaska also occurred over a large portion of northeast Asia. Thus, shorebird species that evolved in Asia are frequently seen in Alaska as accidental visitors, or occasionally as breeders. The same is true for many Alaskan species in the Russian Far East (see Kessel and Gibson 1978).

Buff-breasted Sandpiper • Ted Swem

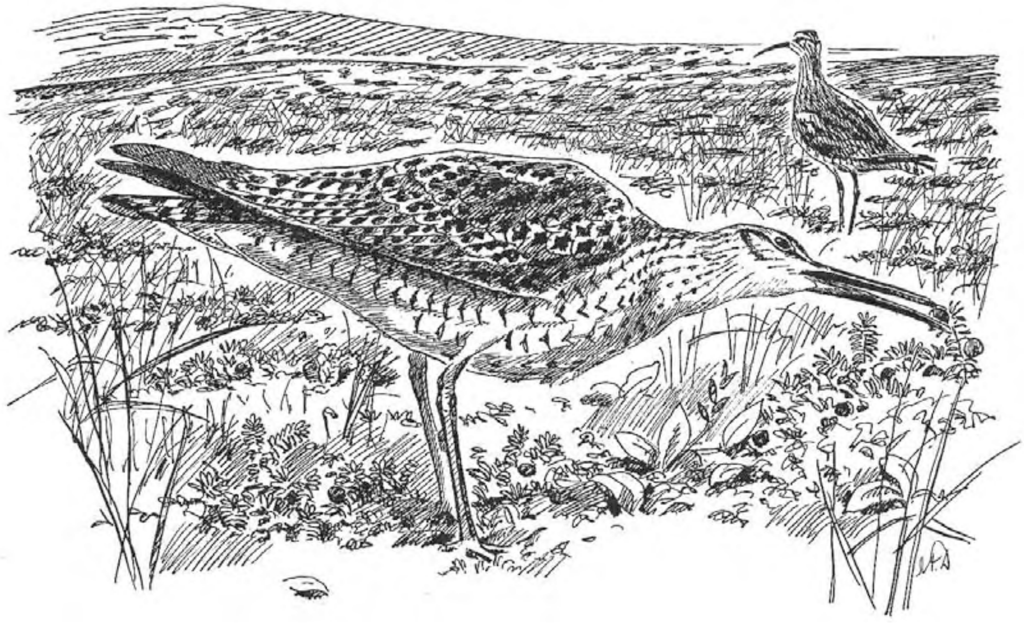
Table 1. Estimated population sizes of North American shorebirds, and percent of these populations that occur seasonally in Alaska. See Appendix 1 for scientific names. See http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm for updates to this table.

Species (population)[1]	North American Population[2]	% Occurrence in Alaska[3]		
		Breeding	Migration	Winter[4]
Black-bellied Plover (*squatarola*)	50,000	100	100	<5
American Golden-Plover	200,000	25–50	25–50	0
Pacific Golden-Plover	35,000–50,000	100	100+	0
Semipalmated Plover	150,000	>25	>25	0
Killdeer	1,000,000	<1	<1	<1
Black Oystercatcher	10,000	45–70	45–70	45–70
Spotted Sandpiper	150,000	10–30	10–30	0
Solitary Sandpiper (*cinnamomea*)	50,000	>75	>75	0
Wandering Tattler	10,000–25,000	>50	>50	0
Greater Yellowlegs	100,000	25–50	25–50	0
Lesser Yellowlegs	400,000	25–50	25–50	0
Upland Sandpiper	350,000	<3	<3	0
Whimbrel (*rufiventris*)	26,000	>80	>80	0
Bristle-thighed Curlew	10,000	100	100	0
Hudsonian Godwit	70,000	<25	<25	0
Bar-tailed Godwit (*baueri*)	80,000–120,000	100	100	0
Marbled Godwit (*beringiae*)	2,000	100	100	0
Ruddy Turnstone (*interpres*)	65,000	>35	35	<1
Black Turnstone	95,000	100	100	>25
Surfbird	70,000	>75	>75	<5
Red Knot (*roselaari*)	<50,000	>20	100	0
Sanderling	300,000	<10	<10	<5
Semipalmated Sandpiper	2,000,000	>25	>25	0
Western Sandpiper	3,500,000	>95	100	0
Least Sandpiper	700,000	25–50	25–50	0
White-rumped Sandpiper	1,120,000	<5	<5	0
Baird's Sandpiper	300,000	5–15	5–15	0
Pectoral Sandpiper	500,000	30–50	>70	0
Sharp-tailed Sandpiper[5]	160,000	0	5–30	0
Rock Sandpiper (*ptilocnemis*)	25,000	100	100	>90
Rock Sandpiper (*couesi*)	75,000	100	100	100
Rock Sandpiper (*tschuktschorum*)	50,000	>75	100	>50
Dunlin (*pacifica*)	550,000	100	100	<5
Dunlin (*arcticola*)	200,000–750,000	100	100	0
Stilt Sandpiper	820,000	5–10	5–10	0
Buff-breasted Sandpiper	30,000	<25	<30	0
Short-billed Dowitcher (*caurinus*)	75,000	100	100	0
Long-billed Dowitcher	400,000	>80	>90	0
Wilson's Snipe	2,000,000	25–50	25–50	0
Red-necked Phalarope	2,500,000	20–40	20–40	0
Red Phalarope	1,250,000	60	60	0

[1] Species (populations) that are shaded have breeding ranges that extend to the eastern or central Palearctic. Some individuals breeding in the Old World presumably pass through Alaska during migration (Alerstam et al. 2007). Taxonomy consistent with Morrison et al. (2006).
[2] Population sizes represent the maximum number of birds estimated to be present in North America at any time during the annual cycle and may include breeding, migrant, or nonbreeding birds. Estimates from Morrison et al. and Alaska Shorebird Group.
[3] Estimates of seasonal occurrence derived by Alaska Shorebird Group.
[4] Winter includes November through March.
[5] Sharp-tailed Sandpipers do not breed in Alaska but juveniles commonly occur as migrants. It is estimated that 5–30% of the world's population of 160,000 birds may occur annually in Alaska, essentially all juveniles.

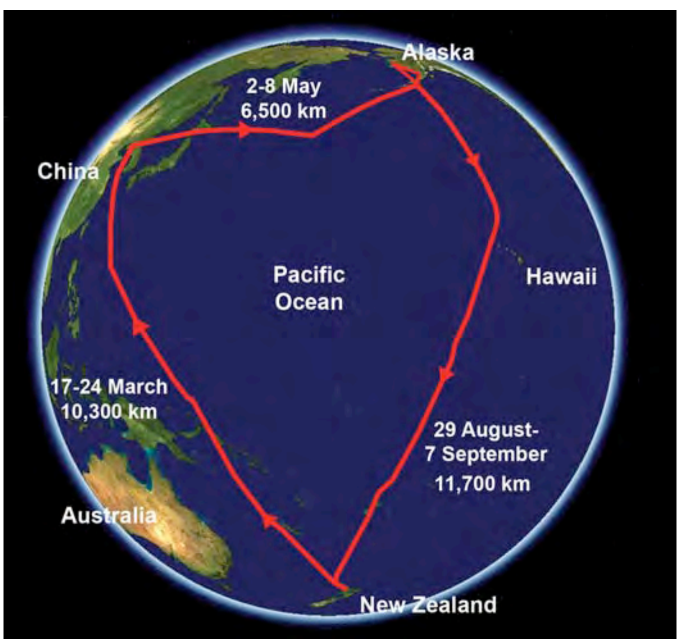
The list of shorebird populations restricted wholly or in large part to Alaska is indeed impressive (Table 1). For example, most of the world's populations of three species (Bristle-thighed Curlew, Black Turnstone, and Western Sandpiper) and six subspecies (Black-bellied Plover *P. s. squatarola;* Dunlin *C. a. pacifica* and *C. a. arcticola*; Rock Sandpiper *C. p. ptilocnemis* and *C. p. couesi*; and Short-billed Dowitcher *L. g. caurinus*) occur entirely within Alaska. As much as 75% of the world's breeding population of Surfbird and a subspecies of Rock Sandpiper (*C. p. tschuktschorum*), occurs in Alaska. Equally impressive is the large proportion of North American populations of several other species that occur in Alaska, including Black Oystercatcher, Pacific Golden-Plover, Wandering Tattler, Whimbrel (*N. p. rufiventris*), Bar-tailed Godwit (*L. l. baueri*), and Red Knot (*C. c. roselaari*).

Of 37 shorebird species regularly occurring in Alaska, only seven remain in Alaska in substantial numbers during winter (Black Oystercatcher, Black Turnstone, Surfbird, Sanderling, Rock Sandpiper, Dunlin, and Wilson's Snipe). More than one-third of Alaska's species migrate upwards of 30,000 kilometers a year. Shorebirds that breed in Alaska use numerous flyways to and from nonbreeding grounds in Australia, New Zealand, central and southern Oceania, southeast Asia, southern Canada, the contiguous U.S., Mexico, and Central and South America (Boland 1991, Gill et al. 1994, Gill and Senner 1996; Appendix 7). Spring and fall concentrations of migrating shorebirds at coastal staging/stopover sites in Alaska are impressive. The Copper River Delta, Yukon-Kuskokwim Delta, and lagoons on the north side of the Alaska Peninsula each support millions of migrant shorebirds annually. Numerous estuaries elsewhere along the coast of Alaska support more than 100,000 migrant shorebirds each year. For several species, the majority of their populations concentrate at only a few sites in Alaska during certain periods of the annual cycle.



CONSERVATION ISSUES IN ALASKA

Because of its immense size and small human population, Alaska provides habitats that are still mostly pristine. Despite this fact, the state's ever-growing population and economy present many challenges that could affect shorebird populations. These challenges are not unique to the region but could have significant impacts because Alaska provides critical resources for millions of shorebirds. Threats to shorebirds in Alaska are certainly less significant than threats occurring outside of this region where shorebird habitat is currently threatened by reclamation, degradation, pollution, and human disturbance. For example, important habitats that are used by Alaska's shorebirds during the nonbreeding season are being eliminated or compromised by seawall construction and estuarine reclamation along the Yellow Sea, oil spills in Korea and San Francisco Bay, loss of native mangroves in Panama Bay, alteration of grasslands in Brazil, Uruguay and Argentina, and the spread of invasive mangroves in New Zealand. While conservation threats in Alaska are less immediate than elsewhere, they nonetheless carry important consequences.



Migration tracks of a satellite-tagged Bar-tailed Godwit. This bird flew non-stop during all three major legs of its annual journey. Godwits rely on foods found at a few key intertidal stopover areas to fuel their spectacular flights.• Map by Pacific Shorebird Migration Project.

Herein we restrict our discussion to conservation issues solely within Alaska, and leave discussion of conservation issues outside Alaska to other relevant regional plans (e.g., Yellow Sea, Barter 2002; coastal and central California, Hickey et al. 2003). Conservation issues are examined in greater detail in Part II wherein we describe the issues and proposed actions specific to each BCR.

Our taxonomy of conservation threats is adapted from the Conservation Measures Partnership (http://conservationmeasures.org/CMP). This taxonomy provides a consistent framework for describing conservation issues across the region and forms an effective basis for discussing relevant mitigation and conservation actions. We categorized issues into nine groups, some of which pose serious threats throughout the state (e.g., pollution, habitat degradation), and others that are restricted to limited areas of the state (e.g., invasive species). We describe threats to shorebirds in Alaska within the following categories:

Habitat Conversion and Degradation: This category incorporates threats from loss or damage of habitats due to urban or commercial development. Despite the relatively small footprint of human activity in Alaska, the future impacts of habitat degradation, particularly in wetlands and river deltas, will increase along with Alaska's human population. Alaska's population nearly tripled over the period 1960–2000, and this rapid population growth has resulted in increased conversion of native habitats. Although it is tempting to discount these impacts due to the sheer extent of unaltered habitats throughout the state, Alaska is not without limit. The state's pristine landscapes will grow in importance to shorebirds as habitats outside Alaska undergo further development and degradation.

Transportation Infrastructure: These threats include the effects of habitat alteration and fragmentation due to land, water, and air transportation corridors and the associated disturbance to species. Alaska's network of roads, railroads, shipping lanes, and utility lines is currently limited, but impacts will increase as the transportation network expands to support a growing human population. Particularly important are the increases in arctic shipping traffic that are predicted to occur, which could affect critical staging areas along the Beaufort Sea Coast.

Energy Production and Mining: This category includes effects on habitats and wildlife specifically associated with the exploration, development, and production of non-biological resources (e.g., oil, gas, mining, renewable energies). Oil and gas development continues to be the driving force behind Alaska's economy (Institute of Social and Economic Research 2006). New projects have been proposed that would promote these industries near important shorebird sites throughout Alaska (e.g., oil leases in Bristol Bay, Cook Inlet, Chukchi Sea). The greatest potential impacts on shorebirds from these industries likely pertain to effluence and pollution (see *Pollution* below), but because these industries often co-occur in areas important to shorebirds, effects due to disturbance or habitat loss could be substantial.

Biological Resource Harvesting: This category includes threats from the consumptive use of biological resources, including logging and subsistence harvest. Currently logging poses little threat to Alaska's shorebirds. Alaska's vast boreal forests are largely intact, and the state's commercial harvest is largely restricted to mountainous coastal zones supporting few shorebird species. With a few exceptions, however, Alaska's shorebirds are included on the list of species open to spring and summer subsistence harvest, with the harvest of large, long-lived species (e.g., Bar-tailed Godwit) a special concern. Accurate data on traditional harvest of shorebirds in Alaska are largely lacking, but the take may be substantial for certain species. For instance, during the period 1995–2000, the average annual shorebird harvest on the Yukon-Kuskokwim Delta was 1,162 "large" and 101 "small" shorebirds. Given that the populations of most large-bodied shorebirds are declining across their ranges, biological resource harvest concerns must be considered as part of any effective conservation action.

Baird's Sandpiper • Joel Sartore

Recreation and Work in Natural Habitats: This category includes threats tied to disturbance from humans who are working, camping, or sightseeing in terrestrial or marine environments. Habitats required by many shorebirds overlap with preferred human-use areas, with subsequent disturbance and degradation of these sites. Black Oystercatchers, for example, often nest and raise their chicks in coastal habitats that are frequently visited by people (Morse et al. 2006). Tourism is one of Alaska's biggest industries, generating about $1.7 billion dollars in revenue from over 1.8 million visitors per year (http://www.dced.state.ak.us/oed/toubus/research.htm). As more visitors focus their trips in wilderness settings, additional pressure will be placed on shorebirds in sensitive natural habitats.

Pollution: This category includes the introduction of exotic, harmful materials into the air, land, or water; it includes many types of pollution, including chemical (e.g., oil, mercury), solid (e.g., garbage), and residual (e.g., errant logs). Shorebirds as a group are particularly susceptible to the effects of chemical pollution because they predictably gather in large groups at staging sites in the spring and fall. Given the adverse effects from the *Exxon Valdez* oil spill in 1989 and the continued U.S. economic dependence upon energy extraction, this category poses a serious threat statewide.

Invasive and Problematic Species: This category includes threats resulting from species that have a negative effect on natural systems following their introduction, spread, or increase in abundance. Such species may be non-native ones that negatively affect natural ecosystem equilibrium (e.g., rats [*Rattus* spp.] in the Aleutian Islands), or native ones that, due to anthropogenic disturbance, increase in population unnaturally and become "out of balance" in their natural setting (e.g., arctic fox [*Alopex lagopus*], Common Raven [*Corvus corax*] on the Arctic Coastal Plain). Effects of these problematic species are usually restricted in geographic scope but may be profound in their impact. For instance, reproductive effort of Black Oystercatchers was extremely low on islands with introduced populations of arctic foxes but breeding resumed following the removal of foxes (Byrd et al. 1997).

Thawing permafrost • Stephen Brown

Climate Change and Severe Weather: This category comprises threats linked to global climate change, including habitat shifts, increased variability of climate, and disruption of seasonal phenology. Global sea levels are predicted to rise on the order of one-half meter over the 21st century (IPCC 2007), making Alaska and parts of its 54,000 kilometers of coastline especially susceptible to concomitant ecological changes. Littoral-zone invertebrate communities will likely be affected by sea level rise in terms of both species composition and total productivity (Rehfisch and Crick 2003). Increased frequency and intensity of storm surges could affect invertebrate communities and vegetation of low-lying coastal areas. Changes in temperature and precipitation will likely cause dwarf shrubs and boreal forests to expand farther north and higher in elevation, thus displacing tundra-breeding shorebirds into narrower coastal strips and alpine-breeding shorebirds into smaller and fewer fragments at higher elevations. Subsequent changes in the overall abundance and types of wetlands will likely affect prey abundance and distribution for both boreal and tundra-nesting species. The degree to which the timing of shorebird breeding remains coupled to the life cycles of their prey is of key importance, since shorebird hatch appears synchronized with peak availability of surface-active insects upon which the chicks depend (Holmes 1970, 1972). Recent studies suggest that timing of arthropod emergence has advanced with warming temperatures in recent years (Tulp and Schekkerman 2008), and whether shorebirds can likewise adjust their annual cycle to synchronize with arthropod abundance is unclear (Meltofte et al. 2007). Changes in the distribution and abundance of predators and parasites may also occur in response to changing habitat and climatic conditions. Finally, changes in broad-scale climatological patterns could impact a large number of shorebirds that rely on predictable wind patterns for their annual migrations (Gill et al. *in press*). Given the extent of potential impacts, threats to Alaska's shorebirds posed by global climate change will likely be profound.

Disease: This category includes direct or indirect effects of virulent avian-borne diseases. Recent outbreaks of highly pathogenic H5N1-type avian influenza in Asia and Europe have raised the specter of outbreaks in North America through migratory birds carrying the virus from Asia to Alaska. Because Alaska hosts numerous sites where shorebird species gather in huge numbers during migration, Alaska's shorebirds are potentially susceptible to both direct effects (e.g., mortality) and indirect effects (e.g., selective culling) of disease outbreaks. Current strains of avian influenza have proven highly virulent to certain species of wild birds, posing a direct mortality threat. Although current strains do not pose a grave threat to humans, shorebird species could suffer indirectly in attempts to restrict bird movements or reduce population sizes to mitigate outbreaks. Shorebirds that spend the nonbreeding season in Asia and migrate north to breed in Alaska could potentially transmit virulent diseases to nearctic/neotropical species in areas of Alaska where ranges overlap.

Ruddy Turnstone • Jorge Valenzuela

SHOREBIRD SPECIES PRIORITIES IN ALASKA

NATIONAL PRIORITIZATION PROCESS

The magnitude of shorebird population declines around the world has led to the development of an international prioritization process to ensure that species at higher risk are given the attention needed to avoid further significant declines. The system for prioritizing shorebird species of concern was developed as part of the U.S. Shorebird Conservation Plan (Brown et al. 2001) with input from many shorebird experts from across the U.S. and Canada. The goal of the system was to provide a clearly organized method for categorizing the various risk factors that affect the conservation status of each species in a format that can be easily updated as additional information becomes available. The system has been modified in collaboration with Partners in Flight (PIF) to ensure that it is as compatible as possible with the PIF plan while still reflecting the unique biology of shorebirds.

The variables used in the national and regional prioritization processes—population trend and size, breeding and nonbreeding threats, breeding and nonbreeding distribution—are presented in detail in Appendix 3. Several of these variables, while widely agreed to affect conservation status, are very difficult to estimate. For example, population sizes of highly dispersed nesting species (e.g., Solitary Sandpiper, Upland Sandpiper) are difficult to determine because of their low densities, their broad distribution, and the lack of systematic surveys for these species. Because appropriate data are often lacking, the classifications produced by this system are considered estimates of the actual conservation status of each species. Further study is needed for most species with respect to most of these variables.

The current list of priority species in Alaska (Table 2) has undergone significant revision since publication of the first Alaska Shorebird Conservation Plan (Alaska Shorebird Working Group 2000). Most importantly, this edition has eliminated the separate conservation category score for Alaska. Instead, we have followed the U.S. and Canadian Shorebird Conservation Plans whenever possible in evaluating conservation priorities at the subspecific or population level. The classifications presented here are based on the best data currently available, updating scores presented in the U.S. Shorebird Conservation Plan (Brown et al. 2001) with recent information on population sizes and trends (USSCP 2004, Morrison et al. 2006, Bart et al. 2007) and on threats and distribution (from experts in the Alaska Shorebird Group). All sources used to update scores are documented in Table 2. Alaska currently has 20 shorebird populations considered to be of high concern or highly imperiled (Conservation Categories 4–5) and 21 populations of low to moderate concern (Categories 2–3). No species in Alaska is considered to be not at risk (Category 1). Shorebird populations with composite scores of 4 or 5 are considered of highest priority for conservation efforts, and reasons for their designation are detailed in the following species accounts.

American Golden-Plover • Ted Swem

Table 2. Conservation prioritization scores for shorebirds regularly occurring in Alaska. Species in Conservation Categories 4–5 are of high concern and are priority species in Alaska (shaded light blue); those in categories 2–3 are of low to moderate concern.

Species (population)	Population Trend	Population Size	Breeding Threats	Nonbreeding Threats	Breeding Distribution	Nonbreeding Distribution	Conservation Category
Black-bellied Plover (*squatarola*)	3[1]	4	2	2	4[2]	1[5]	3[3]
American Golden-Plover	5	3	2	4	2	3	4
Pacific Golden-Plover (Alaska population)	3	4[4]	2	2	5	3[5]	3[3]
Semipalmated Plover	3	3	2	2	1	1	2
Killdeer	4[6]	1	3	3	1	2	3
Black Oystercatcher	3	5	4	4[7]	3	4	4
Spotted Sandpiper	3	3	2	2	1	1	2
Solitary Sandpiper (*cinnamomea*)	4[6]	4[4]	2	4[7–9]	3	2	4[3]
Wandering Tattler	3	5	2	2	3	1[5]	3
Greater Yellowlegs	3	4	2	2	2	1	3
Lesser Yellowlegs	5	2	2	4[7,8]	2	1	4[3]
Upland Sandpiper	5	2	2	4	2	3	4
Whimbrel (*rufiventris*)	3	4	2	4[8]	3	3	4[3]
Bristle-thighed Curlew	3	5	2	5[10]	5	3	5[3]
Hudsonian Godwit (Alaska population)	3	5	3[11]	4	4[5]	4[5]	4
Bar-tailed Godwit (*baueri*)	4[6]	4	2	5[10]	4	3	4
Marbled Godwit (*beringiae*)	3	5	2	4	5	4	4
Ruddy Turnstone (*interpres*)	3	4[4]	2	3[12]	3[5]	1	3
Black Turnstone	3	4	4	4	5	3	4
Surfbird	4	4	2	4	4	1[5]	4
Red Knot (*roselaari*)	4[6]	5[4]	2	4	5[2]	3	4[3]
Sanderling	5	2	2	4	2	1	4
Semipalmated Sandpiper	5	1	2	3	3	3	3
Western Sandpiper	4[6]	1	2	4	4	1[5]	4
Least Sandpiper	5	2	2	2	2	2	3
White-rumped Sandpiper	4[6]	1[4]	2	2	3	3	3[3]
Baird's Sandpiper	3	2	2	2	3	3	2
Pectoral Sandpiper	3	2	2	3	2	3	2
Sharp-tailed Sandpiper[13]	3[6]	3[4]	3	3	-	2	2[3]
Rock Sandpiper (*ptilocnemis*)	4	5	4	4[7]	5	5	4
Rock Sandpiper (*tschuktschorum*)	3	4	3	3	5	3[5]	3[3]
Rock Sandpiper (*couesi*)	3	4	3	3	5	4	3[3]
Dunlin (*pacifica*)	4	2	2	4	4	2[5]	4
Dunlin (*arcticola*)	4[6]	2[4]	4[14]	5	5	3	4[3]
Stilt Sandpiper	3	2[4]	3	4	3	3	3
Buff-breasted Sandpiper	4	4[4]	3	4	3	4	4

Species (population)	Population Trend	Population Size	Breeding Threats	Nonbreeding Threats	Breeding Distribution	Nonbreeding Distribution	Conservation Category
Short-billed Dowitcher (*caurinus*)	3	4[4]	2	4	4	2[5]	4[3]
Long-billed Dowitcher	3[6]	2	2	3	4	3	3[3]
Wilson's Snipe	5	1	3	2	1	2	3
Red-necked Phalarope	4	1	2	3	2	1	3
Red Phalarope	5	1	2	3	2	1	3

Notes: This table updates scores from the U.S. Shorebird Conservation Plan (Brown et al. 2001) using recent data on population sizes and trends (USSCP 2004, Morrison et al. 2006, Bart et al. 2007) and expert knowledge from the Alaska Shorebird Group (ASG), primarily regarding distribution and threats. See footnotes in this table and species accounts in text for sources of information. Appendix 3 lists definitions and scoring criteria for conservation categories. Updates to this table will be posted at http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.

[1] Population trend listed as declining in Morrison et al. (2006) but no evidence cited, so retained score for status unknown listed in Brown et al. (2001).
[2] Breeding or nonbreeding distribution evaluated by ASG as smaller than originally classified in Brown et al. (2001).
[3] Composite score has been revised to reflect changes in component scores.
[4] Revised estimate of population size per Morrison et al. (2006).
[5] Breeding or nonbreeding distribution evaluated by ASG as greater than originally classified in Brown et al. (2001).
[6] Revised estimate of population trend per USSCP (2004) and/or Morrison et al. (2006).
[7] Significant potential threats from oil pollution (ASG).
[8] Significant potential threats from habitat conversion and degradation (ASG).
[9] Significant potential threats from harvesting (ASG).
[10] Local extirpation, hunting actually occurring (ASG).
[11] No known threats, but wetland nesting habitats may be drying (ASG).
[12] No known threats, and considered highly adaptable to human-related impacts (ASG).
[13] Sharp-tailed Sandpipers do not breed in North America and were not ranked in Brown et al. (2001). Score for population size considers both adults and juveniles, although only juveniles occur in Alaska (Morrison et al. 2006; R. E. Gill, unpubl. data). No known threats on breeding or nonbreeding grounds (ASG).
[14] Significant potential threats from energy development and increased predation by problematic species.

PRIORITY SPECIES

***American Golden-Plover*—**Despite a population of moderate size for a migratory shorebird (200,000; Morrison et al. 2006), this is a species of high concern because of an apparent population decline and significant potential threats on the nonbreeding grounds (Brown et al. 2001). Among the latter, changing agricultural practices at spring staging areas in Indiana and Illinois, exposure to agricultural pesticides during much of the spring migration in North America, and the loss of suitable habitat on the nonbreeding grounds in South America are probably the most important (Johnson 2003).

***Black Oystercatcher*—**The global population is estimated to number fewer than 11,000 individuals (Morrison et al. 2006). Over half of these nest in Alaska, concentrated especially in Prince William Sound and the Kodiak Archipelago (Andres and Falxa 1995, Tessler et al. 2007). Oystercatchers are completely dependent upon a narrow coastal area throughout their life cycle, where they are highly susceptible to oil spills. Breeding success is generally low and productivity is primarily limited by predation and storm tides (Morse et al. 2006), although recreational disturbance is becoming increasingly important. Their strong fidelity to breeding territories, easy accessibility, conspicuous behavior, and limited reproductive potential make them particularly vulnerable to local extirpation through persistent disturbance by foxes and humans (Andres 1997, 1998).

***Solitary Sandpiper*—**The current continental population of the Solitary Sandpiper (*Tringa solitaria)* is estimated to be 100,000 individuals, and the Alaska-breeding race, *T. s. cinnamomea*, is estimated to be 25,000 individuals (Morrison et al. 2006). The precision of these estimates, however, is thought to be poor. Breeding Bird Survey (BBS) data from Alaska since 1980 suggest a population decline of 3.5% per year ($P = 0.15$, $n = 27$ routes; Sauer et al. 2007), suggesting that the Alaskan population today may be less than half of what it was a quarter century ago. The species is listed as declining by USSCP (2004) and a significant negative trend was documented in eastern North America by Bart et al. (2007). Threats on the nonbreeding grounds include hunting, loss of habitat, and oil development (Bird Life International 2008). The *cinnomomea* race of the Solitary Sandpiper is ranked a species of high conservation concern due to its small population size and apparent negative population trend.

Solitary Sandpiper • Ted Swem

***Lesser Yellowlegs*—**The estimated continental population size of the monotypic Lesser Yellowlegs was recently revised downward from 500,000 to 400,000 individuals based on evaluation of recent survey results (Morrison et al. 2006). Analysis of Breeding Bird Survey data suggests that the continental population has declined significantly during the past 40 years (estimate of -16.5% per year, $P < 0.001$, $n = 33$ routes; Sauer et al. 2007), although survey coverage has been relatively scant and inconsistent. Recent analysis of data from the Maritime and International shorebird surveys in eastern North America, however, also suggests that the species may be declining (Bart et al. 2007). Wetland habitats in the boreal taiga of

Alaska where yellowlegs breed are drying as a result of recent climate changes (Klein et al. 2005, Riordan 2005), although effects on survival and productivity have not yet been documented. Significant threats exist to the population on nonbreeding areas from hunting, loss and degradation of habitats (pesticides), and oil development (Bird Life International 2008). The Lesser Yellowlegs is considered a species of high concern because of its declining population size and current threats on nonbreeding grounds.

***Upland Sandpiper*—**A grassland obligate throughout the year, the Upland Sandpiper's core breeding range is spread across the prairies of the U.S. and Canada; however, small, disjunct breeding populations also occur west of the Rocky Mountains, including areas in central and east-central Alaska. The species' current global population is estimated to be 350,000 (Morrison et al. 2006) with the Alaska population likely in the low thousands. Populations have been declining in eastern North America (Houston and Bowen 2001, Bart et al. 2007) and the decline may be more widespread as suggested by breeding bird surveys (Morrison 2001). Populations appear to be stable in the core breeding range (B. Sandercock, pers. comm.); however, declines or the extirpation of breeding birds at the periphery of the range suggest probable range contractions (Houston and Bowen 2001). Nonbreeding surveys conducted on the Argentine pampas (Bucher and Nores 1988, Canevari et al. 1991 *in* Houston and Bowen 2001) showed significant reductions in numbers of Upland Sandpipers. Little is known about Alaska's breeding population and data are needed to determine current distribution, population status, and whether the population breeding in Alaska is morphologically or genetically distinct from birds breeding elsewhere.

***Whimbrel*—**The U.S. Shorebird Conservation plan provides conservation assessments for the two known North American races of Whimbrel. The eastern Canadian form, *Numenius phaeopus hudsonicus*, is highly imperiled, but the Alaskan and western Canadian subspecies, *N. p. rufiventris* (Gibson and Kessel 1997, Engelmoer and Roselaar 1998), is considered to be of only moderate concern (Brown et al. 2001). The U.S. Plan, however, does not take into account the recent rapid elimination of much of the intertidal mangrove habitat used extensively by Whimbrels in Latin America during the nonbreeding season (Mallory 1981; Skeel and Mallory 1996; P. O'Hara, pers. comm.). Consideration of this potential threat to both races raises the prioritization score of *rufiventris* to that of high concern. There are an estimated 26,000 Whimbrels in Alaska (Morrison et al. 2006). Published estimates of density in Alaska, however, are low (McCaffery 1996**,** Skeel and Mallory 1996), and the largest Alaskan nonbreeding concentrations involve only a few thousand birds (Gill et al. 1981). Population trends, migration routes, and nonbreeding destinations of Alaska-breeding Whimbrels are largely unknown.

***Bristle-thighed Curlew*—**This species is of high conservation concern because it nests only in Alaska, and is found in two relatively small, disjunct regions: in the Andreafsky Wilderness near the north Yukon Delta and on the central Seward Peninsula (Marks et al. 2002). The total breeding population is among the smallest of all North American shorebirds, estimated at only 3,200 pairs (Handel et al. 1990). Numerous lines of evidence suggest the population is being negatively affected by anthropogenic factors on the nonbreeding grounds in central Oceania (Marks and Redmond 1994, Gill 1998). Uncertainty about the specific identity of "large shorebirds" harvested in western Alaska also raises the possibility that subsistence harvest may be a threat to this species.

Hudsonian Godwit • Luke Smithwick

Bar-tailed Godwit • Jan van de Kam

***Hudsonian Godwit*—**Alaska likely supports between 5,000 and 7,500 Hudsonian Godwits, 10–15% of the global population of this enigmatic species (Gill and Tibbitts 1999). Nonbreeding sites in Alaska that support concentrations of more than 100 birds are located in Carter Bay, Cook Inlet, upper Bristol Bay, and the Yukon-Kuskokwim Delta (Seppi 1995, 1997; Gill and Tibbitts 1999; McCaffery and Harwood 2000); in July 2008, several hundred were observed at Egegik Bay (J. Johnson, pers. comm.). An estimated 5,000 birds have recently been observed staging at Aropuk Lake on the Yukon-Kuskokwim Delta (McCaffery et al. 2005), making it one of the largest post-breeding aggregations of Hudsonian Godwits in North America. Because the level of genetic differentiation among the three major breeding populations (Churchill Manitoba; Mackenzie River Delta; and Alaska) is one of the highest reported for any species of bird (Haig et al. 1997), the Alaskan population may be at higher risk because it would not be buffered by the other continental populations. This risk would be exacerbated if the Alaskan sub-populations are similarly isolated; the degree of gene flow among Alaskan sub-populations remains to be determined (McCaffery and Harwood 2000). The breeding distribution is poorly known, both in Alaska and Canada, and the nonbreeding grounds and spring migration routes used by Alaskan breeders are unknown (McCaffery 1996, McCaffery and Harwood 2000). The very low breeding densities and patchy distribution of Hudsonian Godwits within apparently suitable habitat render both research and monitoring problematic (McCaffery and Harwood 2000, Elphick and Klima 2002). During the nonbreeding season, the Hudsonian Godwit is restricted to a handful of sites in southern South America. High levels of human disturbance, habitat loss and alteration, and the risk of oil spills, pose serious risks to a large proportion of the species' population.

***Bar-tailed Godwit*—**Alaska likely supports the entire breeding population of *Limosa lapponica baueri*. Despite having a moderate population size (80,000–120,000 birds), this population is potentially at risk. The species is vulnerable to subsistence harvest throughout its annual cycle. A few thousand godwits are harvested annually on the Yukon-Kuskokwim Delta; a harvest of similar magnitude apparently occurs in China, and the indigenous Maori of New Zealand have recently petitioned their government to legalize harvest there (R. E. Gill, Jr., pers. comm.). The absolute levels of such harvest and their cumulative impacts on the population are largely unknown but could be significant. In addition, post-breeding surveys on the Yukon-Kuskokwim Delta suggest that large-scale reproductive failures occurred each year from 1999–2004, during which juveniles made up no more than 3% of staging flocks (McCaffery and Gill 2001, McCaffery et al.

2006). Even lower proportions have been detected among birds arriving in fall on the nonbreeding grounds of New Zealand and eastern Australia. Finally, limited data suggest that clutch size has declined significantly over the last century (B. J. McCaffery, unpubl. data), which may have contributed to the low numbers of juveniles seen on the fall staging grounds.

Marbled Godwit—Alaska hosts a small (~ 2,000 birds), geographically and morphologically distinct breeding population of Marbled Godwits (*Limosa fedoa beringiae*, Gibson and Kessel 1989). Among North American shorebirds, only populations of Snowy Plover (*Charadrius alexandrinus*), Piping Plover (*C. melodus*), Eskimo Curlew (*N. borealis*, if extant), and the Hudson Bay Marbled Godwit (*L. f. fedoa*) are smaller (Brown et al. 2001). The Alaskan subspecies breeds only along a small section of the central Alaska Peninsula (R. E. Gill, Jr., pers. comm.) and to date less than a dozen nests have ever been found in Alaska. The very small population size, very limited distribution, and lack of basic life history information render this a population of high concern.

Marbled Godwit nest • Julie Morse

Black Turnstone—The entire global population of Black Turnstones (~95,000 birds) breeds in Alaska, primarily along a narrow section of the coastal Yukon-Kuskokwim Delta (Handel and Gill 1992). Its affinity for nesting in the lowest vegetated intertidal regions makes it especially susceptible to loss or change of habitat resulting from global sea level rise. More than 70% of the world's population historically concentrated in Prince William Sound, particularly at Montague Island, to feed on herring (*Clupea pallasi*) spawn during spring migration (Norton et al. 1990, Senner and McCaffery 1997, Bishop and Green 2001, Handel and Gill 2002), although a significant decline in herring may have caused turnstones to alter their distribution. This critical bottleneck in the annual cycle renders Black Turnstones vulnerable to oiling incidents such as the 1989 *Exxon Valdez* oil spill.

Surfbird—The Surfbird has a relatively small population (70,000 birds), more than 75% of which breeds in Alaska (Senner and McCaffery 1997). Most Surfbirds concentrate for a few weeks each spring on traditional staging areas in Prince William Sound, particularly on Montague Island (Norton et al. 1990, Senner and McCaffery 1997, Bishop and Green 2001). Several staging areas were affected by the *Exxon Valdez* oil spill, which resulted in a significant decline in herring spawn, a rich food resource for Surfbirds. Oil spills will likely continue to occur in the Sound or in the Gulf of Alaska as long as the production and transportation of petroleum products continue in this region.

Red Knot—Little is known about the distribution and status of the population of Red Knots occurring in Alaska (*Calidris canutus roselaari*). The breeding population in Alaska is at most a few thousand birds scattered across the montane tundra of northern and northwestern Alaska (R. E. Gill, Jr., pers. comm.). A larger number of *roselaari* migrate along the Pacific Coast of North America and through Alaska to breeding grounds on Wrangel Island in Siberia, where the breeding population has declined during recent decades (Tomkovich and Dondua 2008). The current size of this migrant population is thought to be <50,000 birds (R. E. Gill, Jr., pers. comm.), considerably lower than the estimates of at least 100,000 birds just a quarter century ago (Gill and Handel 1990, Morrison et al. 2001). Recent evidence strongly indicates that populations of other subspecies of Red Knot have also been declining, some precipitously, within the past several years (Baker et al. 2004, Morrison et al. 2004, Niles et al. 2007). *C. c. roselaari* may mix on nonbreeding areas in South America with the subspecies *C. c. rufa*, whose population size plummeted by nearly 50% from 2000–2002 and whose adult survival rate dropped by 37% from 2000–2001 (Baker et al. 2004, Morrison et al. 2004). Knots are hunted for food in some regions of South America, especially in the Guianas, and for sport in Barbados. The extent of this harvest is suspected to be substantial. As with several other species of high conservation concern, knots concentrate at a few nonbreeding sites along temperate coastlines, which makes them vulnerable to various anthropogenic and environmental perturbations.

***Sanderling*—** Only a small fraction of the continental population of Sanderlings occurs in Alaska; most occur in the Eastern Arctic of North America. It is a very rare and irregular breeder on the North Slope, with most confirmed records limited to Barrow and the easternmost portion of the Arctic Coastal Plain (Johnson et al. 2007). The Sanderling, however, is one of only a handful of shorebird species that winters in Alaska, where it is only relatively common in the Aleutian Islands (Kessel and Gibson 1978, Gibson and Byrd 2007). The Sanderling was among the very first shorebird species for which significant population declines were documented (Howe et al. 1989). Subsequent analyses have generally confirmed that trend (Donaldson et al. 2000, MacWhirter et al. 2002).

***Western Sandpiper*—**Although the Western Sandpiper is one of North America's most common shorebirds (numbering ~3.5 million; Morrison et al. 2006), its population status is uncertain and may be declining (USSCP 2004).

Western Sandpiper • Milo Burcham

Western Sandpipers rely heavily on relatively few stopover sites during spring and fall migration, increasing risks of disturbance and mortality during critical phases of their annual cycle (Fernández et al. 2006). For instance, during spring migration each year at least one million Western Sandpipers use the Copper River Delta (Bishop et al. 2000), which lies adjacent to major shipping lanes for oil tankers. Given the uncertainty surrounding the species' population trend and reliance on discrete stopover sites, Western Sandpipers rank as a species of high conservation concern.

***Rock Sandpiper*—**Multiple subspecies of Rock Sandpipers have evolved in the Bering Sea region of Alaska, each with a highly restricted distribution (Conover 1944). Two forms (*Calidris p. ptilocnemis* and *C. p. couesi*) breed and winter almost exclusively in Alaska. Most individuals of a third subspecies (*C. p. tschuktschorum*) breed and winter within the region as well. Because the Siberian-breeding members of the latter race apparently stage during fall migration in western Alaska, the state supports the entirety of all three populations during at least some portion of the year (Gill et al. 2002a). None of the three populations is large, ranging in size from 25,000 to 75,000 individuals (Brown et al. 2001, Gill et al. 2002a). The *ptilocnemis* population breeds only on Bering Sea islands, where habitat has been markedly altered by reindeer grazing, especially on the Pribilof Islands (A. Sowls, pers. comm.). Although all three races are listed as populations of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001), their scores for population trend and size indicate that only the nominate race warrants that designation. Both *tschuktschorum* and *couesi* should be considered populations of moderate conservation concern.

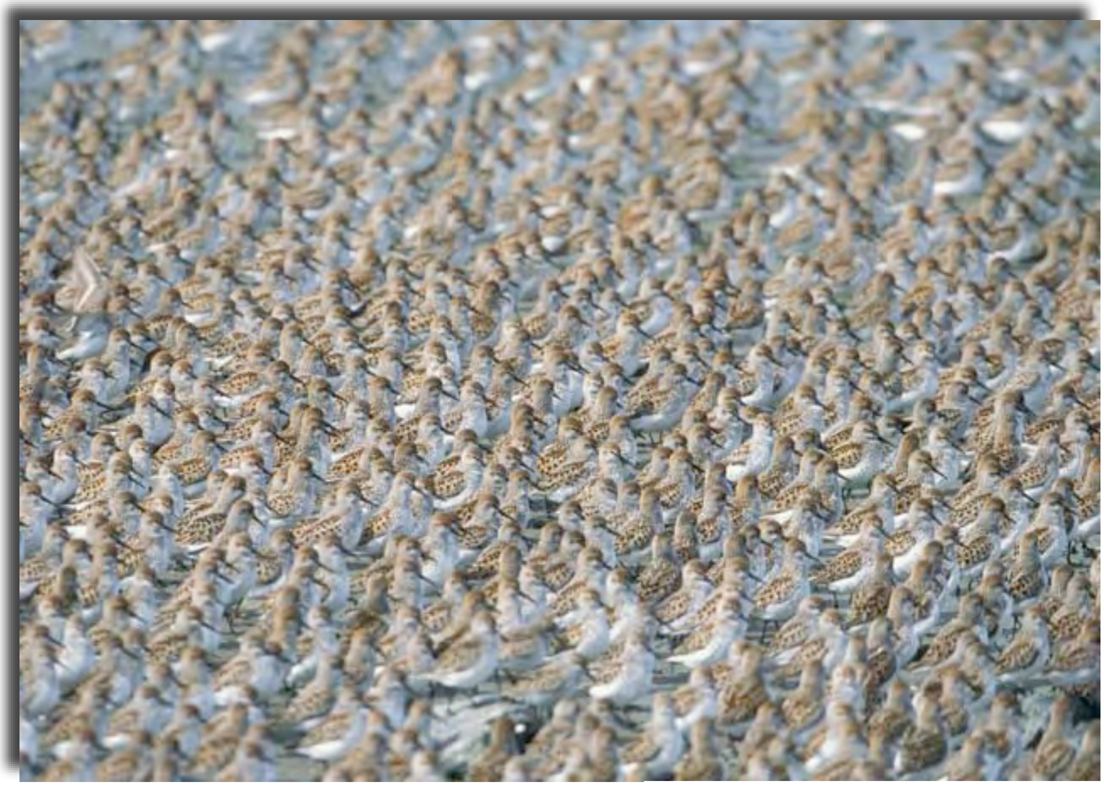
Dunlin—Two subspecies of Dunlin (*Calidris alpina pacifica* and *C. a. arcticola*) nest in Alaska. The *pacifica* population nests exclusively in Alaska; a very small fraction of *arcticola* nests outside of Alaska in western Canada (Warnock and Gill 1996). Despite the relatively large population size of *arcticola* (between 200,000 and 750,000 birds; Morrison et al. 2006; R. Lanctot and R. Gill, unpubl. data), this subspecies is of high conservation concern because of a significant population decline documented on the North Slope of Alaska (D. Troy, pers. comm.) and because of the alarming rate of loss of nonbreeding habitat in east Asia (Barter 2003). The population size of *C. a. pacifica* is also relatively large, estimated at 550,000 birds (Morrison et al. 2006). Similar to *arcticola*, however, this subspecies is of high conservation concern because of probable population declines, significant threats during the nonbreeding season (e.g., large concentrations near oil-shipping lanes in Prince William Sound), and its small breeding range (Brown et al. 2001).

Buff-breasted Sandpiper—The Buff-breasted Sandpiper is of high conservation concern because of its apparent decline from historical numbers, small population size (30,000), restricted nonbreeding distribution, and threats on the nonbreeding grounds (Brown et al. 2001, Morrison et al. 2006). Primary threats include habitat loss and exposure to pesticides along the migration route; and resort developments, planting of carbon-sequestering forests, and agricultural development of habitat used during the austral summer in South America (Lanctot and Laredo 1994, Lanctot et al. 2002).

Short-billed Dowitcher—The Short-billed Dowitcher is listed as a species of high conservation concern in the U.S. Shorebird Conservation Plan (Brown et al. 2001). The eastern Canadian race (*Limnodromus griseus griseus*) has declined significantly, and the central Canadian race (*L. g. hendersoni*) has probably also declined (Donaldson et al. 2000, Brown et al. 2001). Although formal trend data for the Alaskan form (*L. g. caurinus*) are lacking, several researchers are concerned that numbers have declined, especially over the past decade (J. Jehl, R. Gill, Jr., and G. Page, pers. comm.). Morrison et al. (2006) recently revised the estimated population size of *caurinus* to 75,000, half the size of the original population estimate, based on survey data summarized by Jehl et al. (2001). Given its population size, its relatively restricted breeding distribution, potential threats during the nonbreeding season, and documented declines among the other populations, the *caurinus* subspecies merits high conservation concern.

Buff-breasted Sandpiper • Amy Leist

CONSERVATION STRATEGY FOR ALASKA



Western Sandpiper • Milo Burcham

VISION OF THE ALASKA SHOREBIRD GROUP

To ensure the conservation of shorebirds in Alaska we must integrate components of research, monitoring, management, habitat protection, education, and public outreach. We consider partnerships at the international, national, and regional scales to be integral to effective conservation in Alaska. Our conservation strategy takes a landscape perspective within each of Alaska's Bird Conservation Regions, and is focused on biological considerations of priority species and ecosystems. The overall goal of this program is to maintain or enhance current breeding populations, species diversity, and distribution of shorebirds throughout Alaska.

RESEARCH

Vast gaps exist in our knowledge of Alaska's shorebirds. The most crucial research need is to identify factors that are limiting shorebird populations so that we can determine how to stop and reverse population declines. The Shorebird Research Group of the Americas (http://www.shorebirdresearch.org) has outlined several potentially limiting factors: climate change, increasing predator populations, long-term environmental contamination, increased human disturbance, and habitat loss and degradation. To understand possible impacts of these factors, we need long-term research on habitat requirements throughout the annual cycle, migration routes and strategies, breeding ecology, foraging ecology, energetics, and population dynamics. Identifying discrete populations is also important, since they are the units upon which conservation actions must be based.

One of the most exciting avenues of current shorebird research is the use of color-banding, geolocators, and telemetry (both conventional and satellite) to uncover the migratory patterns of shorebirds. These techniques provide critical natural history information, including the timing and routes of migration, temporal and spatial use of stopover and staging sites, and habitat needs of each species. Population genetics and stable isotope analyses are also elucidating links among breeding, staging, and nonbreeding areas for species that are difficult to track with conventional markers. These studies establish the biological connections between habitats in Alaska and areas at risk elsewhere in the flyways. Of equal importance are the personal connections being established among shorebird conservationists across the globe, since united and holistic efforts are essential to protect the network of sites necessary to conserve shorebird populations. Special attention should be given to designing marking programs that will allow for analysis of shorebird movements at multiple scales, from the local, to the hemispheric, to the global. Understanding how and why shorebirds move within and among landscapes throughout the flyways is essential for identifying critical habitats that need protection and for determining how to counter global-scale threats to shorebirds, such as climate change and the spread of infectious diseases.

Black Oystercatcher • Ron Niebrugge

Objectives

⇒ Investigate causes of shorebird population declines.

⇒ Within the framework of the Pan American, Eastern Pacific, and East Asian-Australasian shorebird banding programs, prioritize and implement new shorebird marking programs to document migration routes, nonbreeding destinations, and stopover sites of priority species.

⇒ Develop and implement contemporary research techniques (e.g., genetics, banding, geolocators, telemetry, stable isotopes) to identify unique populations of shorebirds that reside in Alaska and to link sites used throughout their annual cycles.

⇒ Encourage long-term studies synthesizing measures of shorebird breeding phenology and environmental conditions.

⇒ Conduct long-term studies to assess the impacts of global climate change (e.g., sea level rise, habitat alteration, Pacific storm cycles) on shorebird migration.

⇒ Develop quantitative population models, measure key demographic parameters, and analyze population dynamics to estimate the long-term effects of subsistence harvest, depressed productivity, and other factors that may affect viability of shorebird populations.

Population Monitoring

Recent evidence suggests many shorebird species throughout the world are declining (International Wader Study Group 2003, Morrison et al. 2006, Stroud et al. 2006, Bart et al. 2007). One shorebird species that historically occurred in Alaska, the Eskimo Curlew, is now likely extinct, and 20 other Alaskan species have populations that have been identified as priority species (Table 2). Within the United States and Canada, shorebirds have historically been monitored during migration through programs such as the Maritimes Shorebird Survey (MSS) and the International Shorebird Survey (ISS). Because of difficulties associated with interpreting the data collected under these programs and the obvious bias towards monitoring birds in the Eastern and Midwestern portions of North America, the Canadian Shorebird Working Group and the U.S. Shorebird Council implemented the Program for Regional and International Shorebird Monitoring in 2001 (PRISM; Skagen et al. 2004, Bart et al. 2005). The goals of PRISM are to (1) estimate the size of breeding populations of 74 shorebird taxa in North America; (2) describe the distribution, abundance, and habitat relationships for each of these taxa; (3) monitor trends in shorebird population size; (4) monitor shorebird numbers at stopover locations (by expanding the MSS and ISS programs); and (5) assist local managers in meeting their shorebird conservation goals (Bart et al. 2005). To accomplish these goals, a variety of survey programs are currently being designed or implemented to monitor shorebirds during different phases of their annual cycle.

While recent declines have been documented at a few arctic and subarctic breeding areas (Gould 1988; Pattie 1990; Gratto-Trevor 1994; Gratto-Trevor et al. 1998, 2001), little information is available on the trends of most populations of shorebirds breeding in Alaska. Thus, there is a need for the development and implementation of a broad-scale monitoring program within Alaska.

Dunlin • Dan Ruthrauff

Because several Alaska-breeding species have breeding and nonbreeding ranges outside of the state and many species disperse to other parts of the world during the nonbreeding season, monitoring efforts should be coordinated with and provide data to PRISM and CHASM (Committee for Holarctic Shorebird Monitoring; CHASM 2004).

To date, most shorebird monitoring in Alaska has focused on breeding birds. A double-sampling protocol was developed and tested in low tundra within arctic and subarctic regions of Alaska between 1994 and 2000 (Bart and Earnst 2002). This protocol involves habitat regression analysis techniques, and rapid and intensively surveyed plots that are used in combination to correct density estimates. This protocol was used to estimate population sizes of shorebird species breeding in the Arctic National Wildlife Refuge (Brown et al. 2007) and to describe the distribution of shorebirds across the Arctic Coastal Plain (Johnson et al. 2007). This protocol is also being implemented in low tundra regions of Canada. A second protocol that relies on variable circular plots and distance estimation to survey shorebirds has been used in montane tundra regions within Alaska since 1987. This protocol was first tested on Bristle-thighed Curlews on the Seward Peninsula and in the Nulato Hills region within the Yukon-Kuskokwim Delta and has provided useful information on shorebird distribution and abundance (C. Handel and R. E. Gill, Jr., pers. comm.). A program for surveying shorebirds in boreal forests is in the development stages; initial work is focused on incorporating shorebird surveys within existing landbird monitoring programs and testing aerial techniques for counting boreal species. Migration counts of shorebirds have been conducted in a few places in Alaska—most notable are aerial surveys on the Alaska Peninsula and Copper and Yukon-Kuskokwim river deltas. Digital aerial photography has been tested as a means of counting shorebirds on the Copper River Delta and nearby Cook Inlet. Surveys of wintering shorebirds have been restricted to only a few endemic species that reside in Alaska during the nonbreeding season.

Under the broader umbrellas of PRISM and CHASM, the Alaska Shorebird Group recommends implementing rigorously designed protocols for monitoring the status and trends of shorebird populations in Alaska. Such protocols should address differences among species in life history traits; habitats; and factors that influence detection rates and accuracy and precision of counts. Clearly defined goals should be included. For species with dispersed breeding populations that are impractical or financially infeasible to survey, support should be given to monitoring programs outside of Alaska during the nonbreeding season. Monitoring efforts on the breeding grounds should focus on priority species with small or declining populations, or on ranges and habitats where accurate and precise trend information may be more readily derived.

Objectives

⇒ Develop regional, national, and international partnerships to promote range-wide monitoring of shorebird populations.

⇒ Develop and implement standardized methods for assessing the distribution and population size of shorebirds in various habitats of Alaska.

⇒ Assess the feasibility of using the Alaska Landbird Monitoring Survey program for monitoring shorebirds.

⇒ Develop better estimates of subsistence harvest levels for large- (e.g., Bristle-thighed Curlews, Whimbrels, Godwits) and small-bodied shorebirds (e.g., Dunlin).

⇒ Monitor demographic parameters and use demographic models (developed through research initiatives) to better understand limiting factors at the population level.

Habitat Management and Protection

The conservation action most likely to buffer shorebirds against the impacts of any conservation threats is to protect, restore, and create as much shorebird habitat as possible. In general, habitats used by shorebirds in Alaska remain relatively undisturbed, but identifying the habitat types critical to shorebirds is becoming increasingly important as human populations and developments increase in the state. Current efforts to prioritize areas are based primarily on bird use data collected during previous surveys within the state (e.g., Outer Continental Shelf Environmental Assessment Program during the late 1970s and early 1980s); these data should be updated. Development of bird-habitat models that predict bird abundance and distribution in non-surveyed areas will also be needed in the future. Such predictive information will assist managers in protecting critical areas and assessing the impacts of proposed developments throughout Alaska. The development of bird-habitat models will require the consistent collection of habitat data that reflects a particular species' habitat requirements. The impact of habitat loss or change on shorebirds also requires further study. Previous studies are limited primarily to the assessment of oil and gas exploration, development, and spills within the Arctic Coastal Plain (Troy 1988, TERA 1993). Many of these studies have been short in duration and have rarely followed individual birds over several years to determine the potential long-term effects of disturbance on survival and productivity.

Objectives

⇒ Coordinate, promote, initiate, and participate in flyway-wide initiatives that define shorebird habitat needs, and protect important habitats used by shorebirds during their breeding, migratory and nonbreeding periods.

⇒ Develop habitat-based models to predict seasonal distribution and abundance of shorebirds.

⇒ Model the potential impact of changing environmental conditions (e.g., sea level rise, snow depth, storm frequency and severity) on shorebird habitats.

⇒ Identify important shorebird habitats throughout the state, and where appropriate, designate them within the Western Hemisphere Shorebird Reserve Network, East Asian-Australasian Shorebird Reserve Network, RAMSAR, and Important Bird Areas Program.

⇒ Develop and implement techniques to monitor the environmental health of important shorebird sites.

⇒ Identify shorebird habitats prone to human disturbance and develop mitigation prescriptions to reduce negative impacts.

Environmental Education and Public Outreach

Creating awareness about the complex and remarkable natural history of Alaska's shorebirds may be one of the greatest contributions the Alaska Shorebird Group can make towards the conservation of shorebirds. Strategic implementation of education and outreach programs is critical to facilitate acceptance of conservation recommendations by key stakeholders. The Alaska Shorebird Group seeks to inform government agencies, industries, non-government organizations, and private citizens (including schoolchildren) about Alaska's shorebirds and the importance of their breeding, nonbreeding, staging, and migratory stopover habitats. Our primary goal is to increase opportunities to view, enjoy, and learn about shorebirds that occur in Alaska, and increase international and national coordination and

Shorebird science field camp on Yukon-Kuskokwim Delta • Ayme Johnson

collaboration among shorebird conservation efforts. One avenue for increasing awareness is the Shorebird Sister Schools Program, which encourages public participation in the conservation of shorebirds and their habitats by connecting people along flyways and increasing their awareness and knowledge of local natural resources.

Objectives

⇒ Raise the profile of Alaska's shorebirds by supporting shorebird festivals in Alaska and by collaborating with education programs on the Copper River Delta and elsewhere.

⇒ Host workshops in villages to improve communication with rural Alaskans about shorebird resources and their conservation.

⇒ Encourage the synthesis and reporting of results of Alaskan shorebird studies to scientific and general audiences via the research booklet and annual meetings of the Alaska Shorebird Group.

⇒ Maintain the Shorebird Sister Schools Program and promote shorebird education curricula such as the Arctic-nesting Shorebird Curriculum.

International Collaborations

Alaska's shorebirds actually spend relatively little time in Alaska; most species spend six to nine months of the nonbreeding season outside Alaska. Shorebirds highlight interconnectedness of the hemispheres as they undergo their annual migrations from breeding to nonbreeding grounds via international flyways. Shorebirds breeding in Alaska migrate over a vast region of the globe, including at least 40 different countries (Appendix 7). Nearly all of Alaska's shorebird species migrate beyond the U.S. during the nonbreeding season, with only a few species remaining in Alaska during the winter months. Of the 45 breeding species that migrate internationally, about 70% use the three North American flyways en route to Mexico, the Caribbean, and South America, while 30% use either the Central Pacific or East Asian-Australasian flyways to reach East Asia, Australasia, and Oceania.

Given that shorebirds experience different population threats in different countries, migratory bird conservation can only be achieved by integrating management, research, and conservation efforts throughout the birds' range (or within an entire flyway). To do this, Alaskans must join colleagues within the lower 48 states of the U.S., and at an international level, within each of the five flyways, to provide joint protection and conservation of these incredible migrants. Alaska provides crucial breeding habitat for many migratory shorebirds at the terminus of their migrations. As such, Alaska is well situated to lead range-wide conservation and research efforts. Efforts to promote shorebird conservation actions outside of Alaska will be challenging, but that should not preclude the Alaska Shorebird Group from moving forward where opportunities exist.

Objectives

⇒ Foster cooperative research efforts throughout the Western Hemisphere (via the Western Hemisphere Shorebird Group), Asia (East Asian-Australasian Flyway Partnership), and elsewhere along migratory flyways.

⇒ Coordinate and participate in international, national and other regional shorebird conservation planning efforts (see groups listed in Appendix 6).

⇒ Participate in species-specific conservation planning efforts (e.g., Western Sandpiper Working Group, Black Oystercatcher Working Group).

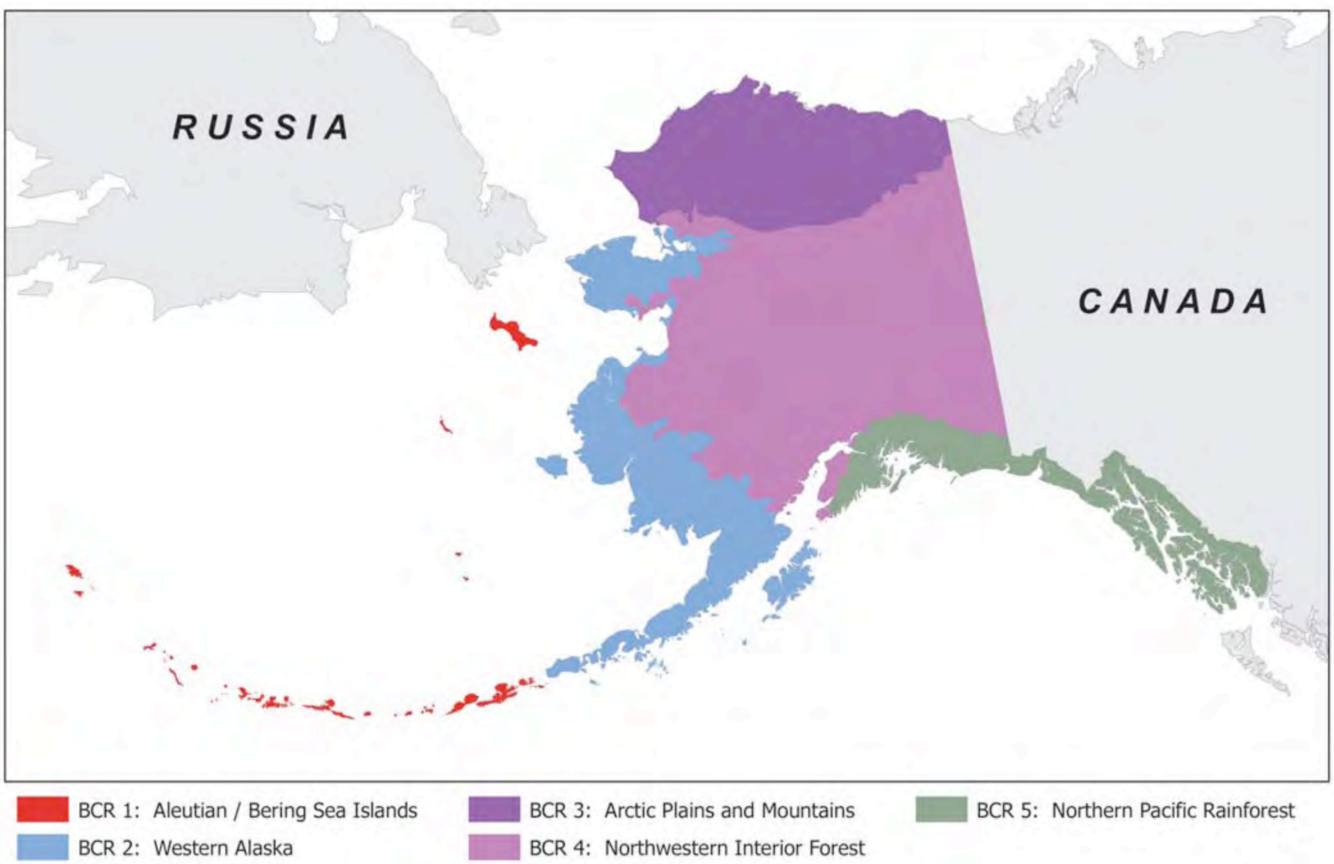
⇒ Cooperate with other countries in the circumpolar arctic to standardize data gathering and enhance the investigation of ecological factors that occur across the arctic (e.g., Committee for Holarctic Shorebird Monitoring, and Arctic Birds Breeding Conditions Survey http://www.arcticbirds.ru).

Implementation, Coordination, and Evaluation of the Plan

In order for the Alaska Shorebird Conservation Plan to be effective, there must be a strategy to implement and evaluate the objectives outlined in this plan. The Alaska Shorebird Group will assume primary responsibility for coordinating and implementing the goals and objectives identified in this plan. At the national level, the Chair of the Alaska Shorebird Group will meet with other regional working group representatives during the annual meeting of the U.S. Shorebird Plan Council. The Alaska Shorebird Group will also assume primary responsibility for evaluating and updating the objectives of this conservation plan. The BCR-specific conservation plans in Part II are intended to be 'living' online documents that will be updated as necessary by members of the ASG (see http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm for updates). Species conservation priority scores (Table 2) will also be updated as new information becomes available.

Dunlin chick • Blake Trask

PART II: ALASKA'S BIRD CONSERVATION REGIONS



THE ALASKA ENVIRONMENT

Alaska's North Slope • Jim Johnson

Alaska encompasses more than 1.5 million km^2, representing an area one-fifth the size of the contiguous United States. The region spans more than 20 degrees of latitude (51° to 71° N) and 58 degrees of longitude (130° W to 172° E), and is bordered by almost 55,000 km of shoreline. The Yukon River, the third longest river in the U.S., flows through 3,000 km of Alaska and drains a watershed encompassing over half of the state. Broad, shallow rivers and associated valleys are dominant features of Alaska's interior landscape, but equally prominent are numerous mountain ranges that criss-cross the state. For example, nine of the 16 tallest peaks in North America occur within the Wrangell-St. Elias Mountains bordering the northern Gulf of Alaska. The continent's highest peak, Mount McKinley (6,252 meters), is part of the Alaska Range that arcs across south-central Alaska to the base of the Alaska Peninsula. The periphery of the mostly mountainous interior of the state is a mixture of expansive coastal wetlands and riverine deltas, the extent of which exceeds that of all such habitat in the contiguous United States. Permafrost occurs throughout most of the state and is continuous north of the Arctic Circle. Finally, Alaska has over 40 active volcanoes, mostly along the Alaska Peninsula and Aleutian Islands, and more than 100,000 glaciers, which cover 5% of its land area.

Alaska's climate varies markedly by region. The maritime influence of the Gulf of Alaska brings warm winters, cool summers, heavy precipitation, and persistent wind to most of southeastern Alaska. In contrast, interior Alaska has warm summers, very cold winters, little wind, and light precipitation. Cool summers, cold winters, moderate winds, and light precipitation are typical of western and northwestern Alaska. Periods of over two months of continuous darkness in winter and continuous sunlight in summer characterize northern Alaska.

The diversity of physiographic features has shaped an equally diverse assemblage of landcovers (Bailey et al. 1994) but, as is typical of northern ecoregions, biotic communities are generally of low species richness. For example, only 128 species of trees and shrubs are known from Alaska (Viereck and Little 1972). Vegetation across Alaska ranges from that found in temperate rainforests of southeast to that of high arctic tundra in the north.

Two-thirds of Alaska is publicly owned (Duffy et al. 1999; Appendix 2). Of the nation's conservation lands, the two largest National Forests, nine of the ten largest National Parks and Preserves, and 83% of all National Wildlife Refuge lands occur in Alaska. In northern Alaska the Bureau of Land Management administers the 96,000 km^2 National Petroleum Reserve-Alaska. And in the southeast, Glacier Bay and Wrangell-St. Elias National Parks in the U.S., and adjacent Kluane National Park and Tatshenshini-Alsek Wilderness Provincial Park in Canada, form the largest contiguous protected wilderness on the globe.

The human population of Alaska has more than doubled from 302,583 people in 1970 to 676,987 people in 2007, yet the state remains one of the least populated areas of North America with an average density of slightly more than one person per square mile. Nonetheless, a few major population centers exist, including Anchorage, where 42% of all Alaskans resided as of 2007. Outlying areas near Anchorage, including the Matanuska-Susitna Borough, support another 12% of the state's population. Indigenous people constitute about 16% of the state's population.

Oil and gas development is the major revenue-producing industry in Alaska and is concentrated in Cook Inlet and on the Arctic Coastal Plain. In 2007, the State of Alaska received $5.2 billion in royalties from oil extracted from its lands. Alaska leads the U.S. in oil production, accounting for 20% of domestic production. Four of the 10 largest oilfields in North America are located on Alaska's North Slope, including Prudhoe Bay—the largest oilfield in North America. Shorebirds are especially vulnerable to oil spills, and such oil development and its supporting infrastructure are potential threats to the conservation of shorebirds in Alaska.

Alaska's current growth industry is tourism; 1.6 million people visited Alaska in the summer of 2006, and visitors spent an estimated $1.5 billion in the state (State of Alaska 2007). More than 75% of this tourism is based in south-central and southeast Alaska. With increases in tourism in Alaska, recreational disturbance in coastal habitats is becoming a major concern for shorebird conservation. Ecotourism in general, and bird-watching tours in particular, are also increasing in popularity throughout Alaska. Shorebird festivals have become important to the regional economies of Cordova and Homer. A third festival in Wrangell is also beginning to celebrate the migration of shorebirds.

Alaska's Bird Conservation Regions

State, provincial, federal, and non-governmental organizations from Canada, Mexico, and the U.S. met in Puebla, Mexico, in November 1998 to adopt an ecological framework that would facilitate coordinated conservation planning, implementation, and evaluation of major bird conservation initiatives (NABCI 1998). The scheme adopted by the group was based on the Commission for Environmental Cooperation's (1998) hierarchical framework of nested ecological units. From these, five Bird Conservation Regions (BCRs) were designated within Alaska. These roughly follow the biogeographic regions previously defined for the state by Kessel and Gibson (1978). Shorebird occurrence varies spatially and temporally across each BCR (Table 3).

The Alaska Shorebird Conservation Plan is drafted within the context of these five BCRs, and the following sections contain a shorebird conservation plan for each of them. General descriptions of the BCRs include lists of the primary ecoregions that occur within each BCR. (See Appendix 8 for the 'Ecoregions of Alaska' map; descriptions of ecoregions are provided in Gallant et al. [1995] and Nowacki et al. [2001].) Conservation issues and action items identified in these sections highlight those deemed of highest priority. However, these sections are not intended to be all inclusive and will be updated regularly. The latest version of each BCR conservation plan can be accessed at http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.

Table 3. Relative importance of Alaska's Bird Conservation Regions (BCRs) for each species.

Species (population)	BCR 1	BCR 2	BCR 3	BCR 4	BCR 5
Black-bellied Plover (*squatarola*)	m	B, M	B, m	M	M
American Golden-Plover	*	B	B, m	B	m
Pacific Golden-Plover	m	B, M			
Semipalmated Plover	b	B, M	b	B, M	B, M
Killdeer				*	b, w
Black Oystercatcher	B, W	B, W			B, W
Spotted Sandpiper	b	B	b	B	B
Solitary Sandpiper (*cinnamomea*)		B	*	B	b
Wandering Tattler	b	B	b	B	B
Greater Yellowlegs		B, M		B, m	B, m
Lesser Yellowlegs	*	B	b	B, M	b
Upland Sandpiper			b	B	
Whimbrel (*rufiventris*)		B, M	B	B, M	m
Bristle-thighed Curlew		B, M		B	
Hudsonian Godwit		B, M		B, M	
Bar-tailed Godwit (*baueri*)		B, M	B		
Marbled Godwit (*beringiae*)		B, M			m
Ruddy Turnstone (*interpres*)	M	B, M	b		
Black Turnstone		B, M	b	*	M, w
Surfbird		B, w	b	B	M, w
Red Knot (*roselaari*)		B, M	B	*	M
Sanderling	w	m, w	b*, m	m	m, w
Semipalmated Sandpiper		B, m	B, M	m	m
Western Sandpiper	b, m	B, M	b, m	M	M
Least Sandpiper	b	B, m	b	b, m	B, M
White-rumped Sandpiper			B		
Baird's Sandpiper	b	B	B	B, m	m
Pectoral Sandpiper	*	b, M	B, M	m	M
Sharp-tailed Sandpiper	m	M	m		*
Rock Sandpiper (*ptilocnemis*)	B, W	B, M		W	W
Rock Sandpiper (*tschuktschorum*)		B, M		W	W
Rock Sandpiper (*couesi*)	B, W	B, M			
Dunlin (*arcticola*)	*	B, M	B, M		
Dunlin (*pacifica*)	*, m	B, M		M	M
Stilt Sandpiper			B	*	*
Buff-breasted Sandpiper			B		
Short-billed Dowitcher (*caurinus*)		B, M		B, M	B, M
Long-billed Dowitcher	b	B, M	B, M	b, m	M
Wilson's Snipe	b	B	b	B	B, w
Red-necked Phalarope	b, M	B, M	B, M	B, m	b, M
Red Phalarope	b, M	B, m	B, M	m	*

Codes:

B = breeding, M = migration, and W = wintering.
B, M, W = high numbers of individuals occur within BCR relative to other BCRs in Alaska during seasons listed.
B, M, W = common or locally abundant; BCR important to the species.
b, m, w = uncommon to fairly common; BCR within species' range but species occurs in low abundance relative to other BCRs.
* = rare; BCR within expected range but species occurs at low frequency.

BCR 1: ALEUTIAN/BERING SEA ISLANDS

The relatively small (18,000 km^2) BCR 1 is one of the most seismically and volcanically active regions in the world. This BCR includes two ecoregions, the Aleutian Islands and the Bering Sea Islands (Nowacki et al. 2001). The Aleutian Islands consist of thousands of volcanic summits of a submarine ridge created by the subduction of the Pacific plate by the North American plate. These islands extend westward from the Alaskan mainland for 1,770 km terminating at the Kamchatka Peninsula in Russia. The Bering Sea Islands (i.e., Pribilofs, St. Matthew, Hall, St. Lawrence, and Little Diomede) are also volcanic mounts, and are situated in the relatively shallow Bering Sea. Nearly all (97%) of this region is included within the Alaska Maritime National Wildlife Refuge (AMNWR; Appendix 2).

This region experiences a maritime climate; rain, fog, and persistent winds are the defining climatic features. Permafrost and winter sea ice are both important physical processes of the Bering Sea Islands, but these conditions are not prevalent in the Aleutian Islands. Elevations range from sea level to over 1,900 m, with the higher volcanoes glaciated. Most of the region is treeless, and vegetation at higher elevations consists of dwarf shrub communities, mainly willow (*Salix* spp.) and crowberry (*Empetrum nigrum*). Meadows and marshes of herbs, sedges, and grasses are plentiful and ericaceous bogs occur on several islands.

PRIORITY SPECIES

Table 4. Priority shorebird species that commonly breed, stage during migration, or winter in BCR 1 (see Table 2 for conservation priority scores).

Breeding	Migration	Winter
Black Oystercatcher Rock Sandpiper (*ptilocnemis*) Dunlin (unknown subspecies)	Rock Sandpiper (*ptilocnemis*)	Black Oystercatcher Sanderling

The breeding diversity of shorebirds is relatively low in this region; the most abundant species include the Black Oystercatcher, Ruddy Turnstone, Dunlin, and Rock Sandpiper. Semipalmated Plovers, Least Sandpipers, and Red-necked Phalaropes also breed in this region in small numbers. Numerous Old World species are regular migrants or visitants, and some of these also regularly breed in the region in small numbers (e.g., Common Ringed Plover, Wood Sandpiper; Gibson and Byrd 2007). Three races of Rock Sandpiper (*ptilocnemis, couesi, tschukschorum*) occur on the islands.

IMPORTANT SHOREBIRD AREAS

Unlike the other BCRs in Alaska, BCR 1 contains no large embayments or river deltas. Consequently, the region does not support large numbers of shorebirds during migration. The region does, however, provide important breeding and nonbreeding habitat for shorebirds. The Bering Sea Islands are home to the *ptilocnemis* race of Rock Sandpiper, an endemic race which breeds only on the Pribilof, St. Matthew, and Hall islands. A large proportion of the *couesi* race of Rock Sandpiper breeds and winters in the Aleutian Islands (Gill et al. 2002a). Similarly, the Aleutian Islands support many hundred breeding pairs of Black Oystercatchers (Gibson and Byrd 2007), constituting approximately 10% of the breeding population (Tessler et al. 2007).

PRIMARY CONSERVATION OBJECTIVES

The distribution and seasonal occurrence of shorebirds in parts of the region are relatively well documented (e.g., Friedmann 1932, Fay and Cade 1959, Murie 1959, Gibson and Byrd 2007), but many of these observations are anecdotal and do not include the nonbreeding season. A formal assessment of the status of the region's shorebirds will form a foundation for future conservation efforts. Future work should address the following objectives for BCR 1:

⇒ Implement breeding and nonbreeding population monitoring programs for priority species, particularly Black Oystercatchers and *ptilocnemis* and *couesi* subspecies of Rock Sandpipers.

⇒ Assess the importance of the Aleutian Islands in supporting trans-Pacific migrants.

⇒ Determine the subspecies of Dunlin breeding on St. Lawrence Island.

Priority Conservation Issues and Actions

Pollution

The islands throughout BCR 1 are extremely susceptible to pollution. Both point source and atmosphere-borne contaminants have been identified in the region (Anthony et al. 1999, Rocque and Winker 2004), but the biggest threat to shorebirds likely derives from marine transport. The Aleutian Islands straddle major shipping routes between Asia and North America, with over 3,600 container ships and freighters passing through the Aleutian Islands each year. The region's notoriously bad weather makes the threat of shipwrecks and groundings a huge concern, a fact recently emphasized by the grounding of the M/V *Selendang Ayu* off Unalaska Island in December 2004. This wreck spilled nearly 11,300 barrels of bunker fuel and diesel and 60,000 metric tons of soybeans over more than 110 km of shoreline. Since 1988, over 80,000 barrels of diesel oil have been spilled in the Aleutian region alone (State of Alaska 2008). Once ashore, marine pollution is concentrated along coastlines, making shorebirds especially vulnerable to physical contamination and displacement.

Rock Sandpipers • Dan Ruthrauff

Shipping traffic is likely to increase across the region, and effective planning can help alleviate the effects due to marine-derived pollution. Given that most of the islands in BCR 1 are remote and unpopulated, spill response measures are unlikely to be effective. Even when a vessel has the relative good fortune to encounter problems near an inhabited island, as in the case of M/V *Selendang Ayu* off Dutch Harbor, extreme weather events often preclude effective rescue and mitigation measures. Nonetheless, federal and state agencies have implemented extensive spill response measures that integrate the realities of prior incidents and region-specific logistics. For example, the Aleutian Islands Emergency Towing System is just one program recently initiated to help assist foundering vessels and prevent groundings (http://www.dec.state.ak.us/spar/perp/aiets/home.htm).

Actions

⇒ Identify sites where large concentrations of Rock Sandpipers and Black Oystercatchers occur in the region.

⇒ Identify the nest-site characteristics of Black Oystercatchers in order to recognize characteristics (e.g., elevation, beach exposure) that may increase risk of exposure to marine-derived pollution.

⇒ Ensure that shorebird conservation concerns are addressed in oil spill response plans.

Invasive and Problematic Species

Perhaps the single biggest threat to bird species in this region is the introduction of non-native mammals (e.g., rats, mice [*Mus musculus, Peromyscus maniculatus*], foxes, reindeer [*Rangifer tarandans*]). Ship-borne rats and mice have been accidentally introduced to many islands in the Aleutian archipelago, and foxes were purposefully introduced to foster the fur trade. The AMNWR has been actively involved in fox eradication efforts in the Aleutian Islands since the 1950s. To date, more than 40 islands have been successfully cleared of non-native foxes, and the response of the birds has been dramatic. For instance, the Aleutian subspecies of the Cackling Goose (*Branta hutchinsii leucopareia*), once threatened with extinction, has made a dramatic population recovery and has reestablished nesting populations on several islands from which foxes were removed (Byrd 1998). This bird was removed from the list of threatened species under the Endangered Species Act in 2001, and eradication of foxes on their breeding grounds played a vital role in this species' recovery.

The eradication of rats and mice in the region is a more daunting task than fox removal. Due to their small size and high fecundity, total eradication of these problematic species is extremely difficult. Despite the inherent difficulties, efforts to remove these invasive predators are planned. To date, preventative measures are the most effective methods of dealing with rats and mice in the region. The program *Stop Rats!* (http://www.stoprats.org) is a major effort to educate the public concerning the threat of rat and mouse introductions to island settings. Through this program, AMNWR provides free kits for trapping and monitoring accidental introductions of rats and mice. The tribal governments on the Pribilof Islands are actively involved in this organization, and have implemented and maintain anti-rat measures around their harbor facilities. The threat from introduced species is greatest for seabirds that nest in high-density colonies. Nonetheless, shorebirds in this region are also extremely vulnerable to nest predators, and respond positively to restoration efforts (Byrd et al. 1997).

Actions

⇒ Participate with key groups and agencies (e.g., *Stop Rats!*, AMNWR, Pribilof Island tribal governments) in the planning and implementation of programs to eradicate introduced mammals.

⇒ Develop and implement studies to assess the response (i.e., recolonization, breeding success, site fidelity) of Black Oystercatchers and Rock Sandpipers following eradication efforts.

Habitat Conversion and Degradation

A less obvious result of the introduction of non-native species to the region is the conversion and degradation of habitat due to trampling and over-grazing by animals. Reindeer, cattle, and horses have been introduced to islands in BCR 1, and these large herbivores can produce marked changes to fragile native habitats. For instance, reindeer were introduced to St. Matthew Island in 1944 and over-grazed the island to the extent that the herd suffered a spectacular population crash due to an exhaustion of food resources (Klein 1968). Fragile, lichen-dominated upland tundra suffered serious impacts across the island, and a recent comparison of these areas to pristine tundra on adjacent Hall Island demonstrated that recovery has not yet occurred (D. Ruthrauff, pers. comm.). While reindeer no longer occur on St. Matthew Island, they are still present on the Pribilof Islands, where they have been an important food resource for island inhabitants since their introduction in 1911 (Scheffer 1951).

Native vegetation on these islands has been subjected to conversion and degradation (Scheffer 1951), but the extent to which habitat conversion adversely affects shorebirds (primarily Rock Sandpipers) breeding at these sites is unknown.

Immediate threats posed by reindeer are obvious (e.g., nest trampling, egg consumption; Wright 1979), but threats due to habitat conversion are more difficult to assess given the lack of knowledge of conditions prior to reindeer introductions. Habitat conversion may adversely affect nest concealment, potentially increasing nest predation. Alternatively, a change in vegetation cover may precipitate a change in the invertebrate community, potentially eliminating the preferred prey items of shorebirds and shorebird chicks during the breeding period.

Actions

⇒ Assess patterns of habitat degradation due to introduced ungulates at Pribilof, St. Matthew, and Hall islands.

⇒ Compare Rock Sandpiper habitat use at pristine (Hall Island), recovering (St. Matthew Island), and impacted (Pribilof Islands) sites. Compare habitat-specific measures of reproductive success (e.g., hatching success, fledging success) across these sites.

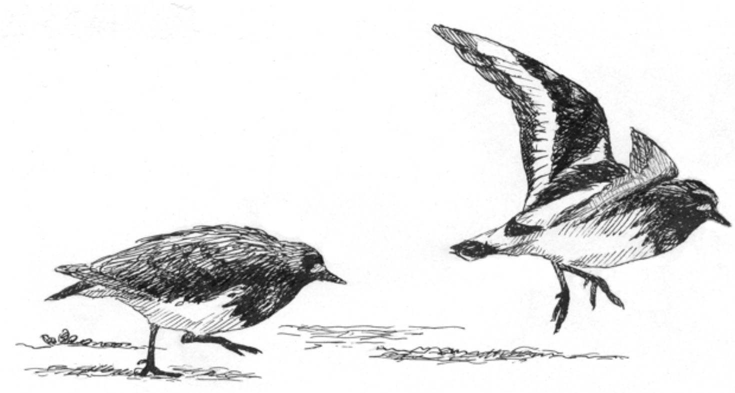
⇒ Advise local governments and management agencies on potential impacts of habitat alteration to shorebird species; promote the removal of introduced grazers at sites lacking their population regulation.

Climate Change and Severe Weather

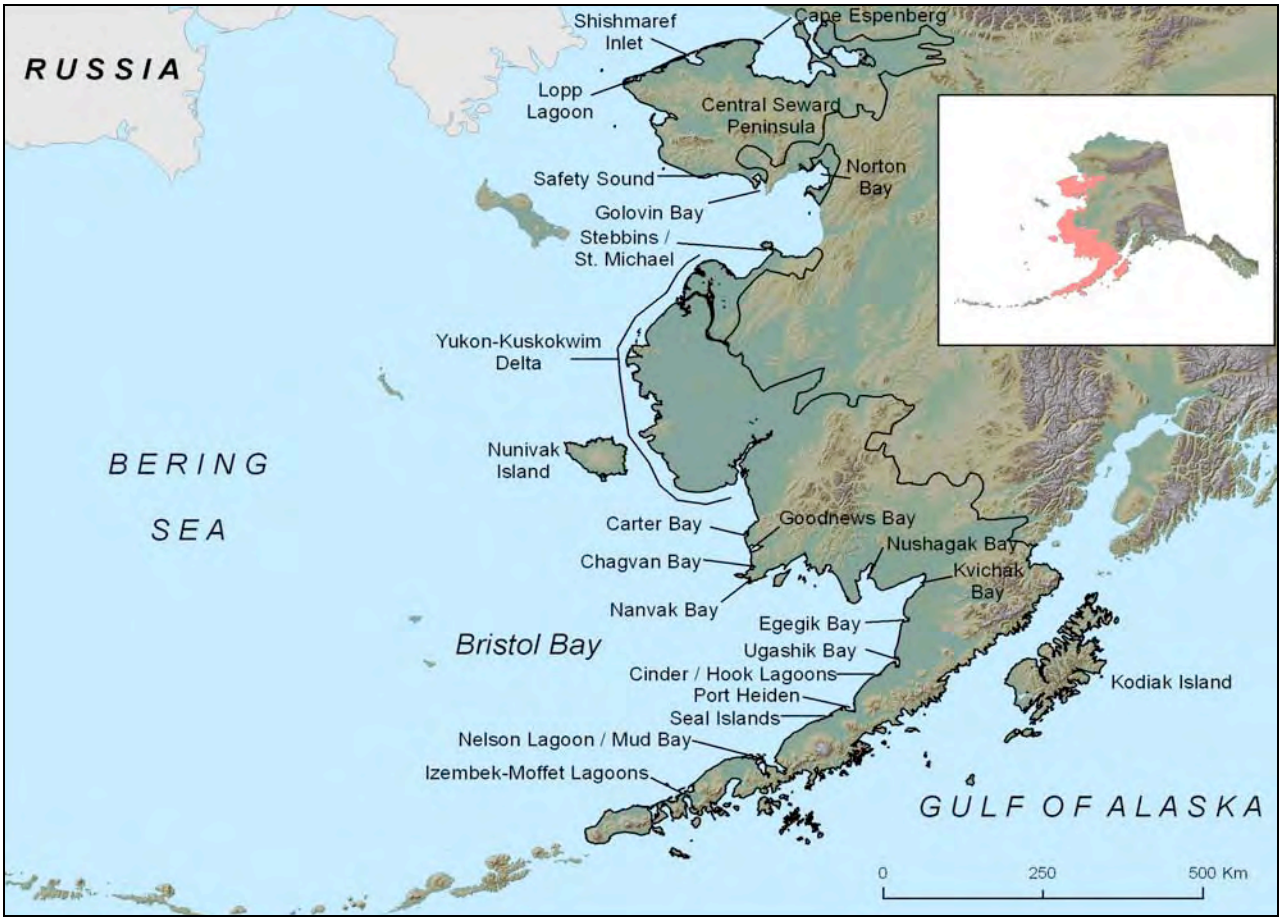
In addition to the general threats of climate change discussed in Part I, perhaps the greatest specific threat to shorebirds in BCR 1 concerns the alteration of broad-scale climatological patterns, specifically predicted changes in the position, frequency, and seasonality of storm tracks in the Northern Hemisphere. Some models predict regional reductions in the number of weaker cyclones and a poleward shift of the storm track in the North Pacific (Graham and Diaz 2001, Brayshaw 2005, Bengtsson et al. 2006, Yin 2006), and others indicate a likely increase in frequency and intensity of high-latitude cyclones, particularly in the North Pacific (McCabe et al. 2001). A large number of shorebirds that pass through BCR 1 exploit predictable weather patterns to enable successful annual migrations (e.g., Pacific Golden-Plover, Bar-tailed Godwit, Sharp-tailed Sandpiper; R. E. Gill, Jr., pers. comm.). The effect of projected changes in frequency, intensity, and tracking of storms in the North Pacific on the migration strategy of these birds is unknown but likely significant.

Actions

⇒ Encourage long-term studies synthesizing measures of shorebird breeding phenology (e.g., mean nest initiation, mean hatch date) and environmental conditions (e.g., temperature, snow depth, snow persistence).



BCR 2: WESTERN ALASKA



This large, 293,000 km^2 region consists of the coastal plain and mountains of western and southwestern mainland Alaska, as well as three of Alaska's largest islands: Kodiak, Nunivak, and Unimak. BCR 2 spans 12^o of latitude from the southernmost point of mainland Alaska near False Pass to just above the Arctic Circle near Cape Espenberg. From east to west, the BCR extends across nearly 17^o of longitude from the Kodiak Archipelago in the Gulf of Alaska to Cape Prince of Wales at Bering Strait. Ecoregions include: Kodiak Island, Alaska Peninsula, Bristol Bay Lowlands, Ahklun Mountains, Yukon-Kuskokowim Delta, Kotzebue Sound Lowlands, and Seward Peninsula (Nowacki et al. 2001). Over half of BCR 2 is included within federal land conservation units, including national parks, preserves, monuments, and wildlife refuges (Appendix 2). In fact, the seven national wildlife refuges within BCR 2 account for one-third of the entire landmass protected by the National Wildlife Refuge system. BCR 2 also includes several Alaska state conservation units; the Izembek State Game Refuge and the Bristol Bay Critical Habitat Areas are particularly important for migrating shorebirds.

Expansive intertidal habitat associated with the numerous river deltas characterizes this region and far exceeds that of any other region of Alaska. Sea cliffs are present along both the Bering Sea and Pacific Ocean coasts of BCR 2. The highest mountains exceed 1,000 m on the Seward

Peninsula, 700 m on the Yukon-Kuskokwim Delta, and 1,300 m in the Kilbuck-Ahklun Mountains. On the Alaska Peninsula, several volcanic summits exceed 2,400 m. Alpine tundra and fell fields dominate the summits and ridges of these mountainous areas. Lowlands are particularly rich in wetlands, including marshes, ponds, lakes, and meandering rivers, and wet and mesic graminoid herbaceous habitats dominate these sites. Tall shrub communities are found along rivers and streams and low shrub communities occupy uplands; forests of spruce and hardwoods penetrate the region on the eastern edge and approach the coast along major rivers. Permafrost is continuous except in southern parts of the region. A cool maritime climate prevails throughout much of this region, with moderate seasonal temperatures, abundant annual precipitation, and persistent fog and often overcast conditions. In the northern latitudes sea ice spans the Bering Sea in the winter creating persistent cold and windy conditions.

PRIORITY SPECIES

Table 5. Priority shorebird species that commonly breed, stage during migration, or winter in BCR 2 (see Table 2 for conservation priority scores).

Breeding	Migration	Winter
American Golden-Plover	Whimbrel (*rufiventris*)	Black Oystercatcher
Black Oystercatcher	Bristle-thighed Curlew	
Solitary Sandpiper (*cinnamomea*)	Hudsonian Godwit	
Whimbrel (*rufiventris*)	Bar-tailed Godwit (*baueri*)	
Bristle-thighed Curlew	Marbled Godwit (*beringiae*)	
Hudsonian Godwit	Black Turnstone	
Bar-tailed Godwit (*baueri*)	Red Knot (*roselaari*)	
Marbled Godwit (*beringiae*)	Western Sandpiper	
Black Turnstone	Rock Sandpiper (*ptilocnemis*)	
Surfbird	Dunlin (*arcticola, pacifica*)	
Western Sandpiper		
Dunlin (*pacifica*)		

BCR 2 hosts over 30 species of shorebirds that are known or suspected to breed in the region. Western Alaska has a unique breeding shorebird component that is largely restricted to Beringia, including Bristle-thighed Curlew, Bar-tailed Godwit, Marbled Godwit, Black Turnstone, Western Sandpiper, Rock Sandpiper (*C. p. tschuktschorum*), and Dunlin (*C. a. pacifica*). The Yukon-Kuskokwim Delta supports some of the highest breeding densities of shorebirds in the world (Meltofte et al. 2007). The Program for Regional and International Shorebird Monitoring (PRISM) data from the outer Yukon-Kuskokwim Delta yield density estimates of nearly 200 pairs/km^2 (McCaffery et al. 2002; B. J. McCaffery and J. Bart, unpubl. data). At least five species (Black Turnstone, Semipalmated Sandpiper, Western Sandpiper, Dunlin, and Red-necked Phalarope) have densities exceeding 20 pairs/km^2.

Intertidal habitats and coastal meadows in BCR 2, particularly on the Yukon-Kuskokwim Delta and along the Alaska Peninsula, support millions of shorebirds during migration (Gill and Jorgensen 1979, Gill and Handel 1981, Gill et al. 1981, Gill and Handel 1990). Regionally significant numbers of Red Knots, Pectoral Sandpipers, and Long-billed Dowitchers occur in the spring, and globally significant numbers of Sharp-tailed Sandpipers and the Beringian breeders noted above use coastal habitats during the post-breeding period (R. E. Gill, Jr., and B. J. McCaffery, unpubl. data).

Important Shorebird Areas

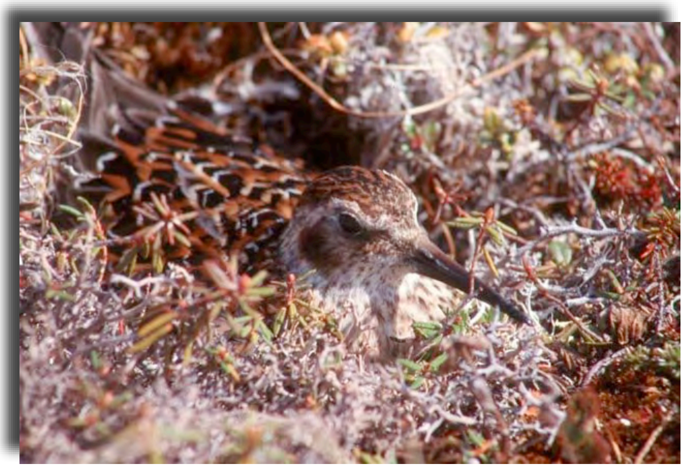
The Western Hemisphere Shorebird Reserve Network (WHSRN) specifically seeks to identify and protect sites important to migratory shorebirds. Within BCR 2, three sites are currently part of the WHSRN: Kvichak and Nushagak bays (both regional reserves) and the Yukon-Kuskokwim Delta (one of only two hemispheric reserves in Alaska). Both of the regional reserves support tens of thousands of post-breeding shorebirds. As a hemispheric reserve, the Yukon-Kuskokwim Delta is the most important autumn staging area for shorebirds in the Pacific flyway, and is among the dozen most important shorebird sites in the world. The central delta alone supports over a million shorebirds during fall migration, with peak numbers reaching 300,000 shorebirds on a given day in September. About half of the world's Western Sandpiper population nests on the Delta and probably 70–80% of the population (2.5 million) uses coastal littoral habitats during the post-breeding period (B. J. McCaffery and R. E. Gill, Jr., pers. comm.). In addition, the Yukon-Kuskokwim Delta supports at some time during the annual cycle: most of the world's populations of Black Turnstones and Bristle-thighed Curlews; most of the *baueri* race of Bar-tailed Godwits and the *tschuktschorum* race of the Rock Sandpiper; and the majority of the Pacific flyway populations of Dunlin and Red Knots.

Elsewhere in BCR 2, at least another 18 sites qualify as WHSRN reserves but have yet to be formally included within the network (Alaska Shorebird Working Group 2000). Among these, nine, five, and four would qualify as regional, international, and hemispheric reserves, respectively. The Important Bird Areas (IBA) program of the National Audubon Society and BirdLife International identifies nearly 40 IBAs in BCR 2, over half of which are recognized for their importance to shorebirds. These sites range from tiny islands to vast swaths of the coastal plain of the Kuskokwim River Delta. Under this program, an area may be identified as important for supporting a few hundred shorebirds (e.g., Northwest Afognak Island's 125–150 Black Oystercatcher pairs) or for supporting millions of breeding and post-breeding shorebirds (e.g., the central Yukon-Kuskokwim Delta).

When interpreting the number and significance of important shorebird sites in BCR 2 it is imperative to recognize that these sites are profoundly connected, most conspicuously by the birds themselves during their migratory journeys. Important connections, as defined by bird movements, include those among important wetlands on the Alaska Peninsula, those between the Yukon-Kuskokwim Delta and the Alaska Peninsula, those along the seemingly endless mudflats of the Yukon-Kuskokwim Delta itself, and those between inland breeding sites and coastal staging sites throughout the BCR.

Primary Conservation Objectives

Shorebird conservation objectives in BCR 2 must be framed in the context of the sparse human population and expansive protected landscapes, a combination unique to this region. While both the human population and the size of the anthropogenic footprint are growing in western



Rock Sandpiper • Jesse Conklin

Alaska, they remain limited relative to other areas in Alaska and elsewhere. Further, compared to most other landscapes supporting significant numbers of shorebirds around the world, the proportion of land under some form of protection in BCR 2 is very high. Taken together, these facts demonstrate that the greatest threats to most shorebird populations in BCR 2 probably occur outside the region (e.g., habitat degradation and loss due to direct and indirect anthropogenic change). Thus, conservation actions implemented outside of BCR 2 are likely to have the greatest proportional benefit for shorebirds that use BCR 2. As such, a perspective that extends beyond the region will be most productive for shorebird conservation in BCR 2.

⇒ Develop national and international partnerships to foster habitat protection in regions to which BCR 2 shorebirds migrate.

⇒ Monitor subsistence harvest of shorebirds and engage subsistence users in global shorebird conservation efforts.

⇒ Acquire additional habitat recognition through formal designation as WHSRN or East Asian-Australasian Flyway Partnership network sites.

⇒ Promote and expand flyway-wide educational efforts in the Pacific Basin.

⇒ Determine better estimates of population status and investigate causes of shorebird population declines.

⇒ Implement long-term population monitoring programs for priority species, including Bristle-thighed Curlew, Hudsonian Godwit, Marbled Godwit, Bar-tailed Godwit, and Black Turnstone.

⇒ Encourage the acquisition and protection of priority shorebird habitats throughout the flyway by land trust or conservation agencies.

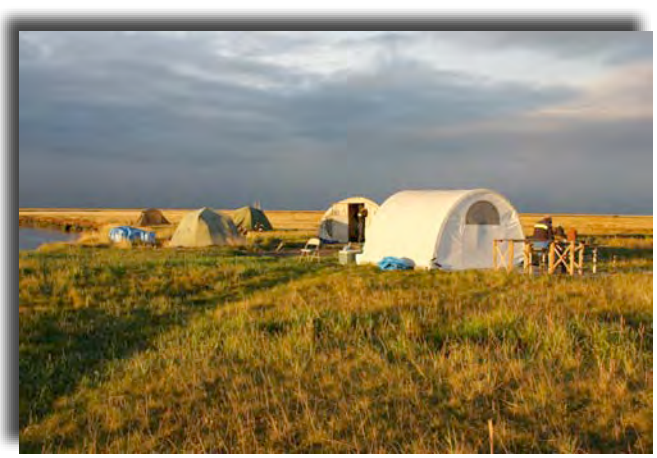
Priority Conservation Issues and Actions

Habitat Conversion and Degradation

Incremental degradation and loss of shorebird habitat in BCR 2 is increasing. Despite the relatively small human population, the *rate* of population growth in some regions and communities is quite high. In addition, as these rural communities strive for the same comfort, security, and connectivity that communities outside of rural Alaska have long taken for granted, the size of the human development footprint will grow regardless of changes in population size. Small-scale impacts, such as concentrated ATV use, chronic small fuel spills, airport runway expansions, and housing developments, will combine with major resource extraction enterprises to reduce the absolute amount of shorebird habitat in BCR 2. These impacts within the region, however, should not distract us from recognizing that the most profound habitat threats to BCR 2 shorebirds are occurring *outside* of the region.

Actions

⇒ Contribute biological expertise to those planning new developments, and promote mitigation measures to limit the negative impacts on important shorebird habitats throughout the flyways.



Yukon-Kuskokwim Delta field camp • Robert Gill, Jr.

⇒ Develop and implement flyway-wide conservation initiatives that define shorebird habitat needs and protect important habitats.

⇒ Promote existing flyway-based shorebird conservation programs, including the Western Hemisphere Shorebird Reserve Network, Shorebird Sister Schools Program, and the Pacific Shorebird Migration Project.

CLIMATE CHANGE AND SEVERE WEATHER

Climate change, and the resulting alteration of natural habitats and broad-scale changes in climatological patterns, are among the most significant threats to shorebirds in BCR 2. The potential impacts of climate change on arctic-breeding shorebirds have been suggested repeatedly (Rehfisch and Crick 2003, Meltofte et al. 2007). In BCR 2, species especially vulnerable to the risk of climate-induced habitat change include the Black Turnstone and the Bristle-thighed Curlew. These two species would be extremely vulnerable to predicted changes in sea level, storm frequency, and storm intensity due to their occupation of extremely low-lying habitats during the breeding and nonbreeding seasons, respectively. Via different pathways, both species could also be susceptible to ecological changes resulting from melting permafrost, shrubification of tundra and meadow habitats, and temporal decoupling of important stages of their annual cycle from the resources that currently support them at those times. Additionally, many of BCR 2's breeding shorebirds rely on predictable weather patterns to enable successful annual migrations. The effect of projected changes in frequency, intensity, and track of storms in the North Pacific on the Numeniini tribe (curlews and godwits) in particular, is of high concern due to their dependence on wind patterns for long-distance migrations (Gill et al. *in press*).

While the magnitude of the potential impacts of global climate change on shorebirds in BCR 2 is great, the opportunities for implementing shorebird conservation efforts that will address (i.e., ameliorate, retard, or reverse) global climate change and its impact on shorebird habitats are extremely limited. Perhaps the most important, if still limited, conservation actions to buffer shorebirds against the impacts of climate change will be to protect, restore, and create as much current and potential future shorebird habitat as possible.

Actions

⇒ Identify and prioritize shorebird habitat currently not protected within BCR 2, and along flyways used by BCR 2 shorebirds during the nonbreeding season, for protection (e.g., GAP analyses).

⇒ Encourage the acquisition and protection of these priority shorebird habitats by land trust or conservation agencies.

⇒ Conduct modeling studies to examine the impact of changing environmental conditions (e.g., sea level rise, storm severity) on shorebird habitats. Protect environments where shorebirds have the maximum opportunity to respond to the challenges of climate change.

BIOLOGICAL RESOURCE HARVESTING

Hunting and Collecting Terrestrial Animals

For most species of Alaskan shorebirds, there is little evidence that subsistence harvest is a serious threat. It should be noted, however, that over 50% of the species open for spring and summer subsistence harvest in Alaska are known or suspected to be declining (Morrison et al. 2006), and that all of these species breed in BCR 2. Similarly, nearly 30% of BCR 2's shorebird priority species are open to harvest during the breeding season. Given the lack of data about population trends and resilience to harvest in all of these species, the current harvest management paradigm is, in effect, an uncontrolled experiment. For a handful of the larger species, the potential impact of subsistence harvest is clearly a cause for concern. At the same time, threats away from BCR 2 are known to be affecting species used by subsistence hunters in western Alaska. Thus, the threats to shorebirds posed by subsistence harvest, and threats to subsistence users because of human activity elsewhere along the flyways, must both be addressed in the conservation planning process.

Prior to 2002, subsistence harvest surveys in western Alaska distinguished only between large and small shorebirds. From 1986 to 2001, the average annual subsistence harvests of large and small shorebirds were 645 and 187, respectively (Wentworth 2007). Based on the distributions of large shorebirds and the shorebird harvest during the periods when harvesting occurred, it is likely that Bar-tailed Godwits made up the majority of large shorebirds harvested during this period. Beginning in 2002, and continuing in 2004 and 2005, the category "large shorebird" was replaced by Bristle-thighed Curlew, Whimbrel, and godwits. The three-year average annual harvests for these taxa were 34, 69, and 923, respectively (Wentworth 2007), confirming the relative importance of godwits in the overall large shorebird harvest.

The effects of subsistence harvest on the populations of large shorebirds are not known. Even a small harvest of Bristle-thighed Curlews is of concern, given their very small global population (est. 3,200 breeding pairs). Even the larger Bar-tailed Godwit population may be negatively impacted by human harvest. From 1997 to 2005, godwit counts in western Alaska declined from an estimated 94,000 to just over 40,000 (B. J. McCaffery and R. E. Gill, Jr., unpubl. data); the annual subsistence harvest during that same period averaged 1,721 (Wentworth 2007). Whether a harvest of that magnitude contributed to or exacerbated the reported decline remains to be determined.

Bar-tailed Godwits • Jan van de Kam

Actions

⇒ Develop and implement better subsistence harvest surveys for shorebirds.

⇒ Develop better estimates of population status of large shorebirds vulnerable to subsistence harvest (e.g., Bristle-thighed Curlew, Bar-tailed Godwit).

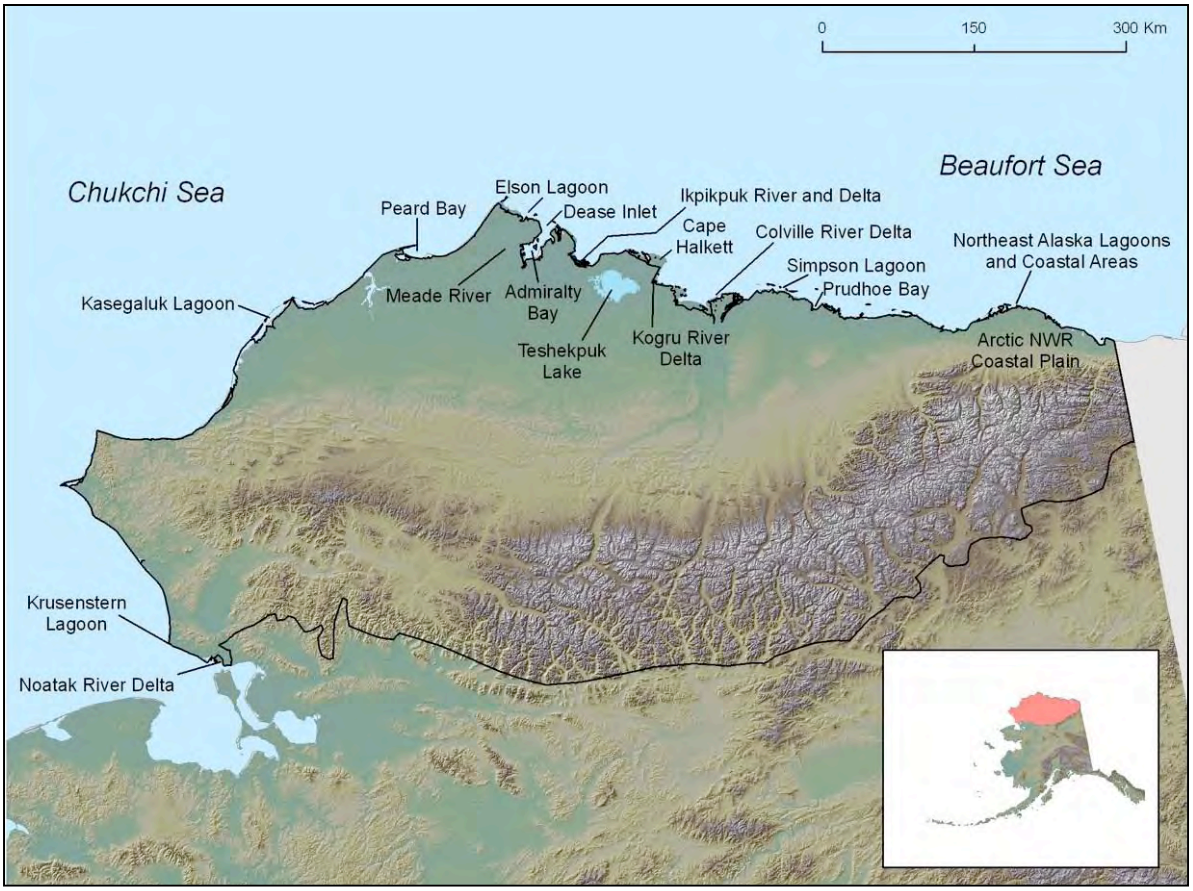
⇒ Develop quantitative population models to determine if populations of large shorebirds can sustain human harvest and, if so, of what magnitude.

⇒ Engage subsistence users in shorebird conservation initiatives.

⇒ Develop flyway-wide management strategies for species taken by subsistence hunters.

⇒ Work with Alaska Migratory Bird Co-Management Council, USFWS, and other stakeholders to educate the public about the potential impacts of subsistence harvest on shorebirds and to develop workable enforcement protocols for the illegal harvest of large shorebirds.

BCR 3: ARCTIC PLAINS AND MOUNTAINS



The 240,000 km^2 Arctic Plains and Mountains BCR includes low-lying coastal tundra, drier uplands of the Arctic Foothills of the Brooks Range, and montane areas of the Brooks Range. Ecoregions include Beaufort Coastal Plain, Brooks Foothills, and Brooks Range. The region extends from the Alaska-Canada border at Demarcation Point westward and southward to the mouth of the Noatak River. Seventy percent of this BCR is federally managed as part of the Arctic National Wildlife Refuge, the National Petroleum Reserve-Alaska (NPR-A) and the Arctic Network of National Parks (Appendix 2).

Most of the region is underlain with thick, continuous permafrost, and much of the coastal plain landscape is dominated by surface water during the brief arctic summer, especially in northern areas of NPR-A in the central region of the coastal plain. Freezing and thawing form a patterned mosaic of polygonal ridges and ponds. Several rivers (e.g., Colville and Canning rivers) traverse the plain from south to north, flowing into the Arctic Ocean. Being so far north, this region experiences 67 days when the sun is below the horizon in the winter and 84 days when the sun does not set in the summer. The ocean surface, except for open water leads, is frozen nine to ten months a year, and the ice pack is typically close to shore.

PRIORITY SPECIES

Table 6. Priority shorebird species that commonly breed or stage during migration in BCR 3 (see Table 2 for conservation priority scores).

Breeding	Migration
American Golden-Plover	American Golden-Plover
Upland Sandpiper	Red Knot (*roselaari*)
Whimbrel (*rufiventris*)	Sanderling
Bar-tailed Godwit (*baueri*)	Dunlin (*arcticola*)
Red Knot (*roselaari*)	
Sanderling	
Dunlin (*arcticola*)	
Buff-breasted Sandpiper	

The large amount of surface water on the coastal plain supports a large avian community, predominately waterfowl and shorebirds. At least 29 species of shorebirds breed in BCR 3 (Johnson et al. 2007), the most abundant being American Golden-Plover, Semipalmated Sandpiper, Pectoral Sandpiper, Dunlin, Long-billed Dowitcher, and Red-necked and Red phalaropes. Detailed density estimates of breeding shorebirds are available for only the Arctic Coastal Plain of the Arctic National Wildlife Refuge. Brown et al. (2007) estimated 230,000 shorebirds reside in that region during the breeding season, and the most abundant species had densities of approximately 2–6 birds/km^2. Higher densities of breeding shorebirds occur in the Prudhoe Bay Region and the NPR-A (especially near Barrow, Teshekpuk Lake, Dease Inlet, and the Ikpikpuk River, see Appendix 5); densities in these locations can exceed 20 to 30 birds/km^2 for some species (B. Andres and J. Bart, unpubl. data).

The breeding ranges of Old World shorebird species penetrate the region from the west (e.g., Bar-tailed Godwit) and shorebird species regularly breeding in the Canadian Arctic penetrate from the east (e.g., Sanderling and White-rumped Sandpiper). The *arcticola* subspecies of Dunlin breeds in BCR 3 and winters in Asia, in contrast to the *pacifica* subspecies, which breeds in western Alaska and winters in the New World. Hundreds of thousands of shorebirds also congregate on BCR 3's river deltas and coastal lagoons during fall migration.

Distributions of shorebird species vary within BCR 3; in general, larger numbers and the greatest diversity occur west of the Colville River, although certain sites east of the Colville (e.g., Prudhoe Bay, Canning River Delta) also have relatively high species richness (Johnson et al. 2007). Semipalmated Sandpipers, Pectoral Sandpipers, Long-billed Dowitchers, Red-necked Phalaropes and Red Phalaropes occur throughout the Arctic Coastal Plain and are infrequently found in the Brooks Range foothills (Johnson et al. 2007). Black-bellied Plovers, Dunlin, and Stilt Sandpipers are concentrated in the central portion of the coastal plain. Western Sandpipers are found principally in the western Arctic Coastal Plain, while White-rumped, Baird's, and Buff-breasted sandpipers are found in disjunct regions of the Coastal Plain. Semipalmated Plovers and Ruddy Turnstones occur in low densities primarily along riparian or gravel coastal areas, and Whimbrel and Wilson's Snipe are generally found close to major rivers and in the Brooks Foothills ecoregion. Several montane nesting shorebird species (e.g.,

Wandering Tattler, Surfbird) breed in very low densities in dry, high-elevation regions of the Arctic Network of National Parks (Tibbitts et al. 2005) and other areas in the Brooks Range (S. Kendall, pers. comm.).

IMPORTANT SHOREBIRD AREAS

Breeding

During the short summer season, BCR 3 supports large numbers of breeding shorebirds, estimated at over six million in the NPR-A alone (Pitelka 1974). Unlike for post-breeding shorebirds, there are no locations where very large numbers of breeding shorebirds can aggregate. There are, however, general areas of importance that have higher numbers and diversity of breeding birds (Appendix 5). Prominent sites include Prudhoe Bay and portions of the NPR-A, including Barrow and the areas surrounding Admiralty Bay, the Kogru River, the Ikpikpuk River and Delta, and the area surrounding Teshekpuk Lake (TERA 1993b; Mallek et al. 2006; B. Andres and J. Bart, unpubl. data).

The Colville River Delta is the largest river delta in BCR 3 and supports 20 species of breeding shorebirds. Important concentrations of Stilt Sandpipers and American Golden-Plovers breed here, as well as several priority species such as Whimbrel, Bar-tailed Godwit, and Buff-breasted Sandpiper. The Canning River Delta in the Arctic National Wildlife Refuge also supports relatively high densities of breeding shorebirds. The most abundant breeding species are Semipalmated Sandpipers, Pectoral Sandpipers, Red-necked Phalaropes, and Red Phalaropes (Brown et. al. 2007). Over 7% of the world's population of American Golden-Plovers is estimated to breed in the refuge.

Post-breeding

The river deltas and coastal lagoons of BCR 3 are used extensively by post-breeding shorebirds from July through September to build energy reserves

Polygonal tundra, North Slope • Stephen Brown

necessary for migration to wintering areas. Some of the more important areas for shorebirds are described below.

Kasegaluk Lagoon is one of the longest lagoon-barrier island systems in the world, and is used by over 19 different species of shorebirds during fall migration. Up to 68,000 post-breeding shorebirds are estimated to use the Kasegaluk Lagoon system between July and September (A. Taylor, unpubl. data). These are mostly juvenile Semipalmated and Western sandpipers, Dunlin, and Red Phalaropes.

Peard Bay is a large, relatively deep bay, located on the north Chukchi Sea coast west of Barrow. It is protected on the north by a 25-km-long sand spit and a series of small barrier islands. Upwards of 56,000 shorebirds are thought to use Peard Bay during the post-breeding season (A. Taylor, unpubl. data), with Red Phalaropes comprising the majority. Other species present in substantial numbers included Semipalmated Sandpipers, Western Sandpipers, Pectoral Sandpipers, and Dunlin.

Elson Lagoon is another large, mostly closed lagoon protected from the Beaufort Sea by barrier islands and spits. The lagoon extends from Pt. Barrow to Cape Simpson and includes the Plover Islands and the mouth of Dease Inlet to Black Head. The area is also heavily used by post-breeding shorebirds, with as many as 418,000 shorebirds stopping there for weeks during fall migration (>90% phalaropes, A. Taylor, unpubl. data). Farther to the east, Pogik Bay, a small inlet located north of Teshekpuk Lake, has had ≥21,000 shorebirds during the peak of post-breeding staging (A. Taylor, pers. comm.)

The Colville River delta hosts an estimated 40,000 individuals of 18 species during fall migration, including large numbers of American Golden-Plovers, Dunlin, and Stilt Sandpipers (Andres 1994). More contemporary surveys estimate 17,000 Dunlin may occur on a single day (A. Taylor, unpubl. data) Earlier in the staging period, surveys indicate that large numbers of small shorebirds (likely Semipalmated and Western sandpipers) and phalaropes stage on the delta (A.Taylor, pers. comm.).

Shorelines and barrier islands along the coastal plain of the Arctic National Wildlife Refuge also support large numbers of staging shorebirds (>112,000 individuals have been observed during a single survey; A. Taylor, unpubl. data). Semipalmated Sandpipers, Red-necked Phalaropes, Dunlin, Black-bellied Plovers, and Pectoral Sandpipers are the most common species (listed in order of abundance) staging in this area (S. Kendall, unpubl. data). Radio telemetry data indicate the Canning River may serve as a southward migration corridor for Semipalmated Sandpipers leaving the Arctic Coastal Plain.

Several sites have been recognized by the National Audubon Society and Birdlife International program as Important Bird Areas, including Kasegaluk Lagoon, Teshekpuk Lake, east Dease Inlet, Peard Bay, Elson Lagoon, Colville River Delta, and lagoons and barrier islands of the eastern Beaufort Sea (http://www.audubon.org/bird/iba/).

Primary Conservation Objectives

While extensive shorebird research has been conducted in this region, further study is needed to evaluate the cumulative impacts of the many threats facing shorebird populations in this region. Such research would inform policy decisions and help identify actions that could mitigate impacts from oil and gas development and from climate change. For effective conservation, collaboration with key stakeholders (federal, state and local governments, non-governmental organizations, and industry) is essential to ensure that development does not adversely affect shorebird populations. Immediate action is needed to address the conservation objectives listed below:

⇒ Develop models to predict the effects of long-term climate change on shorebird populations.

⇒ Model cumulative impacts on shorebird populations of oil and gas development on the Arctic Coastal Plain.

⇒ Assess and implement methods for monitoring shorebirds during the breeding and post-breeding seasons.

⇒ Study breeding ecology to identify factors limiting population size.

⇒ Determine factors regulating the temporal and spatial distribution of post-breeding shorebirds at stopover sites along the Arctic Coast.

⇒ Develop habitat-based models to predict the presence of breeding and post-breeding shorebirds on the Arctic Coastal Plain.

Priority Conservation Issues and Actions

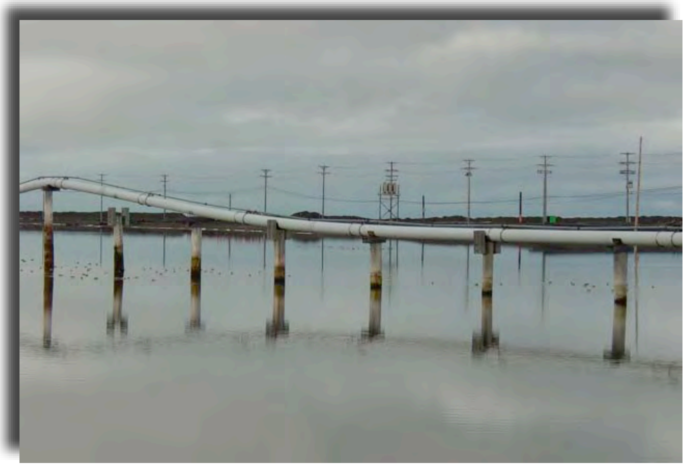
Energy Production and Mining

Oil and Gas Production

Development associated with oil production has occurred for several decades in BCR 3 and is expanding. The largest development, the Prudhoe Bay-Kuparuk complex, encompasses about 2,000 km^2 along the central Beaufort Sea coast. Oil and gas exploration and development is continuing to expand within the Colville River delta, and exploratory wells are being drilled within the NPR-A and in offshore waters of the Beaufort and Chukchi seas. Millions of hectares have been leased to oil companies in the NPR-A and additional lease sales are likely. More offshore development is likely within the millions of hectares recently leased in the Beaufort and Chukchi seas.

Primary potential effects of oil development include displacement of breeding birds due to loss and fragmentation of habitat and reduced nest success associated with predation. Additional effects may include alteration of habitat due to changes in drainage patterns, roadside dust, thermokarst (i.e., melting of permafrost), physical and noise disturbance, industrial pollution, and collisions with human structures (NRC 2003). The area affected indirectly by roadside flooding, dust, and thermokarst can greatly exceed the development footprint (NRC 2003). Loss and alteration of habitat in the oil fields are known to result in displacement of nesting shorebirds (TERA 1993a), but effects at the population level are unknown and difficult to measure. The cumulative effects of potential spills, facility construction and expansion, road building, industrial pollution, and increased ground, air, and water traffic may have deleterious effects on shorebirds.

Oil spills could have immediate and dramatic effects on shorebird populations, particularly in sensitive areas such as lagoons and littoral habitats.



Prudhoe Bay pipeline • Rick Lanctot

Thus, adequate measures for spill prevention and response should be strongly encouraged. Spill response planning is a joint Federal-State responsibility, coordinated through the multi-agency Regional Response Team. Plans identifying "Areas of Major Concern," and "Geographic Response Strategies (GRS)" are developed for the most sensitive sites. GRS are oil spill response plans tailored to protect a specific sensitive area from impacts following a spill.

Actions

⇒ Identify important areas used by breeding and post-breeding shorebirds and advocate for protection, or development of GRS, for the most important sites.

⇒ Assess the impacts of oil and gas development on shorebird communities and evaluate mitigation options.

⇒ Use habitat-based models to evaluate the probability of occurrence of breeding and post-breeding shorebirds at proposed development sites.

⇒ Work with industry to conduct study of shorebirds and ensure that adequate spill response equipment, personnel, and plans are in place.

⇒ Collaborate with stakeholders to promote industry environmental compliance.

⇒ Contribute biological expertise about shorebirds to future planning efforts, and promote mitigation measures to limit any negative impacts to important shorebird habitats.

Mining and Quarrying

Industry has expressed some interest in retrieving hardrock and coal from the southern portions of NPR-A, but this is currently prohibited and would require Congressional legislation to change. In addition to direct physical modifications to habitats, mining can also indirectly affect the biological components of a region through introduction of fuels, heavy metals, and acids into the environment. Contaminated sites may have broader effects due to persistence of the contaminant in the environment or effects far from the point source.

Renewable Energy

Several villages along the Arctic Coast have explored the potential to use wind turbines that are "hybridized" to existing diesel generators. To the extent that wind power diminishes reliance on diesel fuel, risk of oil spills would be reduced. Wind turbines themselves pose a risk to migrating shorebirds, however, because migrating flocks may collide with towers, blades, or guy-wires.

Actions

⇒ Assess potential impacts of mining and renewable energy development on shorebird communities and evaluate options for mitigation.

⇒ Contribute biological expertise about shorebirds to those planning new developments, and promote mitigating measures to limit negative impacts on important shorebird habitats.

INVASIVE AND PROBLEMATIC SPECIES

Problematic Native Species

Changes in predator distribution and abundance due to human activity are major concerns in and near the oilfields in BCR 3. Landfills may provide a supplemental food resource to avian (e.g., gulls, ravens) and mammalian (e.g., foxes) scavengers, especially when garbage is not burned. Additionally, oil field infrastructure provides denning and nesting structures otherwise not available for arctic foxes and ravens (S. Backensto, pers. comm.). Supplemental food resources and availability of den and nest sites may result in higher predator populations on a local, or even regional, scale.

A number of studies have supported the hypothesis that predator population sizes and productivity are higher in oil fields than in comparable undeveloped portions of the Arctic Coastal Plain. Burgess et al. (1993) reported a higher density of fox dens in the Prudhoe Bay region compared to surrounding areas outside of the oilfields. However, no pre-development data exist to address the alternative explanation that the fox population was always higher in the Prudhoe Bay region. Eberhardt et al. (1983) found that arctic foxes in oil-developed areas were more sedentary than those in undeveloped areas, and foraging sites were limited primarily to areas of high human activity. Christmas Bird Count data from 1988 to 2007 show an increasing abundance of wintering Common Ravens at Prudhoe Bay (National Audubon Society 2008). Common Ravens probably did not breed on the Arctic Coastal Plain historically (Johnson and Herter 1989), but have expanded into human-developed regions because of the increased availability of human-made nest sites (Day 1998).

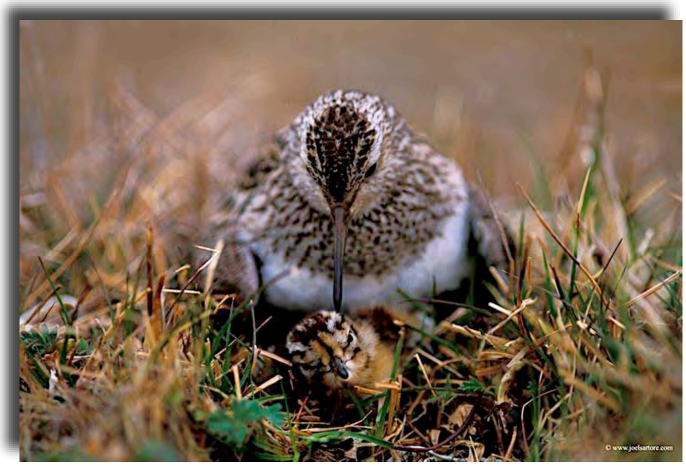
Estimating the impact of apparently higher predator populations on nesting shorebirds has been difficult given the large interannual and geographic variation in nest success, predator numbers, and alternative prey resources in developed and undeveloped areas (USFWS 2003; J. Liebezeit, unpubl. data). An experimental study in Barrow, however, indicated that shorebird productivity was higher when arctic foxes were removed (R. Lanctot, unpubl. data). Because predation is an important controlling influence on productivity of arctic-breeding shorebirds, this potential threat must be addressed in new developments.

Actions

⇒ Encourage studies that examine natural and human-altered patterns of predation on shorebirds.

⇒ Encourage efforts to reduce the availability of human food and artificial den and nest sites to predators.

⇒ Provide biological expertise and mitigation recommendations to address this issue in proposed developments.



Pectoral Sandpiper • Joel Sartore

CLIMATE CHANGE AND SEVERE WEATHER

Habitat Shifting and Alteration

Both direct and indirect effects of climate change (see Part I), especially those influencing habitat, are likely to have severe impacts in BCR 3 (Rehfisch and Crick 2003, Meltofte et al. 2007). Hydrology in terrestrial arctic regions is strongly influenced by the presence or absence of permafrost, as well as the thickness of the active layer (surface layer of ground subject to annual thaw) and the thickness of the underlying permafrost (Hinzman et al. 2005). In areas of continuous and thick permafrost, such as the Arctic Coastal Plain, ice wedge degradation and resulting development of thermokarst ponds has occurred since 1945, increasing the proportion of the landscape covered with surface water (Jorgenson et al. 2003). At the same time, climate change may also cause draining of thaw lakes and a decline in lake abundance (Smith et al. 2005, Smol and Douglas 2007).

Changes in snowmelt may also affect shorebirds. Over the last sixty years, there has been a consistent trend toward earlier snowmelt at Barrow, with snowmelt date advancing by about 10 days (Hinzman et al. 2005). Longer growing seasons and warmer summer temperatures will result in changes to the dominant tundra vegetation types. Tundra areas on the Arctic Coastal Plain have become shrubbier in recent decades (Tape et al. 2006).

The net impact of these habitat changes on breeding shorebirds is difficult to predict. To the extent that boreal forest ecosystems encroach on tundra, tundra-breeding shorebirds may be displaced northward and/or squeezed into less available habitat with more fragmentation. Changes in the overall abundance and types of wetlands will likely affect the temporal and spatial abundance and distribution of prey, but not necessarily in a consistent fashion. For instance, drying could result in landscape-scale reduction of aquatic and semi-aquatic insect populations, but increased thermokarsting may have the opposite effect. The degree to which the timing of shorebird breeding remains coupled to the life cycles of their prey is also of key importance, since shorebird hatch appears synchronized with peak availability of surface-active insects upon which the chicks depend (MacLean 1980, Schekkerman et al. 2003). The distribution and abundance of predators and parasites may also change in response to altered habitat and climatic conditions.

Storms and Flooding

Global sea levels are predicted to rise on the order one-half meter over the 21st century (IPCC 2007). Change of this magnitude would result in loss of some coastal habitats important to shorebirds, particularly low-lying intertidal areas. Climate change also may increase the frequency and severity of storms, causing severe coastal erosion and inundation of salt water into freshwater systems (Mars and Houseknecht 2007). These intertidal areas are used by post-breeding shorebirds, which feed here to build energy reserves necessary for migration. Changes in littoral-zone invertebrate communities may also be expected, both in regard to species composition and total productivity (Rehfisch and Crick 2003).

Actions

⇒ Model potential impacts on shorebird populations from changing environmental conditions (e.g., snow depth and snowmelt, permafrost) on shorebird habitats.

⇒ Monitor the timing of shorebird hatch in relation to insect emergence.

⇒ Assess how coastal erosion and saltwater intrusion into freshwater littoral habitats along the coast may impact the quality of habitats used by post-breeding shorebirds.

⇒ Collaborate with researchers undertaking manipulative studies (e.g., the Barrow Biocomplexity Project) to examine the effects of tundra drying and flooding on shorebird nesting and foraging habitat.

Transportation and Infrastructure

Shipping Lanes

Diesel oil and gasoline for electrical generation and heating are delivered via air or barge (marine or river) to coastal villages in BCR 3. Industries and communities in BCR 3 rely on seagoing vessels, and marine traffic through the Northwest Passage is anticipated to commence in the coming years. Such activities require storage and transfer facilities along the coast; current facilities vary in quality and maintenance, although a multi-year federal initiative to upgrade and consolidate village bulk fuel facilities should lower spill-risk at remote villages. Any spills in the marine environment may lead to chronic oiling of birds and the contamination of prey resources at stopover sites.

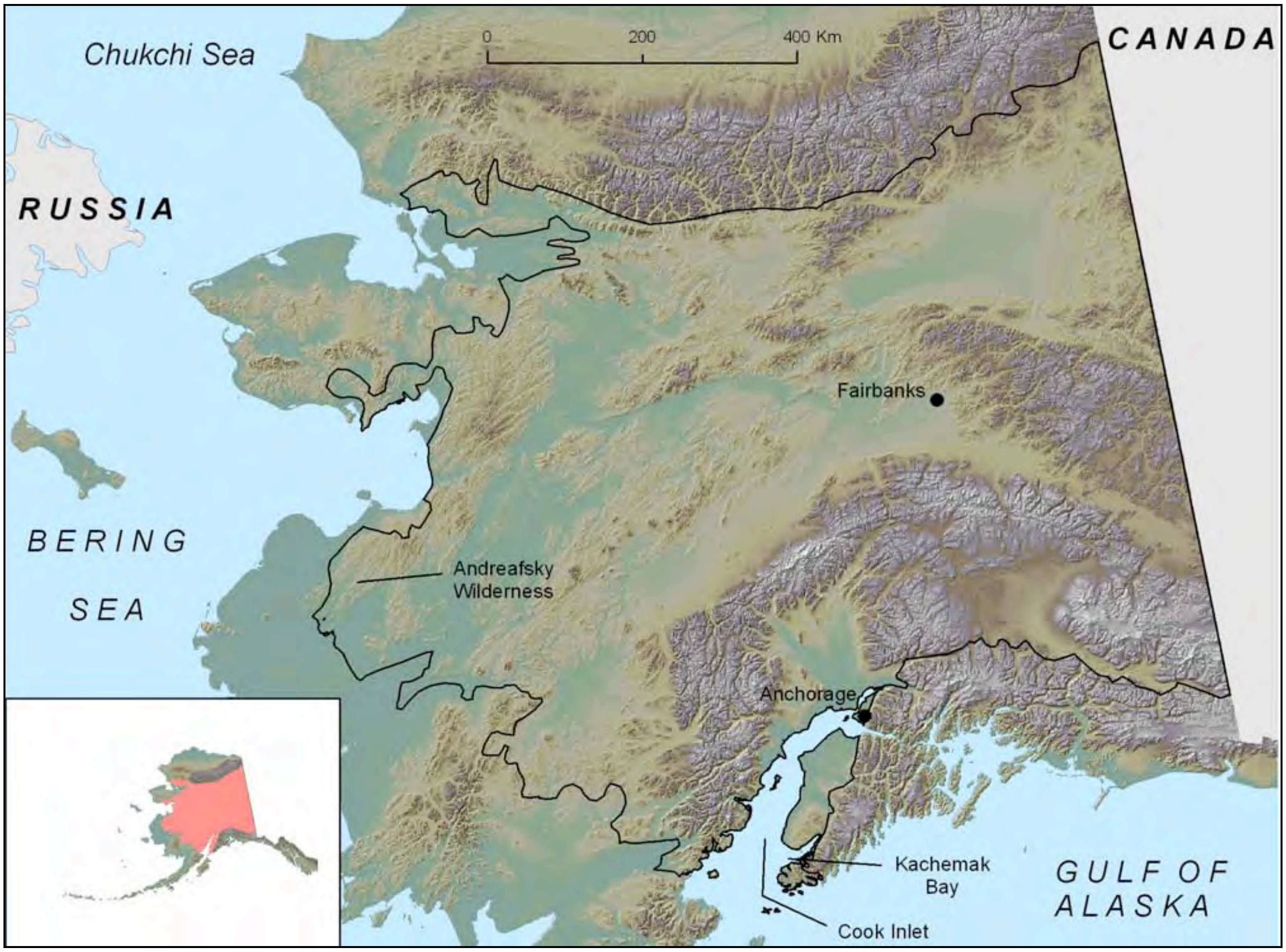
Actions

⇒ Assess the value of shorebird habitats along shipping and transportation lanes and at port sites to mitigate impacts on populations.

⇒ Develop models to assess the potential impact of spills of various sizes, locations, and time periods on shorebirds.

Researcher banding a Red Phalarope • Julie Morse

BCR 4: NORTHWESTERN INTERIOR FOREST



The Alaska portion of the vast Northwestern Interior Forest BCR extends from eastern Norton Sound in the west to the Alaska-Yukon Territory border in the east, and from the southern terminus of the Kenai Peninsula in the south to the southern foothills of the Brooks Range in the north. This largest of Alaska's BCRs is an extensive, 733,000-km^2 patchwork of diverse ecoregions including the Alaska Range, Cook Inlet Basin, Copper River Basin, Davidson Mountains, Kluane Range, Kobuk Ridges and Valleys, Kuskokwim Mountains, Lime Hills, North Ogilvie Mountains, Nulato Hills, Ray Mountains, Tanana-Kuskokwim Lowlands, Wrangell Mountains, Yukon River Lowlands, Yukon-Old Crow Basin, and Yukon-Tanana Uplands (Nowacki et al. 2001). Nearly one-third of this BCR is contained within state- and federally-managed lands, including portions of ten National Wildlife Refuges and seven National Parks (Appendix 2).

Cold winters and warm summers characterize the continental climate of most of the BCR. For example, in Fairbanks average minimum monthly temperatures in winter range between -27 and -21 °C, while in summer average monthly maximum temperatures range between 13° and 22°C. The Cook Inlet Basin ecoregion differs markedly from the rest of the BCR in climate because of the moderating maritime influence. In Anchorage, which borders the Inlet, average monthly minimum temperatures during winter range between -14° and -11° C; during summer, average monthly maximum temperatures range between 13° and 17° F.

Much of the interior BCR is a mosaic of vegetation communities, dominated by boreal forest, which have arisen from the interplay of elevation, aspect, permafrost, surface water, and fire. Needleleaf, deciduous, and mixed forests are all represented. Dominant species include white spruce (*Picea glauca*), black spruce (*P. mariana*), poplars (*Populus* spp.), and paper birch (*Betula papyrifera*). Tall shrub communities occur along rivers, drainages, and near treeline. Bogs, consisting of low shrubs and shrub-graminoid communities, are common in the lowlands. Alpine dwarf shrub communities are common throughout mountainous regions, while highest elevations are generally devoid of vegetation. The Cook Inlet region is characterized by vast expanses of intertidal habitats. Importantly, two-thirds of Alaska's human population resides in the Cook Inlet ecoregion.

PRIORITY SPECIES

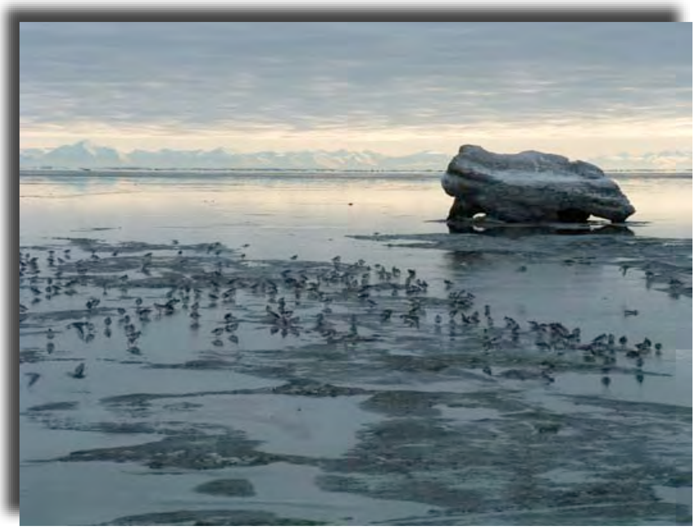
Table 7. Priority shorebird species that commonly breed, stage during migration, or winter in BCR 4 (see Table 2 for conservation priority scores).

Breeding	Migration	Winter
American Golden-Plover	Lesser Yellowlegs	Rock Sandpiper (*ptilocnemis*)
Solitary Sandpiper (*cinnamomea*)	Whimbrel (*rufiventris*)	
Lesser Yellowlegs	Hudsonian Godwit	
Upland Sandpiper	Sanderling	
Whimbrel (*rufiventris*)	Western Sandpiper	
Bristle-thighed Curlew	Dunlin (*pacifica*)	
Hudsonian Godwit	Short-billed Dowitcher (*caurinus*)	
Surfbird		
Short-billed Dowitcher (*caurinus*)		

Many shorebird species move among the ecoregions of this vast BCR. The wet or moist lowlands support multiple species of migrating and breeding shorebirds, including Spotted and Solitary sandpipers, Lesser Yellowlegs, Short-billed Dowitchers, and Wilson's Snipe. American Golden-Plovers, Wandering Tattlers, and Surfbirds are found in tundra habitats (the tattlers often associated with riparian areas) in the Interior's foothills and mountainous ecoregions (Johnson and Connors 1996, Senner and McCaffery 1997, Gill et al. 2002b). Cook Inlet is the primary wintering site for the nominate form of Rock Sandpiper (*C. p. ptilocnemis*), as well as a major spring stopover site for Western Sandpipers and Dunlin. Significant numbers of Hudsonian Godwits and Short- and Long-billed dowitchers also use upper Cook Inlet during migration (Gill and Tibbitts 1999).

IMPORTANT SHOREBIRD AREAS

The interior boreal forest and alpine biomes that constitute most of BCR 4 generally do not support the richness, diversity, or densities of breeding shorebirds found in the more productive coastal biomes to the south, west, and north. Nonetheless, the area does have several important shorebird areas of note. The southern Nulato Hills (including the Andreafsky Wilderness) supports an



Cook Inlet • Robert Gill, Jr.

estimated 60% of the world's breeding population of Bristle-thighed Curlews (Marks et al. 2002). During spring migration, Kachemak Bay's rich tidal mudflats support up to 200,000 shorebirds including substantial numbers of Western Sandpipers and more than 10% of the world's population of Surfbirds (G. West, pers. comm.). As such, Kachemak Bay has been designated as a site of international importance in the Western Hemisphere Shorebird Reserve Network. The vast expanses of intertidal habitats in Cook Inlet are a major spring stopover site for Western Sandpipers and Dunlin, as well as a primary wintering site for the nominate form of Rock Sandpiper (*C. p. ptilocnemis*). Upper Cook Inlet is also an important area during migration for Hudsonian Godwits, and Short- and Long-billed dowitchers (Gill and Tibbitts 1999).

PRIMARY CONSERVATION OBJECTIVES

There is relatively little information about the shorebirds of BCR 4. The combination of a vast region, limited access, and widely dispersed species makes it difficult to obtain basic information. One critical piece of data needed for effective conservation is for accurate population estimates of boreal-nesting shorebirds. Presently the best tool available for monitoring these species is the North American Breeding Bird Survey (BBS). However, the BBS has limited coverage in Alaska and is not optimized for shorebird detections. Similarly, while a substantial amount of work has been done to inventory shorebirds in some alpine and upland areas within BCR 4 (e.g., Kenai National Wildlife Refuge, and Denali, Lake Clark, Kobuk Valley, Yukon-Charley Rivers national parks and preserves), very little work is focused on monitoring breeding shorebirds in these habitats.

⇒ Develop and implement standardized methods for estimating densities of shorebirds in boreal forest and upland habitats.

⇒ Assess the feasibility of using the Alaska Landbird Monitoring Survey to monitor population trends of breeding shorebirds.

⇒ Promote and expand outreach efforts to elevate the profile of boreal forest and upland-nesting shorebirds.

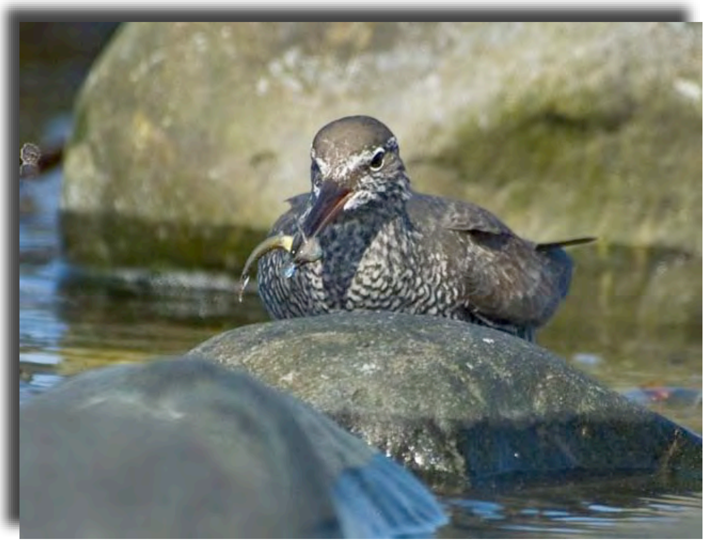
⇒ Assess the effects of climate change (e.g., wetland drying) on boreal forest shorebirds.

⇒ Develop habitat-based models to predict the occurrence and distribution of breeding shorebirds on areas that are difficult to access.

⇒ Assess the use of ephemeral habitats by migrant shorebirds and identify any important areas.

⇒ Assess shorebird use of Cook Inlet in winter.

PRIORITY CONSERVATION ISSUES AND ACTION



Wandering Tattler • Brian Guzzetti

ENERGY PRODUCTION AND MINING

Oil and Gas Production

With the recent increase in oil prices there has been renewed interest in coal-bed methane and natural gas production throughout BCR 4. The associated infrastructure of these developments reduces habitat, fragments remaining habitats, and increases the amount of human activity in previously inaccessible areas. Additionally, spills or industrial pollution at drilling sites can have deleterious effects on shorebirds throughout the year.

Nearly all of Cook Inlet is open to lease sales by either state or federal agencies, and most of the current energy production is concentrated in this region. Currently, 17 gas- and 7 oil-producing offshore fields occur within Cook Inlet along with large storage and sub-seabed transfer facilities, a refinery, and a urea-production plant. Additionally, millions of barrels of jet fuel are transported each year across the intertidal zone between the Port of Anchorage and the Anchorage International Airport via a new subsurface pipeline. Offshore production has occurred in this region since the late 1960s, thus aging production and transportation infrastructure poses an increased risk for spills. Additionally, facilities must withstand relatively frequent seismic events in this earthquake-prone region. A spill or persistent discharge from drilling platforms, transfer facilities, or pipelines would be harmful to the marine, estuarine, tidal, and intertidal environments. Powerful currents and ice floes that choke much of the Inlet in winter would hamper containment and cleanup efforts from a spill in this region. Significant numbers of wintering Rock Sandpipers, migrating Western Sandpipers and Dunlin, and breeding and migrating Solitary Sandpipers, Greater Yellowlegs, Lesser Yellowlegs, Hudsonian Godwits, and Short-billed Dowitchers use the Cook Inlet region (Gill and Tibbitts 1999).

Additional natural gas exploration licenses have been issued within BCR 4 in the Nenana Basin, Minto Flats State Game Refuge, and the Susitna Basin. The State is also evaluating a proposal to explore for coal-bed methane gas in an area of about 840 km^2 in the Healy Basin. Finally, an Alaska Native regional corporation is presently pursuing a land exchange with the Yukon Flats NWR to explore for oil and gas. Breeding shorebirds that could be affected by these developments include Semipalmated Plovers, Spotted and Solitary sandpipers, Lesser Yellowlegs, Whimbrels, Least Sandpipers, and Wilson's Snipe.

Actions

⇒ Monitor the status of the Rock Sandpipers wintering in Cook Inlet.

⇒ Assess the impacts of energy production on shorebird populations and evaluate options for mitigation.

Mining and Quarrying

Recent high prices of precious metals such as gold, nickel, platinum, and copper have spurred a boom in mineral exploration not seen since the early 1980s. Placer mining for gold makes up much of the region's small-scale mining activity. This technique affects entire watersheds by degrading riparian habitats, accumulating silt in downstream water bodies, and destroying permafrost in adjacent areas with heavy equipment use. Physical modification of the watershed may result in displacement of breeding and foraging shorebirds (primarily Wandering Tattlers, Spotted Sandpipers and Semipalmated Plovers); however, in some cases such activity may actually benefit populations. Indeed, some riparian corridors heavily disturbed by placer mining support some of the highest reported nesting densities of Wandering Tattlers (Gill et al. 2002b).

In addition to small-scale placer mines, large industrialized mines present a larger footprint and an increased risk of habitat loss and pollution to a larger area. Industrialized mines use extraction techniques that expose large areas to potentially catastrophic results. For example, cyanide is often used to leach microscopic amounts of gold out of hardrock and can diffuse into the adjacent groundwater. Contaminated sites may have broader effects on shorebirds and important habitats due to the persistence of contaminants in the environment or effects far from the point source. Currently there are three large industrial mines in BCR 4—Pogo, Fort Knox, and True North—and three large proposed mines— Pebble, Chuitna, and Donlin Creek. Additionally, the proposed MAN Alaska mining area (for nickel, platinum group elements, copper, gold) would include some 2,200 km^2 and is located in the Tangle Lakes region at the east end of the Denali Highway. The Chuitna Mine lies right in the heart of the area's Hudsonian Godwit breeding range, and the MAN proposed mine would affect important habitats for American Golden-Plovers and Whimbrels.

Actions

⇒ Identify important areas used by priority species and advocate for their protection.

⇒ Assess the impacts of mining on shorebird populations and evaluate options for mitigation.

⇒ Contribute biological expertise about shorebirds to groups planning new developments, and promote measures to mitigate impacts on important shorebird habitats.

⇒ Collaborate with stakeholders to promote industry environmental compliance.

CLIMATE CHANGE AND SEVERE WEATHER

Habitat Shifting and Alteration

Broad scale habitat changes have already been observed in the boreal forest due to climate change and more are predicted to occur. There has been a significant increase in mean winter annual temperature in the North American boreal forests over the last half century (Hinzman et al. 2005). Concomitant changes observed with the temperature increase include: an increase in shrubbiness across tundra habitats (Silapaswan et al. 2001, Stowe et al. 2003, Tape et al. 2006, Walker et al. 2006); reduction in size and number of waterbodies in wetland habitats (Klein et al. 2005, Riordan 2005); an increase in plant pathogens (aspen leaf miners, alder blight, spruce budworm, spruce bark beetle, sawflies; Werner et al. 2006); and a change in the severity of forest fires and the length of the fire season (Kasischke and Turetsky 2006). Additionally, the advancement of boreal forest into alpine areas has been documented at several alpine areas in BCR 4 (Lloyd 2005, Dial et al. 2007; but see Wilmking et al. 2004).

Of most immediate concern for shorebirds in BCR 4 is the drying of wetland habitats. In a study of drying trends from the 1950s to 2002, Riordan (2005) found a reduction in both the area and number of shallow, closed-basin ponds in all regions studied in Alaska's boreal forest region. The regional trend in shrinking ponds may be due to either increased drainage as the region's discontinuous permafrost warms or increased evapotranspiration as a result of warmer and extended growing seasons. Klein et al. (2005) documented a similar phenomenon on the Kenai Peninsula with the disappearance of kettle ponds and the invasion of black spruce into wetlands and muskeg. Changes in the overall abundance of wetland habitats will likely affect shorebird prey abundance and distribution. Drying of subarctic tundra and taiga could result in landscape-scale reduction of aquatic and semi-aquatic invertebrate populations. The degree to which the timing of shorebird breeding remains coupled to the life cycles of their prey is also of key importance, as shorebird hatch appears highly synchronized with peak availability of surface-active insects upon which the chicks depend (Holmes 1966, Schekkerman et al. 2003).

Further impacts of these habitat changes on shorebirds, particularly breeders, are difficult to predict. Tundra-breeding shorebirds in BCR 4 may be displaced northward or further upward in elevation, and squeezed into more fragmented habitats. The distribution and abundance of predators and parasites may also change in response to altered habitat and climatic conditions.

Actions

⇒ Develop models to assess the potential impacts of global climate change on shorebird distribution and population size in the region.

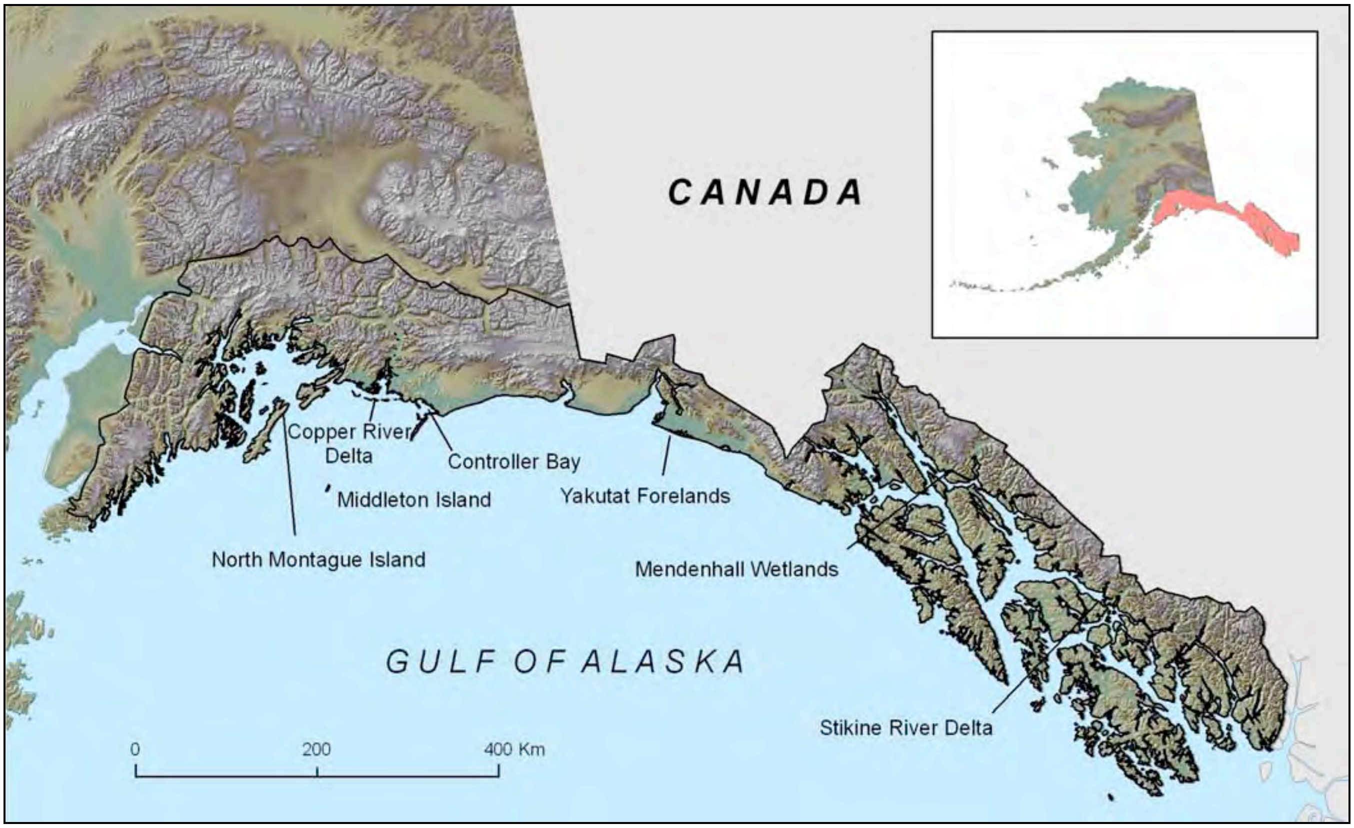
⇒ Monitor the impact of global climate change on wetlands and other habitats used by boreal- and upland-nesting shorebirds.

⇒ Encourage studies that examine the impact of drying wetland habitats on aquatic insect populations.

⇒ Assess the potential decoupling of chick hatch from the peak availability of aquatic insect populations.

Lesser Yellowlegs • Tom Van Pelt

BCR 5: NORTH PACIFIC RAINFOREST



The North Pacific Rainforest BCR extends from the southern extent of the southeastern Alaskan panhandle to the Kenai Peninsula. Approximately 1,500 km in length and 180 km in width, the region is bounded on the landward side by the Coast, St. Elias, Chugach, and Kenai mountain ranges and to the seaward side by the Pacific Ocean and Gulf of Alaska. The narrow mainland and more than 2,000 islands of the region encompass 167,000 km^2. Ecoregions within the BCR include the Alexander Archipelago, Boundary Ranges, Chugach-St. Elias Mountains, and Gulf of Alaska Coast (Nowacki et al. 2001). Over 75% of the BCR comprises public lands under the management of the state of Alaska, U.S. Fish and Wildlife Service, U.S. Forest Service, and the National Park Service; the majority of these lands are within the Tongass and Chugach national forests (Appendix 2).

The Pacific Ocean and steep coastal mountains strongly influence the climate of the BCR. Warm ocean currents, numerous storms originating from the Gulf of Alaska, and orographic lift produced by the region's coastal mountains produce high levels of precipitation and relatively mild temperatures that in turn shape the region's hydrology and diverse vegetation communities.

The largest system of temperate icefields and glaciers in North America occurs within the coastal mountains of this BCR; ice, snow, and rock still cover much of the higher elevations and interior portion of the region. Tundra habitats are prevalent above treeline. Temperate coniferous rainforest communities cover low elevations on the mainland and islands. Deciduous forests, shrublands, and freshwater wetlands are primarily associated with alluvial floodplains of large mainland river systems. Expansive tidal mudflats

and estuarine habitats occur on the deltas and outwash plains of large river systems, particularly those that transect the coastal mountains to drain vast regions of the interior. The region's long and rugged coastline includes extensive exposed and sheltered rocky intertidal shorelines and reefs.

PRIORITY SPECIES

Table 8. Priority shorebird species that commonly breed, stage during migration, or winter in BCR 5 (see Table 2 for conservation priority scores).

Breeding	Migration	Winter
Black Oystercatcher	Marbled Godwit (*beringiae*)	Black Oystercatcher
Short-billed Dowitcher (*caurinus*)	Black Turnstone	Black Turnstone
	Surfbird	Surfbird
	Red Knot (*roselaari*)	Rock Sandpiper (*ptilocnemis*)
	Western Sandpiper	
	Dunlin (*pacifica*)	
	Short-billed Dowitcher (*caurinus*)	

Twelve shorebird species are known or suspected to breed in the BCR. No species is particularly abundant; however, among the more widespread are Semipalmated Plover, Black Oystercatcher, Spotted Sandpiper, Greater Yellowlegs, Lesser Yellowlegs, Least Sandpiper, and Wilson's Snipe (Isleib and Kessel 1989, Andres and Browne 2007, Bishop 2007, Johnson et al. 2008). The vast majority of shorebirds that occur in the BCR are passage birds, which stop in the region en route to northern breeding areas. The deltas of the Copper, Bering, and Stikine rivers support millions of shorebirds during spring migration, including globally significant numbers of Western Sandpipers and Dunlin (*C. a. pacifica*; Bishop et al. 2000). Significant numbers of Marbled Godwits, Black Turnstones, Surfbirds, Red Knots, and Short-billed Dowitchers also migrate along the region's coast (Isleib and Kessel 1989, Norton et al. 1990, Andres and Browne 1998, Bishop and Green 1999, Warnock et al. 2001, Bishop 2007).

The timing, abundance, and distribution of shorebirds in the region during autumn migration are poorly studied (but see Bishop 2007). Depending on the area, substantial numbers of post-breeding and juvenile Western Sandpipers, Least Sandpipers, Pectoral Sandpipers, and dowitchers have been observed at the mouth of the Alsek River as well as the Copper and Stikine river deltas (Bishop 2007, Johnson et al. 2008). The more prolonged autumn migration period (in contrast to spring) makes it difficult to assess accurately the importance of the region to southbound migrants.

IMPORTANT SHOREBIRD AREAS

To date, a number of important areas critical to shorebirds have been identified in the region. Deltas of the Copper and nearby Bering River comprise vast intertidal mudflats and together form one of the most important shorebird concentration sites in the world (http://www.whsrn.org). In spring, as many as five million shorebirds stop there to forage and rest en route to breeding grounds (Bishop et al. 2000). Studies of spring migrants radio-tagged at Pacific Flyway sites south of Alaska have documented that 63% of Short-billed Dowitchers, 61–80% of Western Sandpipers, and >75% of Long-billed Dowitchers and Dunlin stop at the Copper/Bering river deltas (Warnock et al. 2001, 2004; Bishop et al. 2006). Substantial numbers of

Red Knots have also been documented (Bishop 2007, unpubl. data).

The Stikine River supports as many as three million shorebirds during spring migration (http://iba.audubon.org/iba) and is part of a network of coastal sites along the Pacific Coast that are critically important stopover sites for shorebirds, particularly Western Sandpipers (Bishop et al. 2006). The Stikine's vast mudflats and tidal marshes support well over 300,000 Western Sandpipers (Iverson et al. 1996).

The tidal mudflats, salt marsh, and barrier islands of Seal Creek-Ahrnklin River estuary, Yakutat Forelands, are an important spring stopover site for Marbled Godwits, Red Knots, Western Sandpipers, Dunlin, and Short-billed and Long-billed dowitchers (Andres and Browne 1998, 2007). Mendenhall Wetlands in southeastern Alaska, another noteworthy site, supports substantial numbers of shorebirds, including at least 1% of the estimated population of Surfbirds.

Middleton Island, in the Gulf of Alaska, supports the largest concentration of breeding Black Oystercatchers in Alaska (Gill et al. 2004), and eastern Prince William Sound supports a large proportion of southcentral Alaska's breeding population (Tessler et al. 2007). Montague Island in Prince William Sound is a spring stopover for more than 70% of the world's Surfbirds (P. Martin pers. comm. cited in Senner and McCaffery 1997) and thousands of Black Turnstones (Norton et al. 1990, Bishop and Green 1999).

Glacier Bay, in southeastern Alaska, supports a large number of breeding oystercatchers and Geike Inlet, in lower Glacier Bay, is an important autumn staging site for the species (van Vliet 2005). Black Oystercatchers, Black Turnstones, Rock Sandpipers, and Surfbirds occur on shorelines year-round throughout the region.

PRIMARY CONSERVATION OBJECTIVES

Most shorebirds that occur in the region are restricted to a few sites, so conservation objectives and efforts should focus on these locations.

⇒ Continue monitoring shorebird populations and their habitats on the Copper/Bering and Stikine river deltas and other regional stopover sites.

⇒ Monitor survival and other vital rates of Black Oystercatchers.

⇒ Develop a breeding habitat suitability model for Black Oystercatchers to help target survey efforts and to improve estimates of global population size.

⇒ Assess nonbreeding distribution of Black Oystercatchers and the migratory connectivity between the breeding and wintering areas.

⇒ Implement spring migration monitoring programs for Surfbirds and Black Turnstones, including estimates of the numbers of each species that occur in the region.

⇒ Estimate numbers of Red Knots during spring migration at sites where the species is known to occur (e.g., Copper River Delta and Yakutat Forelands). Conduct an intensive spring survey of the Stikine River Delta to determine whether the species occurs there and, if so, in what numbers.

⇒ Promote and expand flyway-wide educational efforts in the Pacific Basin.

Priority Conservation Issues and Actions

Recreation and Work in Natural Habitats

Tourism is the largest growing industry in Alaska, and is concentrated in south-central and southeastern coastal areas. Increases in marine-centered recreational activities in areas where Black Oystercatchers nest is one of this region's greatest conservation concerns. Black Oystercatchers typically nest close to the high tide line and are therefore extremely vulnerable to flooding events (Andres and Faxla 1995). Growing visitation by private boats, sightseeing vessels, water taxis, and cruise ships heightens the probability that oystercatcher nests will be flooded by large wakes, especially when vessel traffic coincides with periods of the high tides. Marine motorized vehicles can flood nests, lower hatching success, and increase chick mortality. Areas of dense nesting activity (e.g., Harriman Fjord in Prince William Sound, Beardslee Islands in Glacier Bay) are of particular concern relative to such flooding.

Recreational activities in coastal Alaska also often coincide with the chick-rearing period of Black Oystercatchers (Morse et al. 2006). Gravel beaches where oystercatchers tend to nest and raise chicks are often popular campsites, so onshore recreational activity can interfere with parental care or foraging. Of greater concern are the indirect effects human disturbance can have on oystercatcher productivity through predation, which is the primary cause of oystercatcher nest failures (Morse et al. 2006). Increased human activity can attract scavengers (i.e., [*Ursus* spp.], mink [*Mustela vison*]) inflating the number of natural shorebird predators in a region.

Semipalmated Plover • Milo Burcham

Actions

⇒ Determine the indirect effects of human-induced disturbance on oystercatcher reproductive success by examining the effects of recreational disturbance on predators.

⇒ Examine the effects of vessel wakes on oystercatcher productivity and develop spatially-explicit management recommendations on maximum vessel size and speed in high traffic areas.

⇒ Work with National Park Service and U.S. Forest Service to develop site-management plans for high-use campsites in Kenai Fjords, Glacier Bay, and Prince William Sound to minimize effects on breeding oystercatchers.

POLLUTION

Shorebirds are vulnerable to oil pollution through both oiling of feathers and the transfer of hydrocarbons through the food chain (see Martin 1994). Shorebird diets are dominated by invertebrates such as bivalves, amphipods, mysids, and polychaetes, organisms that are sensitive to contaminants present in petroleum-based products (Peterson 2001). Increased commercial and recreational vessel traffic in the region can also cause chronic, low-level exposure to diesel fuel and gas absorbed into porous shorelines. The impact on shorebirds of chronic low-level exposure is unknown, but cumulative detrimental effects have been demonstrated in other shoreline-obligate species (e.g., sea otters, eiders; Peterson 2001). As such, these effects warrant consideration with respect to the region's shorebirds.

Within BCR 5, Prince William Sound and the Copper/Bering river deltas both host high numbers of shorebirds and are particularly vulnerable to oil spills. The Trans-Alaska oil pipeline crosses six major tributaries of the Copper River. A breach of the pipeline at one of these sites would pose a severe threat to the ecology of the Copper River Delta. Offshore, the most serious potential pollution threats to the Copper River Delta and Flats include a powered oil-tanker grounding at Hinchinbrook Entrance or a loss of tanker power in the Gulf of Alaska during inclement weather. In addition, on the eastern side of the Delta near Katalla, future onshore oil and gas exploration and coal mining could trigger an increase in shipping activities and heighten the risk of an oil spill. The magnitude of any spill's impact on shorebirds would vary seasonally and would be most catastrophic during peak shorebird migration. Spill effects, however, would likely be long-term due to stranding and scouring of oil as a result of storm and tidal action on the Delta.

The Trans-Alaska pipeline terminates at the Alyeska oil terminal in the city of Valdez on Prince William Sound. In 2003, the terminal handled over 900,000 barrels of oil transported by 39 tankers per month. These tankers, with capacities ranging up to 1.9 million barrels each, travel through Prince William Sound and into the Gulf of Alaska en route to refineries along the west coast of the U.S. Montague Island, an historically important spring stopover area for Surfbirds and Black Turnstones, borders Hinchinbrook Entrance, the shipping lane used by oil tankers going to and from the oil terminal. Northern Montague Island's close proximity to the tanker lane (<6 km) makes this area especially vulnerable to pollution events.

The 1989 *Exxon Valdez* oil spill in Prince William Sound had a major impact on breeding oystercatchers, killing 20% of the population in the spill area outright, and disrupting breeding activity and decreasing chick survival in subsequent years (Andres 1994, 1997). Elevated hydrocarbon concentrations were detected in the feces of some chicks four years after the spill (Andres 1997). In a 2004 study, liver biopsies of oystercatchers nesting in oiled areas of Prince William Sound showed evidence of continued ingestion via trophic uptake (J. Bodkin, pers. comm.).

Spring stopover behavior of Surfbirds and Black Turnstones in Prince William Sound may also be shifting as a result of the 1989 oil spill. Studies between 1989 and 1995 at Montague Island documented the importance of Pacific herring spawn in the diet of Surfbirds and Black Turnstones (Norton et al. 1990, Martin 1994, Bishop and Green 2001). The *Exxon Valdez* oil spill had immediate impacts on herring stocks, and the herring population in Prince William Sound subsequently suffered a spectacular collapse (Carls et al. 2002). The extent to which the oil spill was responsible for the population crash is unclear (Carls et al. 2002, Thorne and Thomas 2008), but certain fish and birds in Prince William Sound continue to be exposed to *Exxon Valdez* oil spill-derived petroleum hydrocarbons (Peterson et al. 2003). Furthermore, the decrease in adult herring in Prince William Sound resulted in a decrease in herring spawn. Thus, shorebirds may suffer both acute (i.e., immediate mortality, decreased food abundance) and chronic (i.e., persistent exposure to petroleum hydrocarbons) effects relating to events like the *Exxon Valdez* oil spill (Peterson et al. 2003).

Other potential developments that could affect shorebird populations include mining and other resource extraction near the headwaters of the Stikine River Delta and on the Yakutat Forelands.

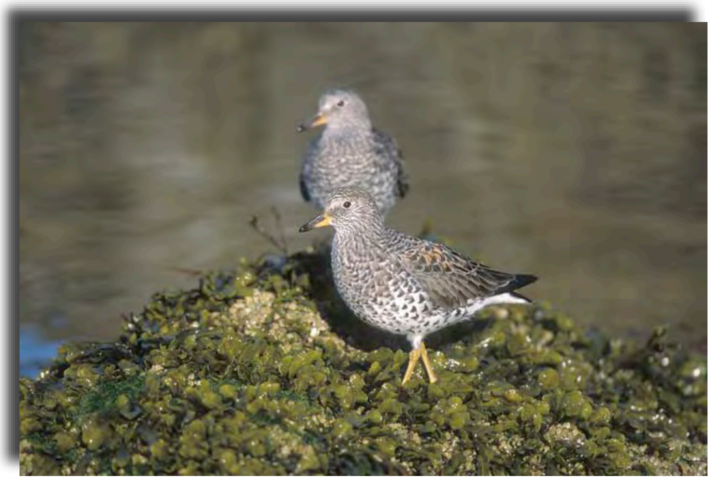
Actions

⇒ Identify areas in BCR 5 with large concentrations of Black Oystercatchers, Surfbirds, and Black Turnstones.

⇒ Identify characteristics of Black Oystercatcher nest sites that potentially increase risk of exposure to marine-derived pollution.

⇒ Review oil spill response plans to ensure that shorebird conservation concerns are addressed.

⇒ Document Surfbird and Black Turnstone foraging habits in Prince William Sound including their response to changes in extent and availability of Pacific herring spawn.



Surfbirds • Milo Burcham

⇒ Assess potential impacts of mining and other resource extraction on shorebirds on the Stikine River Delta and Yakutat Forelands.

CLIMATE CHANGE AND SEVERE WEATHER

Storms and Flooding

Global sea levels are predicted to rise on the order of one-half meter over the 21st century (IPCC 2007). The magnitude of mean sea level rise in BCR 5, however, is uncertain due to the offsetting effects of sedimentation, isostatic rebound, and tectonic uplift. Increases in the frequency and magnitude of storm events are predicted to occur with global climate change and could negatively affect oystercatchers in two ways. More frequent or intense winter storms could increase mortality of adults and juveniles, and summer storms could reduce productivity as a consequence of waves and storm surges flooding nests.

The composition and abundance of invertebrate communities could change with increases in ocean temperatures and fresh water inputs due to glacial melt. Furthermore, increased ocean temperatures could increase the likelihood of harmful algal blooms; such harmful algal blooms have been implicated in die-offs of African Black Oystercatchers (*Haematopus maquini*; Hockey and Cooper 1980) and nonbreeding Red Knots (H. Sitters, pers. comm.).

Actions

⇒ Develop models to examine the potential impacts of changing environmental conditions (e.g., sea level rise, storm severity) on habitats used by shorebirds during breeding and migration.

⇒ Participate in collaborative projects to examine the impact of warming sea temperatures on marine invertebrate communities.

LITERATURE CITED

Alaska Shorebird Group. 2003. Alaska Shorebird Group Terms of Reference. Available at http://alaska.fws.gov/mbsp/mbm/shorebirds/pdf/ASG_Terms_of_Reference_Feb03.pdf (accessed May 2008).

Alaska Shorebird Working Group. 2000. A Conservation Plan for Alaska Shorebirds. Unpublished report, Alaska Shorebird Working Group. Available through U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska. 47 pp.

Alerstam, T., J. Bäckman, G. Gudmundsson, A. Hedenström, S. Henningsson, H. Karlsson, M. Rosén, and R. Strandberg. 2007. A polar system of intercontinental bird migration. Proc. R. Soc. Lond. B 274:2523–2530.

American Ornithologists' Union. 1983. Checklist of North American birds. 7th ed. American Ornithologists' Union, Washington, DC.

Andres, B. A. 1994. Coastal zone use by postbreeding shorebirds in northern Alaska. J. Wildl. Manage. 58:206–213.

Andres, B. A. 1997. The *Exxon Valdez* oil spill disrupted the breeding of Black Oystercatchers. J. Wildl. Manage. 61:1322–1328.

Andres, B. A. 1998. Shoreline habitat use of Black Oystercatchers breeding in Prince William Sound, Alaska. J. Field Ornithol. 69:626–634.

Andres, B. A., and B. T. Browne. 1998. Spring migration of shorebirds on the Yakutat Forelands, Alaska. Wilson Bull. 110:326–331.

Andres, B. A., and B. T. Browne. 2007. The birds of Yakutat, Alaska. Technical Paper R10–TP–141. USDA Forest Service, Yakutat, AK. 92 pp.

Andres, B. A., and G. A. Falxa. 1995. Black Oystercatcher. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology; Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Anthony, R. G., M. W. Miles, J. A. Estes, and F. B. Isaacs. 1999. Productivity, diets, and environmental contaminants in nesting Bald Eagles from the Aleutian Archipelago. Environ. Tox. Chem. 18:2054–2062.

Bailey, R. G., P. E. Avers, T. King, and W. H. McNab (Eds.). 1994. Ecoregions and subregions of the United States. USDA Forest Service, Washington, DC.

Baker, A. J., P. M. Gonzalez, T. Piersma, L. J. Niles, I. de Lima Serrano do Nascimento, P. W. Atkinson, N. A. Clark, C. D. T. Minton, M. Peck, and G. Aarts. 2004. Rapid population decline in Red Knots: Fitness consequences of refueling rates and late arrival in Delaware Bay. Proc. R. Soc. Lond. B 271:875–882

Bart, J., B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. Jones, R. I. G. Morrison, and S. Skagen. 2005. The Program for Regional and International Shorebird Monitoring (PRISM). Pp. 893–901 *in* C. J. Ralph and T. D. Rich (Eds.), Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, March 20–24, 2004, Asilomar, California. Vol. 2. USDA Forest Service Gen. Tech. Rep. PSW–GTR–191.

Bart, J., S. Brown, B. Harrington, and R. I. G. Morrison. 2007. Survey trends of North American shorebirds: Population declines or shifting distributions? J. Avian Biol. 38:73–82.

Bart, J., and S. Earnst. 2002. Double sampling to estimate density and population trends in birds. Auk 119:36–45.

Barter, M. A. 2002. Shorebirds of the Yellow Sea: Importance, threats and conservation status. Wetlands International Global Series 9, International Wader Studies 12, Canberra, Australia.

Barter, M. 2003. The Yellow Sea—a race against time. Wader Study Group Bull. 100:111–113.

Bengtsson, L., K. Hodges, and E. Roecker. 2006. Storm tracks and climate change. J. Climate 19:3518–3543.

Bird Life International. 2008. Waterbird conservation for the Americas. Country-specific reports available at www.birdlife.org/action/science/species/waterbirds/download.html (accessed October 2008).

Bishop, M.A. 2007. Monitoring migrant and breeding shorebirds on barrier island beaches of the Copper River Delta, Alaska. Final Report to Alaska Dept. Fish Game, Nongame Program, Anchorage, AK. 81 pp.

Bishop, M. A., and S. P. Green. 1999. Sound Ecosystem Assessment (SEA): Avian predation on herring spawn in Prince William Sound. *Exxon Valdez* Oil Spill Restoration Project final report (Restoration Project 96320-Q). Copper River Delta Institute, Cordova, Alaska and Center for Streamside Studies, University of Washington. 78 pp.

Bishop, M. A., and S. P. Green. 2001. Predation of Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. Fish. Oceanogr. 10:149–158.

Bishop, M. A., P. M. Meyers, and P. F. McNeley. 2000. A method to estimate shorebird numbers on the Copper River Delta, Alaska. J. Field Ornithol. 71:627–637.

Bishop, M. A., N. Warnock, and J. Y. Takekawa. 2006. Spring migration patterns in Western Sandpipers *Calidris mauri*. Pp. 545–550 *in* G. C. Boere, C. A. Galbraith, and D. A. Stroud (Eds.). Waterbirds around the World. The Stationery Office, Scotland Ltd., Edinburgh, UK.

Boere, G. C., and D. A. Stroud. 2007. The flyway concept: What it is and what it isn't. Pp. 40–47 *in* G. C. Boere, C. A. Galbraith, and D. A. Stroud (Eds.). Waterbirds around the World. The Stationery Office, Scotland Ltd., Edinburgh, UK.

Boland, J. M. 1991. An overview of the seasonal distribution of North American shorebirds. Wader Study Group Bull. 62:39–42.

Brayshaw, D. 2005. Storm tracks and climate change. The University of Reading, Reading, UK. Available at http://www.met.rdg.ac.uk/~sws06djb/bern2005/StormTrackCC.pdf (accessed May 2008).

Brown, S., J. Bart, R. B. Lanctot, J. Johnson, S. Kendall, D. Payer, and J. Johnson. 2007. Shorebird abundance and distribution on the coastal plain of the Arctic National Wildlife Refuge. Condor 109:1–14.

Brown, S., C. Hickey, B. Gill, L. Gorman, C. Gratto-Trevor, S. Haig, B. Harrington, C. Hunter, G. Morrison, G. Page, P. Sanzenbacher, S. Skagen, and N. Warnock. 2000. National Shorebird Conservation Assessment: Shorebird Conservation Status, Conservation Units, Population Estimates, Population Targets, and Species Prioritization. Manomet Center for Conservation Sciences. Available at: http://www.Manomet.org/USSCP/files.htm (accessed June 2008).

Brown, S., C. Hickey, B. Harrington, and R. E. Gill, Jr. (Eds.). 2001. United States Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Bucher, E. H., and M. Nores. 1988. Steppe and savanna birds from Argentina. ICBP Tech. Publ. 7:71–79.

Burgess, R. M., J. R. Rose, P. W. Banyas, and B. E. Lawhead. 1993. Arctic fox studies in the Prudhoe Bay Unit and adjacent undeveloped areas, 1992. Unpublished final report prepared for BP Exploration (Alaska), Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK. 16 pp.

Byrd, G. V. 1998. Current breeding status of the Aleutian Canada goose, a recovering endangered species. Pp 21–28 *in* D. H. Rusch, M. D. Samuel, D. D. Humburg, and B. D. Sullivan (Eds.). Biology and Management of Canada Geese. Proceedings of the International Canada Goose Symposium, Milwaukee, WI.

Byrd, G. V., E. P. Bailey, and W. Stahl. 1997. Restoration of island populations of Black Oystercatchers and Pigeon Guillemots by removing introduced foxes. Colonial Waterbirds 20:253–260.

Canevari, M., P. Canevari, G. R. Carrizo, G. Harris, J. R. Mata, and R. J. Straneck. 1991. Nueva guia de las aves Argentinas. Vol. 1. Fundacion Acindar, Buenos Aires, Argentina.

Carls, M. G., G. D. Marty, and J. E. Hose. 2002. Synthesis of the toxicological impacts of the *Exxon Valdez* oil spill on Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska, U.S.A. Can. J. Fish. Aquat. Sci. 59:153–172.

Commission for Environmental Cooperation. 1998. Ecological regions of North America. Secretariat for the Comm. Environ. Coop., Montreal, Canada. 8 pp.

Committee for Holarctic Shorebird Monitoring (CHASM). 2004. Monitoring Arctic-nesting Shorebirds: An International Vision for the Future. Conclusions from The Pan-Arctic Shorebird/Wader Monitoring and Research Workshop, Denmark, 3–6 December 2003. CHASM Publication No. 1.

Conover, H. B. 1944. The North Pacific allies of the Purple Sandpiper. Field Mus. Nat. Hist. Zool. Ser. 29.

Day, R. H. 1998. Predator populations and predation intensity on tundra-nesting birds in relation to human development. Unpublished report prepared for Northern Alaska Ecological Services, U.S. Fish and Wildlife Service, Fairbanks, AK, by ABR, Inc., Fairbanks, AK. 106 pp.

Dial, R. J., E. E. Berg, K. Timm, A. McMahon, and J. Geck. 2007. Changes in the alpine forest-tundra ecotone commensurate with recent warming in southcentral Alaska: Evidence from orthophotos and field plots. J. Geophys. Res. 112(g4):G04015.

Donaldson, G., C. Hyslop, G. Morrison, L. Dickson, and I. Davidson (Eds.). 2000. Canadian Shorebird Conservation Plan. Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 27 pp.

Duffy, D. C., K. Boggs, R. H. Hagenstein, R. Lipkin, and J. A. Michaelson. 1999. Landscape assessment of the degree of protection of Alaska's terrestrial biodiversity. Conserv. Biol. 13:1332–1343.

Eberhardt, L. E., R. A. Garrot, and W. C. Hanson. 1983. Den use by arctic foxes in northern Alaska. J. Mamm. 64:97–102.

Elphick, C. S., and J. Klima. 2002. Hudsonian Godwit. *In* A. Poole (Ed.)., The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Engelmoer, M., and C. Roselaar. 1998. Geographical Variation in Waders. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Erwin, C. A., K. B. Rozell, and L. B. DeCicco. 2004. Update on the status and distribution of Wilson's Phalarope and Yellow-bellied Sapsucker in Alaska. Western Birds 35:42–44.

Fay, F. H., and T. J. Cade. 1959. An ecological analysis of the avifauna of St. Lawrence Island, Alaska. Univ. Calif. Publ. Zool. 63:73–150.

Fernández, G., N. Warnock, D. L. Lank, and J. B. Buchanan. 2006. Conservation Plan for the Western Sandpiper, Version 1.1. Manomet Center for Conservation Science, Manomet, MA.

Friedmann, H. 1932. The birds of St. Lawrence Island, Bering Sea. U.S. Nat. Hist. Mus. Proc. 80:1–31.

Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby. 1995. Ecoregions of Alaska. U.S. Geological Survey Prof. Pap. 1567, Washington, DC. 73 pp.

Gibson, D. D., and G. V. Byrd. 2007. Birds of the Aleutian Islands, Alaska. Series in Ornithology No. 1, Nuttall Ornithological Club, Cambridge, MA, and American Ornithologists' Union, Washington, DC.

Gibson, D. D., S. C. Heinl, and T. G. Tobish. 2004. Checklist of Alaska birds. University of Alaska Museum, Fairbanks.

Gibson, D. D., and B. Kessel. 1989. Geographic variation in the Marbled Godwit and description of an Alaska subspecies. Condor 91:436–443.

Gibson, D. D., and B. Kessel. 1997. Inventory of the species and subspecies of Alaska birds. West. Birds 28:45–95.

Gill, R. E., Jr. 1998. Trouble in Paradise: The Bristle-thighed Curlew. WWF Arctic Bull. 3:12–13.

Gill, R. E., Jr., R. W. Butler, P. S. Tomkovich, T. Mundkur, and C. M. Handel. 1994. Conservation of North Pacific Shorebirds. Trans. N. Am. Wildl. Nat. Res. Conf. 59:63–78.

Gill, R. E., Jr., and C. M. Handel. 1981. Shorebirds of the Eastern Bering Sea. Pp. 719–730 *in* D.W. Hood and J. A. Calder (Eds.). Eastern Bering Sea Shelf: Oceanography and Resources, Vol. 2. Office of Marine Pollution Assessment., NOAA. Univ. of Washington Press, Seattle, WA.

Gill R. E., Jr., and C. M. Handel. 1990. The importance of subarctic intertidal habitats to shorebirds: A study of the central Yukon-Kuskokwim Delta, Alaska. Condor 92:702–725.

Gill, R. E., Jr., and P. D. Jorgensen. 1979. Preliminary assessment of timing and migration of shorebirds along the northcentral Alaska Peninsula. Stud. Avian Biol. 2:113–123.

Gill, R. E., B. J. McCaffery, and P. S. Tomkovich. 2002a. Rock Sandpiper. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Gill, R. E., Jr., B. J. McCaffery, and P. S. Tomkovich. 2002b. Wandering Tattler. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Gill, R. E., Jr., M. R. Petersen, and P. D. Jorgensen. 1981. Birds of the northcentral Alaska Peninsula, 1976–1980. Arctic 34:286–306.

Gill, R. E., Jr., and S. E. Senner. 1996. Alaska and its importance to Western Hemisphere shorebirds. Internat. Wader Stud. 8:8–14.

Gill, R. E., Jr., and T. L. Tibbitts. 1999. Seasonal shorebird use of intertidal habitats in Cook Inlet, Alaska. Unpublished final report. U.S. Department of Interior, U.S. Geological Survey, Biological Resources Division and OCS Study, MMS 99–0012, Anchorage, AK.

Gill, R. E., Jr., T. L. Tibbitts, D. C. Douglas, C. M. Handel, D. M. Mulcahy, J. C. Gottschalck, N. Warnock, B. J. McCaffery, P. F. Battley, and T. Piersma. *In press*. Extreme endurance flights by landbirds crossing the Pacific Ocean: Ecological corridor rather than barrier? Proc. R. Soc. Lond. B. doi: 10.1098/rspb.2008.1142.

Gill, V. A., S. A. Hatch, and R. B. Lanctot. 2004. Colonization, population growth and nesting success of Black Oystercatchers following a seismic uplift. Condor 106:791–800.

Gould, J. 1988. A comparison of avian and mammalian faunas at Lake Hazen, Northwest Territories, in 1961–62 and 1981–82. Can. Field-Nat. 102:666–670.

Graham, N., and H. Diaz. 2001. Evidence for intensification of North Pacific winter cyclones since 1948. Bull. Am. Meteor. Soc. 82:1869–1893.

Gratto-Trevor, C. 1994. Monitoring shorebird populations in the arctic. Bird Trends 3:10–12.

Gratto-Trevor, C. L., V. H. Johnston, and S. T. Pepper. 1998. Changes in shorebird and eider abundance in the Rasmussen Lowlands, NWT. Wilson Bull. 110:316–325.

Gratto-Trevor, C. L., V. H. Johnston, and S. T. Pepper. 2001. Evidence for declines in Arctic populations of shorebirds. Bird Trends 8:27–29.

Haig, S. M., C. L. Gratto-Trevor, T. D. Mullins, and M. A. Colwell. 1997. Population identification of western hemisphere shorebirds throughout the annual cycle. Molecular Ecology 6: 413–427.

Handel, C. M., and C. P. Dau. 1988. Seasonal occurrence of migrant Whimbrels and Bristle-thighed Curlews on the Yukon-Kuskokwim Delta, Alaska. Condor 90:782–790.

Handel, C. M., and R. E. Gill, Jr. 1992. Breeding distribution of the Black Turnstone. Wilson Bull. 104:122–135.

Handel, C. M., and R. E. Gill, Jr. 2002. Black Turnstone. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed September 2008).

Handel, C. M., B. J. McCaffery, R. B. Lanctot, and G. Peltola. 1990. Distribution and population estimate of breeding Bristle-thighed Curlews. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK.

Hickey, C., W. D. Shuford, G. W. Page, and S. Warnock. 2003. The Southern Pacific Shorebird Conservation Plan: A Strategy for Supporting California's Central Valley and Coastal Shorebird Populations. Version 1.1. PRBO Conservation Science, Stinson Beach, CA.

Hinzman, L. D., N. D. Bettez, W. R. Bolton, F. S. Chapin, M. B. Dyurgerov, C. L. Fastie, B. Griffith, R. D. Hollister, A. Hope, H. P. Huntington, A. M. Jensen, G. J. Jia, T. Jorgenson, D. L. Kane, D. R. Klein, G. Kofinas, A. H. Lynch, A. H. Lloyd, A. D. McGuire, F. E. Nelson, M. Nolan, W. C. Oechel, T. E. Osterkamp, C. H. Racine, V. E. Romanovsky, R. S. Stone, D. A. Stow, M. Sturm, C. E. Tweedie, G. L. Vourlitis, M. D. Walker, D. A. Walker, P. J. Webber, J. Welker, K. S. Winker, and K. Yoshikawa. 2005. Evidence and implications of recent climate change in northern Alaska and other arctic regions. Climatic Change 72:251–298.

Hockey, P. A. R., and J. Cooper. 1980. Paralytic shell-fish poisoning—a controlling factor in Black Oystercatcher populations? Ostrich 51:188–190.

Holmes, R. T. 1966. Feeding ecology of the Red-backed Sandpiper (*Calidris alpina*) in arctic Alaska. Ecology 47:32–45.

Holmes, R. T. 1970. Differences in population density, territoriality, and food supply of Dunlin on arctic and subarctic tundra. Pp. 303–319 *in* A. Watson (Ed.), Animal Populations in Relation to their Food Resources. Oxford Univ. Press, Oxford.

Holmes, R. T. 1972. Ecological factors influencing the breeding season schedule of Western Sandpipers (*Calidris mauri*) in subarctic Alaska. Am. Midl. Nat. 87:472-497.

Houston, C. S., and D. E. Bowen, Jr. 2001. Upland Sandpiper. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Howe, M. A., P. H. Geissler, and B. A. Harrington. 1989. Population trends of North American shorebirds based on the International Shorebird Survey. Biol. Conserv. 49:185–199.

Institute of Social and Economic Research. 2006. Understanding Alaska: People, Economy, and Resources. Institute of Social and Economic Research, University of Alaska, Anchorage. Available at http://alaskaneconomy.uaa.alaska.edu/Publications/UA_summ06_04size.pdf (accessed May 2008).

International Wader Study Group. 2003. Waders are declining worldwide: Conclusions from the 2003 International Wader Study Group Conference, Cádiz, Spain. Wader Study Group Bull. 101/102:8–12.

IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z.

Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (Eds.). Cambridge University Press, Cambridge, UK and New York, NY. 996 pp.

Isleib, M. E., and B. Kessel. 1989. Birds of the North Gulf Coast – Prince William Sound Region, Alaska. University of Alaska Press, Fairbanks, AK.

Iverson, G. C., S. E. Warnock, R. W. Butler, M. A. Bishop, and N. Warnock. 1996. Spring migration of Western Sandpipers along the Pacific Coast of North America: A telemetry study. Condor 98:10–21.

Jehl, J. R., Jr., J. Klima, and R. E. Harris. 2001. Short-billed Dowitcher (*Limnodroma griseus*). *In* A. Poole (Ed.), The Birds of North America Online, Cornell Lab of Ornithology, Ithaca, NY. Available at http://bna.birds.cornell.edu/bna/species/564 (accessed 30 May 2008).

Johnson, J. A., B. A. Andres, and J. A. Bissonette. 2008. Birds of the major mainland rivers of Southeast Alaska. Gen. Tech. Rep. PNW–GTR–739. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 87 pp.

Johnson, J. A., R. B. Lanctot, B. A. Andres, J. R. Bart, S. C. Brown, S. J. Kendall, and D. C. Payer. 2007. Distribution of breeding shorebirds in the Arctic Coastal Plain of Alaska. Arctic 60:277–293.

Johnson, O. W. 2003. Pacific and American Golden-Plovers: Reflections on conservation needs. Wader Study Group Bull. 100:10–13.

Johnson, O. W., and P. G. Connors. 1996. American Golden-Plover, Pacific Golden-Plover. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Johnson, S. R., and D. R. Herter 1989. The Birds of the Beaufort Sea. BP Exploration (Alaska), Inc., Anchorage, AK.

Jorgenson, T., E. Pullman, and Y. Shur. 2003. Degradation of ice wedges in northern Alaska in response to recent warmer temperatures. Search Open Science Meeting: Presentation and Poster Abstracts, 27–30 Oct., Seattle, WA. ARCUS, Fairbanks, AK. Available at: http://siempre.arcus.org/4DACTION/wi_pos_displayAbstract/7/703///IZ/Presentation (accessed June 2008).

Kasischke, E., and M. R. Turetsky. 2006. Recent changes in the fire regime across the North American boreal region – Spatial and temporal patterns of burning across Canada and Alaska. Geophys. Res. Lett. 33:L09703.

Kessel, B. 1979. Avian habitat classification for Alaska. Murrelet 60:86–94.

Kessel, B., and D. D. Gibson. 1978. Status and distribution of Alaska birds. Stud. Avian Biol. 1.

Klein, D. R. 1968. The introduction, increase, and crash of reindeer on St. Matthew Island. J. Wildl. Manage. 32:350–367.

Klein, E., E. E. Berg, and R. Dial. 2005. Wetland drying and succession across the Kenai Peninsula lowlands, south-central Alaska. Can. J. For. Res. 35:1931–1941.

Lanctot, R. B., D. E. Blanco, R. A. Dias, J. P. Isacch, V. A. Gill, J. B. Almeida, K. Delhey, P. F. Petracci, G. A. Bencke, and R. A. Balbueno. 2002. Conservation status of the Buff-breasted Sandpiper: Historic and contemporary distribution and abundance in South America. Wilson Bull. 114:44–72.

Lanctot, R. B., and C. D. Laredo. 1994. Buff-breasted Sandpiper. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Liebezeit, J. R., and S. W. Zack. 2006. Breeding bird diversity, density, nesting success and nest predators in the Olak region of the Teshekpuk Lake Special Area. Annual reports to the North Slope Borough, U.S. Fish and Wildlife Service, and Bureau of Land Management. Wildlife Conservation Society, Bozeman, MT.

Lloyd, A. H. 2005. Ecological histories, ecological futures: What recent changes at treeline reveal about the future. Ecology 86:1687–1695.

Maclean, S. F. 1980. The detritus-based ecosystem. Pp. 411–457 *in* J. Brown, P. C. Miller, L. L. Tieszen, and F. L. Bunnell (Eds.). An Arctic Ecosystem: The Coastal Tundra at Barrow, Alaska. U.S./IBP synthesis series, 12. Dowden, Hutchinson, and Ross, Inc., Stroudsburg.

MacWhirter, B., P. Austin-Smith, Jr., and D. Kroodsma. 2002. Sanderling. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Mallek, E. J., R. Platte, and R. Stehn. 2006. Aerial breeding pair surveys of the Arctic Coastal Plain, Alaska – 2006. Unpublished report. U.S. Fish and Wildlife Service, Waterfowl Management, Fairbanks, AK.

Mallory, E. P. 1981. Ecological, behavioral, and morphological adaptations of a shorebird (the Whimbrel, *Numenius phaeopus hudsonicus*) to its different migratory environments. Ph. D. diss., Dartmouth College, Hanover, NH.

Marks, J. S., and R. L. Redmond. 1994. Conservation problems and research needs for Bristle-thighed Curlews *Numenius tahitiensis* on their wintering grounds. Bird Conserv. Internat. 4:329–341.

Marks, J. S., T. L. Tibbitts, R. E. Gill, Jr., and B. J. McCaffery. 2002. Bristle-thighed Curlew. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Mars, J. C., and D. W. Houseknecht. 2007. Quantitative remote sensing study indicates doubling of coastal erosion rate in past 50 yr along a segment of the Arctic Coast of Alaska. Geology 35:583–586.

Martin, P. D. 1994. Effects of the *Exxon Valdez* oil spill on migrant shorebirds using rocky intertidal habitat of Prince William Sound, Alaska, during spring 1989. Bird Study No. 12. Unpublished final report for *Exxon Valdez* Oil Spill State and Federal Natural Resources Damage Assessment. U.S. Fish and Wildlife Service, Anchorage, AK.

McCabe, G. J., M. P. Clark, and M. C. Serreze. 2001. Trends in northern hemisphere surface cyclones frequency and intensity. J. Climate 14:2763–2768.

McCaffery, B. J. 1996. The status of Alaska's large shorebirds: A review and an example. Internat. Wader Stud. 8:28–32.

McCaffery, B. J., J. Bart, and D. R. Ruthrauff. 2002. Kanaryarmiut Field Station, Yukon Delta National Wildlife Refuge, Alaska, USA. Pp. 17–18 *in* M. Y. Soloviev and P. S. Tomkovich (Eds.). Arctic Birds: Newsletter of International Breeding Conditions Survey, No. 4, International Wader Study Group. Available at: http://www.arcticbirds.ru/newsletter2002.pdf (accessed November 2008).

McCaffery, B., and R. Gill, Jr. 2001. Bar-tailed Godwit. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

McCaffery, B. J., C. M. Handel, R. E. Gill, and D. R. Ruthrauff. 2006. The blind men and the elephant: Concerns about the use of juvenile proportion data. Stilt 50:194–204.

McCaffery, B. J., and C. M. Harwood. 2000. Status of Hudsonian Godwits on the Yukon-Kuskokwim Delta, Alaska. West. Birds 31:165–177.

McCaffery, B. J., M. B. Rearden, and G. Walters. 2005. Hudsonian Godwits staging at Aropuk Lake, Yukon-Kuskokwim Delta. *In* Summaries of ongoing or new studies of Alaska shorebirds during 2005. Unpublished report, Alaska Shorebird Working Group. Available at http://alaska.fws.gov/mbsp/mbm/shorebirds/pdf/2005_summaries_ASG.pdf (accessed May 2008).

Meltofte, H., T. Piersma, H. Boyd, B. McCaffery, B. Ganter, V. V. Golovnyuk, K. Graham, C. L. Gratto-Trevor, R. I. G. Morrison, E. Nol, H. Rosner, D. Schamel, H. Schekkerman, M. Y. Soloviev, P. S. Tomkovich, D. M. Tracy, I. Tulp, and L. Wennerberg. 2007. Effects of climate variation on the breeding ecology of arctic shorebirds. Bioscience 59:1–48.

Morrison, R. I. G., Y. Aubry, R. W. Butler, G. W. Beyersbergen, G. M. Donaldson, C. L. Gratto-Trevor, P. W. Hicklin, V. H. Johnston, and R. K. Ross. 2001. Declines in North American shorebird populations. Wader Study Group Bull. 94:34–38.

Morrison, R. I. G., B. J. McCaffery, R. E. Gill, S. K. Skagen, S. L. Jones, G. W. Page, C. L. Gratto-Trevor, and B. A. Andres. 2006. Population estimates of North American shorebirds, 2006. Wader Study Group Bull. 111:67–85.

Morrison, R. I. G., R. K. Ross, and L. J. Niles. 2004. Declines in wintering populations of Red Knots in southern South America. Condor 106:60–70.

Morse, J. A., A. N. Powell, and M. D. Tetreau. 2006. Productivity of Black Oystercatchers: Effects of recreational disturbance in a national park. Condor 108:623–633.

Murie, O. J. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. N. Am. Fauna 61.

NABCI. 1998. Workshop on the North American Bird Conservation Initiative. November 4– 6, Puebla, Mexico.

National Audubon Society. 2008. The Christmas Bird Count Historical Results. Available from http://audubon2.org/cbchist/ (accessed February 2008).

Niles L. J., H. P. Sitters, A. D. Dey, P. W. Atkinson, K. A. Bennett, K. E. Clark, N. A. Clark, C. Espoz, P. M. González, B. A. Harrington, D. E. Hernandez, K. S. Kalasz, R. Matus, C. D. T. Minton, R. I. G. Morrison, M. K.

Peck, and I. L. Serrano. 2007. Status of the Red Knot, *Calidris canutus rufa,* in the Western Hemisphere. U.S. Fish and Wildlife Service, Ecological Services, Region 5, Pleasantville, NJ.

Norton, D. W., S. E. Senner, R. E. Gill, Jr., P. D. Martin, J. M. Wright, and A. K. Fukuyama. 1990. Shorebirds and herring roe in Prince William Sound, Alaska. Am. Birds 44:367–371, 508.

Nowacki, G., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson. 2001. Ecoregions of Alaska: 2001. U.S. Geological Survey Open-File Report 02–297 (map).

NRC. 2003. Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. National Research Council of the National Academies. National Academies Press, Washington, DC.

Pattie, E. L. 1990. A 16-year record of summer birds on Truelove lowland, Devon Island, Northwest Territories, Canada. Arctic 43:275–283.

Peterson, C. H. 2001. A synthesis of direct and indirect or chronic delayed effects of the *Exxon Valdez* oil spill. Adv. Mar. Biol. 39:1–103.

Peterson, C. H., S. D. Rice, J. W. Short, D. Esler, J. L. Bodkin, B. A. Ballachey, and D. B. Irons. 2003. Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302: 2082–2086.

Pitelka, F.A. 1974. An avifaunal review for the Barrow region and North Slope of Alaska. Arctic Alpine Research 6:161–184.

Rehfisch, M. M., and H. Q. P. Crick. 2003. Predicting the impact of climatic change on arctic-breeding waders. Wader Study Group Bull. 100:86–95.

Riordan, B. 2005. Use of remote sensing to examine changes of closed-basin surface water area in Interior Alaska from 1950–2002. M.S. thesis. University of Alaska, Fairbanks. 122 pp.

Rocque, D. A., and K. Winker. 2004. Biomonitoring of contaminants in birds from two trophic levels in the North Pacific. Environ. Tox. Chem. 23:759–766.

Sauer, J. R., J. E. Hines, and J. Fallon. 2007. The North American Breeding Bird Survey, Results and Analysis, 1966–2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD.

Scheffer, V. B. 1951. The rise and fall of a reindeer herd. Sci. Monthly 73:356–362.

Schekkerman, H., I. Tulp, T. Piersma, and G. H. Visser. 2003. Mechanisms promoting higher growth rate in arctic than in temperate shorebirds. Oecologia 134:332–342.

Senner, S. E., and B. J. McCaffery. 1997. Surfbird. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Seppi, B. E. 1995. Hudsonian Godwit migration at Carter Spit, Alaska. West. Birds 26:167.

Seppi, B. E. 1997. Fall migration of shorebirds and waterfowl at Carter Spit, Alaska. Open file report 65. U.S. Bureau of Land Management, Alaska State Office, Anchorage, AK.

Silapaswan, C. S., D. L. Verbyla, and A. D. McGuire. 2001. Land cover change on the Seward Peninsula: The use of remote sensing to evaluate the potential influences of climate warming on historical vegetation dynamics. Can. J. Remote Sensing 27:542–554.

Skagen, S. K., J. Bart, B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. L. Jones, and R. I. G. Morrison. 2004. Monitoring the shorebirds of North America: Towards a unified approach. Wader Study Group Bull. 100:102–104.

Skeel, M. A., and E. P. Mallory. 1996. Whimbrel. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Smith, L. C., Y. Sheng, G. M. MacDonald, and L. D. Hinzman. 2005. Disappearing arctic lakes. Science 308(5727):1429.

Smol, J. P., and M. S. V. Douglas. 2007. Crossing the final ecological threshold in high arctic ponds. Proc. Nat. Acad. Sci. 104: 12395–12397.

State of Alaska. 2007. Alaska Visitor Statistics Program. Alaska Visitor Volume and Profile Summer 2006. State of Alaska, Department of Commerce, Community and Economic Development. Available from http://www.dced.state.ak.us/oed/toubus/research.htm#2006 (accessed January 2008).

State of Alaska. 2008. 10-year spill summary for the Aleutians Subarea. Department of Environmental Conservation, Division of Spill Prevention and Response. Available from http://www.dec.state.ak.us/spar/perp/ai_risk/ai_risk.htm (accessed January 2008).

Stowe, D. A., A. Hope, D. McGuire, D. Verbyla, J. Gamon, F. Huemmrich, S. Houston, C. Houston, C. Racine, M. Strum, K. Tape, L. Hinzman, K. Yoshikawa, C. Tweedle, B. Noyle, C. Silapaswan, D. Douglas, B. Griffith, G. Jia, H. Epstein, D. Walker, S. Daeschner, A. Peterson, L. Zhou, and R. Myeni. 2003. Remote sensing of vegetation and land-cover change in arctic tundra ecosystems. Remote Sensing Environ. 89:281–308.

Stroud, D. A., A. Baker, D. E. Blanco, N. C. Davidson, S. Delany, B. Ganter, R. Gill, P. González, L. Haanstra, R. I. G. Morrison, T. Piersma, D. A. Scott, O. Thorup, R.. West, J. Wilson, and C. Zöckler (on behalf of the International Wader Study Group). 2006. The conservation and population status of the world's waders at the turn of the millennium. Pp. 643–648 *in* G. C. Boere, C. A. Galbraith and D. A. Stroud (Eds.). Waterbirds around the World. The Stationery Office, Scotland Ltd., Edinburgh, UK.

Tape, K., M. Sturm, and C. Racine. 2006. The evidence for shrub expansion in northern Alaska and the Pan-Arctic. Global Change Biol. 12:686–702.

TERA (Troy Ecological Research Associates). 1993a. Bird use of the Prudhoe Bay Oil Field. Prepared by Troy Ecological Research Associates, for BP Exploration (Alaska) Inc., Anchorage, AK.

TERA. 1993b. Population dynamics of birds in the Pt. McIntyre reference area 1981–1992. Anchorage: British Petroleum Exploration (Alaska) Inc.

Tessler, D. F., J. A. Johnson, B. A. Andres, S. Thomas, and R. B. Lanctot. 2007. Black Oystercatcher (*Haematopus bachmani*) Conservation Action Plan. International Black Oystercatcher Working Group, Alaska Department of Fish and Game, Anchorage, AK, U.S. Fish and Wildlife Service, Anchorage, AK, and Manomet Center for Conservation Sciences, Manomet, MA. 115 pp.

Thorne, R. E., and G. L. Thomas. 2008. Herring and the *Exxon Valdez* oil spill: An investigation into historical data conflicts. ICES J. Mar. Sci. 65:44–50.

Tibbitts, T. L., D. R. Ruthrauff, R. E. Gill, Jr., and C. M. Handel. 2005. Inventory of montane-nesting birds in the Arctic Network of National Parks, Alaska. NPS/AKARCN/NRTR–2006/02. Unpublished report prepared by USGS Alaska Science Center, Anchorage, AK, for Arctic Network Inventory and Monitoring Program, USDI National Park Service, Fairbanks, AK. 156 pp.

Troy, D. M. 1988. Bird use of the Prudhoe Bay oil field during the 1986 nesting season. Unpublished report prepared by LGL Alaska Research Associates, Inc., for the Alaska Oil and Gas Association, Anchorage, AK.

Tulp, I., and H. Schekkerman. 2008. Has prey availability for arctic birds advanced with climate change? Hindcasting the abundance of tundra arthropods using weather and seasonal variation. Arctic 61:48–60.

USFWS (U.S. Fish and Wildlife Service). 2003. Human influences on predators of nesting birds on the North Slope of Alaska. Proceedings of a public workshop held 17–18 April, 2003 in Anchorage, AK. Fairbanks Fish and Wildlife Field Office, Fairbanks, AK.

USSCP. 2004. U.S. Shorebird Conservation Plan High Priority Shorebirds—2004. Unpublished report. U.S. Fish and Wildlife Service, 4401 N. Fairfax Dr., MBSP 4107, Arlington, VA 22203 U.S.A. 5 pp.

van Vliet, G. 2005. Observations of a large post-breeding aggregation of Black Oystercatchers (*Haematopus bachmani*) at a traditional site within Glacier Bay National Park, Alaska. Unpublished report. Glacier Bay National Park and Preserve, Gustavus, AK.

Viereck, L. A., and E. L. Little. 1972. Alaska Trees and Shrubs. Agriculture Handbook No. 410, U.S. Dept. Agric., Washington, DC. 265 pp.

Walker, M. D., C. H. Wahren, R. D. Hollister, G. H. R. Henry, L. E. Ahlquist, J. M. Alatalo, M. S. Bret-Harte, M. P. Calef, T. V. Callaghan, A. B. Carroll, H. E. Epstein, I. S. Jonsdottir, J. A. Klein, B. Magnusson, U. Molau, S. F. Oberbauer, S. P. Rewa, C. H. Robinson, G. R. Shaver, K. N. Suding, C. C. Thompson, A. Tolvanen, O. Totland, P. L. Turner, C. E. Tweedie, P. J. Webber, and P. A. Wookey. 2006. Plant community responses to experimental warming across the tundra biome. Proc. Nat. Acad. Sci. 103:1342–1346.

Warnock, N., M. A. Bishop, and J. Y. Takekawa. 2001. Spring migration of Dunlin and dowitchers along the Pacific Flyway. Unpublished progress report. Point Reyes Bird Observatory, Stinson Beach, CA. 16 pp.

Warnock, N., and R. E. Gill, Jr. 1996. Dunlin. *In* A. Poole (Ed.), The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available from The Birds of North America Online database: http://bna.birds.cornell.edu/ (accessed June 2008).

Wentworth, C. 2007. Subsistence Migratory Bird Harvest Survey, Yukon-Kuskokwim Delta, 2001-2005, with 1985-2005 Species Tables. Unpublished report. U.S. Fish and Wildlife Service, Migratory Birds and State Programs, Alaska Migratory Bird Co-Management Council, Anchorage, AK. Available at: http://alaska.fws.gov/ambcc/ambcc/Harvest/YKD_070730.pdf (accessed May 2008).

Werner, R. A., K. F. Raffa, and B. L. Illman. 2006. Dynamics of phytophagus insects and their pathogens in Alaskan boreal forests. Pp. 133–146 *in* F. S. Chapin III, M. W. Oswood, K. Van Cleve, L. A. Viereck, and D. L. Verbyla (Eds.). Alaska's Changing Boreal Forest. Oxford University Press, Oxford.

Wilmking, M., G. P. Juday, V. Barber, and H. Zald. 2004. Recent climate warming forces contrasting growth responses of white spruce at treeline in Alaska through temperature thresholds. Global Change Biol. 10:1724–1736.

Wright, J. M. 1979. Reindeer grazing in relation to bird nesting on the northern Seward Peninsula. M.S. thesis, University of Alaska, Fairbanks. 109 pp.

Yin, J. H. 2006. A consistent poleward shift of the storm tracks in simulations of 21st century climate. Geophys. Res. Lett. 32:L18701.

Researchers with adult Bristle-thighed Curlew and chicks • Robert Gill, Jr.

APPENDICES

Long-billed Dowitchers • Milo Burcham

Appendix 1. Status of shorebirds in Alaska (Gibson et al. 2004), alpha codes designated by Alaska Shorebird Group, and scientific nomenclature (Engelmoer and Roselaar 1998; American Ornithologists' Union 2006, plus supplements).

Common Breeders

BBPL	Black-bellied Plover	*Pluvialis squatarola*	WESA	Western Sandpiper	*Calidris mauri*
AMGP	American Golden-Plover	*Pluvialis dominica*	LESA	Least Sandpiper	*Calidris minutilla*
PAGP	Pacific Golden-Plover	*Pluvialis fulva*	WRSA	White-rumped Sandpiper	*Calidris fuscicollis*
SEPL	Semipalmated Plover	*Charadrius semipalmatus*	BASA	Baird's Sandpiper	*Calidris bairdii*
KILL	Killdeer	*Charadrius vociferus*	PESA	Pectoral Sandpiper	*Calidris melanotos*
BLOY	Black Oystercatcher	*Haematopus bachmani*	ROSA	Rock Sandpiper	*Calidris p. ptilocnemis*
SPSA	Spotted Sandpiper	*Actitis macularia*			*C. p. couesi*
SOSA	Solitary Sandpiper	*Tringa solitaria cinnamomea*			*C. p. tschuktschorum*
WATA	Wandering Tattler	*Tringa incana*	DUNL	Dunlin	*Calidris alpina pacifica*
GRYE	Greater Yellowlegs	*Tringa melanoleuca*			*C. a. arcticola*
LEYE	Lesser Yellowlegs	*Tringa flavipes*	STSA	Stilt Sandpiper	*Calidris himantopus*
UPSA	Upland Sandpiper	*Bartramia longicauda*	BBSA	Buff-breasted Sandpiper	*Tryngites subruficollis*
WHIM	Whimbrel	*Numenius phaeopus*	SBDO	Short-billed Dowitcher	*Limnodromus griseus caurinus*
BTCU	Bristle-thighed Curlew	*Numenius tahitiensis*	LBDO	Long-billed Dowitcher	*Limnodromus scolopaceus*
HUGO	Hudsonian Godwit	*Limosa haemastica*	WISN	Wilson's Snipe	*Gallinago delicata*
BARG	Bar-tailed Godwit	*Limosa lapponica baueri*	RNPH	Red-necked Phalarope	*Phalaropus lobatus*
MAGO	Marbled Godwit	*Limosa fedoa beringiae*	REPH	Red Phalarope	*Phalaropus fulicarius*
RUTU	Ruddy Turnstone	*Arenaria i. interpres*			
BLTU	Black Turnstone	*Arenaria melanocephala*			
SURF	Surfbird	*Aphriza virgata*			
REKN	Red Knot	*Calidris canutus roselaari*			
SAND	Sanderling	*Calidris alba*			
SESA	Semipalmated Sandpiper	*Calidris pusilla*			

Appendix 1. Continued.

Rare or Sporadic Breeders from Asia		
LSAP	Lesser Sand-Plover	*Charadrius mongolus*
CRPL	Common Ringed Plover	*Charadrius hiaticula*
EUDO	Eurasian Dotterel	*Charadrius morinellus*
COSA	Common Sandpiper	*Actitis hypoleucos*
WOSA	Wood Sandpiper	*Tringa glareola*
RNST	Red-necked Stint	*Calidris ruficollis*
RUFF	Ruff	*Philomachus pugnax*
COSN	Common Snipe	*Gallinago gallinago*

Vagrants from Temperate North America		
SNPL	Snowy Plover	*Charadrius alexandrinus*
AMAV	American Avocet	*Recurvirostra americana*
ESCU	Eskimo Curlew[1]	*Numenius borealis*
PUSA	Purple Sandpiper	*Calidris maritima*
WIPH	Wilson's Phalarope[2]	*Phalaropus tricolor*

Vagrant from Europe		
EUGP	European Golden-Plover	*Pluvialis apricaria*

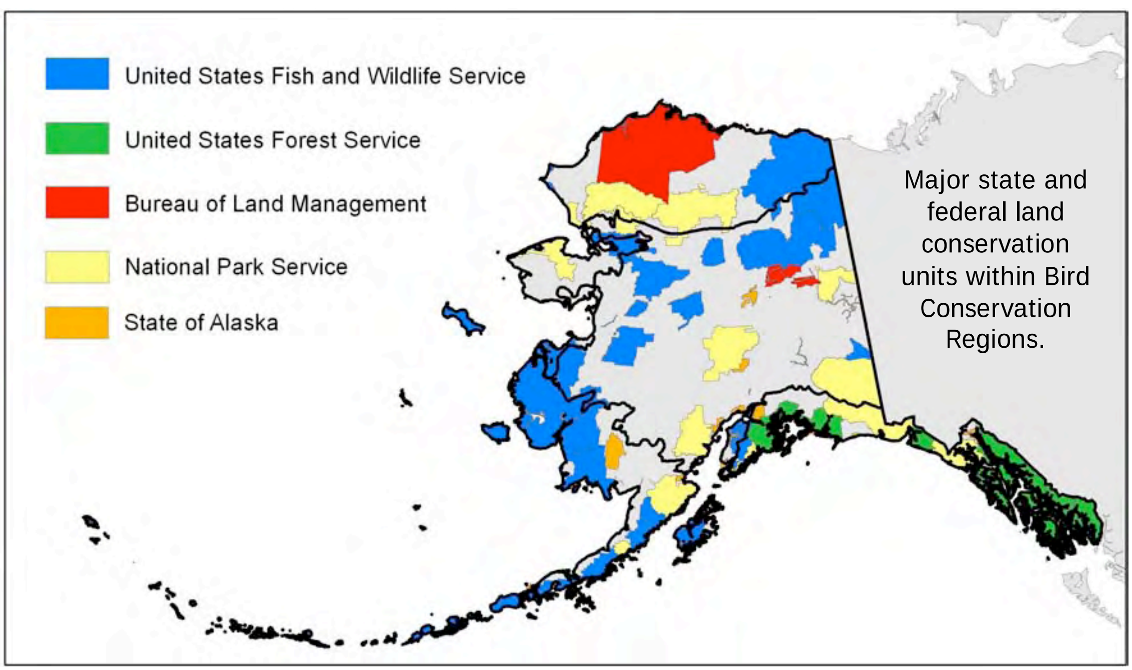
Migrants or Vagrants from Asia		
NOLA	Northern Lapwing	*Vanellus vanellus*
LRPL	Little Ringed Plover	*Charadrius dubius*
BWST	Black-winged Stilt	*Himantopus himantopus*
TESA	Terek Sandpiper	*Xenus cinereus*
GRSA	Green Sandpiper	*Tringa ochropus*
GTTA	Gray-tailed Tattler	*Heteroscelus brevipes*
SPRE	Spotted Redshank	*Tringa erythropus*
COMG	Common Greenshank	*Tringa nebularia*
MASA	Marsh Sandpiper	*Tringa stagnatilis*
LICU	Little Curlew	*Numenius minutus*
FECU	Far Eastern Curlew	*Numenius madagascariensis*
BTGD	Black-tailed Godwit	*Limosa limosa*
GRKN	Great Knot	*Calidris tenuirostris*
LIST	Little Stint	*Calidris minuta*
TEST	Temminck's Stint	*Calidris temminckii*
LTST	Long-toed Stint	*Calidris subminuta*
SHAS	Sharp-tailed Sandpiper	*Calidris acuminata*
SBSA	Spoon-billed Sandpiper	*Eurynorhynchus pygmeus*
BBIS	Broad-billed Sandpiper	*Limicola falcinellus*
JASN	Jack Snipe	*Lymnocryptes minimus*
PTSN	Pin-tailed Snipe	*Gallinago stenura*
ORPR	Oriental Pratincole	*Glareola maldivarum*

[1] Likely extinct (Morrison et al. 2006).

[2] Wilson's Phalarope is a rare breeder in Alaska (Erwin et al. 2004).

Appendix 2. Area of major[1] state and federal land conservation units within Bird Conservation Regions (BCR) of Alaska and percentage of BCR each unit comprises.[2]

BCR 1: Aleutian/Bering Sea Islands					
Conservation Unit[1]	km^2	%	Conservation Unit	km^2	%
Alaska Maritime National Wildlife Refuge	16,805	97.1			
			Total	16,805	97.1
BCR 2: Western Alaska					
Conservation Unit[1]	km^2	%	Conservation Unit	km^2	%
Afognak Island State Park	304	<0.1	Pilot Point State Critical Habitat Area	186	<0.1
Alaska Maritime National Wildlife Refuge	7,990	2.7	Port Heiden State Critical Habitat	293	0.1
Aniakchak National Monument/Preserve	2,435	0.8	Port Moller State Critical Habitat	515	0.2
Alaska Peninsula National Wildlife Refuge	18,164	6.2	Selawik National Wildlife Refuge	8,070	2.7
Becharof National Wildlife Refuge	5,893	2.0	Shuyak Island State Park	190	<0.1
Bering Land Bridge National Preserve	10,875	3.7	Tugidak Island State Critical Habitat	202	<0. 1
Izembek National Wildlife Refuge	1,245	0.4	Togiak National Wildlife Refuge	18,909	6.4
Izembek State Game Refuge	736	0.3	Wood-Tikchik State Park	6,473	2.2
Katmai National Park/Preserve	16,520	5.6	Yukon Delta National Wildlife Refuge	76,034	25.9
Kodiak National Wildlife Refuge	7,122	2.4			
McNeil River State Game Sanctuary	339	0.1			
			Total	181,863	62



Major state and federal land conservation units within Bird Conservation Regions.

Appendix 2. Continued.

BCR 3: Arctic Plains and Mountains					
Conservation Unit[1]	km[2]	%	Conservation Unit	km[2]	%
Alaska Maritime National Wildlife Refuge	998	0.3	Kobuk Valley National Park	2,913	0.9
Arctic National Wildlife Refuge	54,943	17.8	National Petroleum Reserve-Alaska	93,397	30.3
Cape Krusenstern National Monument	2,630	0.9	Noatak National Preserve	26,178	8.5
Gates of the Arctic National Park	31,395	10.2			
			Total	212,454	68.9

BCR 4: Northwest Interior Forest					
Conservation Unit[1]	km[2]	%	Conservation Unit	km[2]	%
Alaska Maritime National Wildlife Refuge	220	<0.1	Noatak National Preserve	403	<0.1
Arctic National Wildlife Refuge	24,858	3.4	Nowitna National Wildlife	8,311	1.1
Chena River State Recreation Area	1,028	0.1	Redoubt Bay State Critical Habitat	653	<0.1
Denali National Park and Preserve	24,400	3.4	Steese National Conservation Area	4,670	0.6
Denali State Park	1,316	0.2	Susitna Flats State Game Refuge	1,217	0.2
Forty-mile Wild and Scenic River	1,000	0.1	Tetlin National Wildlife Refuge	3,776	0.5
Gates of the Arctic NPP[3]	2,887	0.4	Trading Bay State Game Refuge	746	0.1
Innoko National Wildlife Refuge	18,443	2.5	Wrangell-St. Elias NPP[3]	32,705	4.5
Kanuti National Wildlife Refuge	6,627	0.9	White Mountain National Recreation	3,759	0.5
Kenai National Wildlife Refuge	4,458	1.0	Yukon-Charley Rivers National	10,202	1.4
Koyukuk National Wildlife Refuge	18,199	2.5	Yukon Delta National Wildlife Refuge	17,007	2.3
Lake Clark National Park and Preserve	16,303	2.2	Yukon Flats National Wildlife Refuge	45,213	6.2
Minto Flats State Game Refuge	2,023	0.3			
Nancy Lake State Recreation Area	92	<0.1			
			Total	260,507	35.9

BCR 5: Northern Pacific Rainforest					
Conservation Unit[1]	km[2]	%	Conservation Unit	km[2]	%
Admiralty National Monument	4,019	2.4	Kachemak Bay State Park	1,214	0.7
Alaska Maritime National Wildlife Refuge	61	<0.1	Kenai Fjords National Park	2,631	1.6
Chilkat Bald Eagle Preserve	199	0.1	Kenai National Wildlife Refuge	3,673	2.2
Chugach National Forest	25,000	15.3	Misty Fjords National Monument	9,680	5.9
Chugach State Park	2,023	1.2	Tongass National Forest	57,025	34.8
Copper River Delta State Critical Habitat	2,416	1.5	Wrangell-St. Elias NPP[3]	21,052	12.9
Glacier Bay National Park and Preserve	10,779	6.7	Yakataga State Game Refuge	332	0.2
Kachemak Bay State Critical Habitat Area	900	0.6			
			Total	141,026	86.1

[1] Exclusive of some National Wild and Scenic Rivers and small units administered by the State of Alaska.
[2] Area calculated in GIS.
[3] National Park and Preserve (NPP).

Appendix 3. Variables and criteria used for assessing the status of shorebird populations at the national and regional levels (Brown et al. 2000) and for ranking populations of shorebirds that occur in Alaska (Table 2). This information (shorcons3.doc) can be downloaded from the U.S. Shorebird Conservation Plan website: http://www.fws.gov/shorebirdplan/USShorebird/PlanDocuments.htm.

Variables for National Priorities

Population Trend (PT)—The Population Trend variable uses available information on shorebird trends (e.g., Howe et al. 1989, Morrison et al. 2006) to estimate broad categories of population decline. Species with known declines in populations are likely to be at higher risk than species where ongoing study has detected no risk. However, many species may be declining even though trends have not been detected using current monitoring techniques. This is particularly true for species under-represented in ongoing monitoring programs. Only species with documented significant population declines ($P < 0.10$) are included in category 5.

5 Significant population decline ($P < 0.10$)
4 Apparent population decline
3 Apparently stable population or status unknown
2 Apparent population increase
1 Significant population increase

Population Size (PS)—This variable uses population size estimates to classify each species into five categories based on breaks in the distribution of population sizes among shorebirds. Species with smaller absolute population sizes are likely to be more at risk, either as a result of historic declines or from catastrophic disturbances. Population estimates were developed by Morrison et al. (2006). Note that Morrison et al. (2006) discuss the validity and accuracy of these population estimates.

5 <25,000 individuals
4 25,000–<150,000 individuals
3 150,000–<300,000 individuals
2 300,000–<1,000,000 individuals
1 >1,000,000 individuals

Threats during Breeding Season (TB)—This variable ranks the threats known to exist for each species, and generally reflects the limited knowledge available for determining threats to most shorebirds.

5 Known threats are actually occurring (e.g., significant loss of critical habitat), and can be documented.
4 Significant potential threats exist (e.g., oil spills), but have not actually occurred.
3 No known threats, or information not available.
2 Threats assumed to be low.
1 Demonstrably secure.

Threats during Nonbreeding Season (TN)—This score uses the same criteria listed above for the breeding season scores, with the additional factor of concentration risk considered explicitly.

5 Known threats are actually occurring (e.g., significant loss of critical habitat) and can be documented. Concentration results in actual risk.
4 Significant potential threats exist (e.g., oil spills) but have not actually occurred. Concentration results in high potential risk.
3 No known threats, or concentration not a risk, or information not available.
2 Threats assumed to be low from all factors including concentration.
1 Demonstrably secure.

Breeding Distribution (BD)—This variable ranks the size of the breeding range for species that breed in North America, and only applies during the actual breeding season. The assumption is that species with relatively more restricted ranges are more susceptible to breeding failure from natural or human-induced causes. Threats that occur during migration to or from the breeding grounds are addressed in Nonbreeding Distribution (ND) below.

5 <2.5% of North America (<551,360 km^2)
4 2.5–4.9% of North America
3 5.0–9.9% of North America
2 10–20% of North America
1 >20% of North America (>4,410,770 km^2)

Nonbreeding Distribution (ND)—This variable refers to distribution during the nonbreeding season, which includes migration to and from the breeding grounds. Threats resulting from concentration at some point during migration are addressed in threats to nonbreeding above. This variable rates the relative risks associated with having a smaller absolute range size during the nonbreeding season. Because different risk factors occur during the nonbreeding season, the absolute sizes of these categories are different from those above. In addition, the added variable of length of coastline is used for coastal species where measuring area is not as representative of distribution.

5 Highly restricted: ≤50,000 square miles, or very restricted along coastal areas or interior uplands.
4 Local: 50,000–200,000 square miles, or along ≤1,000 miles of coast.
3 Intermediate: 200,000–2,000,000 square miles, or along 1,000–3,000 miles of coast.
2 Widespread: 2,000,000–4,000,000 square miles, or along 3,000–5,000 miles of coast.
1 Very widespread: 4,000,000–7,000,000 square miles, or along 5,000–9,000 miles of coast.

Criteria for National Priorities

The six factors used to determine the conservation status of shorebirds include: Population Trend (PT), Population Size (PS), Breeding Threats (TB), Nonbreeding Threats (TN), Breeding Distribution (BD), and Nonbreeding Distribution (ND). The criteria below were adopted in 2004 by the U.S. Shorebird Conservation Plan Council (USSCP 2004) and applied to scores for populations of shorebirds that occur in Alaska (Table 2).

Highly Imperiled (5)

PT = 5 and PS, TB, or TN = 5
PS = 5 and TB or TN = 5

Species of High Concern (4)

PT = 4 or 5 and PS, BD, TB, or TN = 4 or 5
PS = 4 or 5 and TB or TN = 4 or 5

Species of Moderate Concern (3)

PT = 4 or 5 and PS, BD, ND, TN, or TB = 3
PT = 3 and PS, BD, ND, TN, or TB = 4 or 5
PS = 3 and BD or ND = 4 or 5
PS = 4 and BD and ND <4
PT = 5 and PS, BD, ND, TN, or TB > 1

Species of Low Concern (2)

PT = 3 and PS, BD, ND, TN, or TB = 3
PT = 2 and PS, BD, ND, TN, or TB = 4 or 5
PS = 3

Species Not at Risk (1)

All other species

Appendix 4. Habitat preferences of shorebirds during breeding (B), migration (M), and nonbreeding (NB) seasons in Alaska. Habitat classifications modified from Kessel (1979).

Species	Tundra Meadows[1]	Alpine Rocky Tundra	Woodland & Dwarf Forests	Tall Shrub Thicket	Lacustrine[2]	Mud & Sand Flats[3]	Rocky/ Gravel Shorelines[4]
Black-bellied Plover	B, M				M	M, NB	NB
American Golden-Plover	B, M						
Pacific Golden-Plover	B, M					M	
Semipalmated Plover		B			M	M	B
Killdeer							B
Black Oystercatcher							B, M, NB
Spotted Sandpiper					B, M		B, M
Solitary Sandpiper			B, M	B, M			
Wandering Tattler							B, M
Greater Yellowlegs	B, M		B			M	
Lesser Yellowlegs	B, M		B	B		M	
Upland Sandpiper	B, M		B				
Whimbrel	B, M						
Bristle-thighed Curlew	B, M						
Hudsonian Godwit	B, M		B			M	
Bar-tailed Godwit	B, M					M	
Marbled Godwit	B					M	
Ruddy Turnstone	B, M	B				M	M, NB
Black Turnstone	B					M	M, NB
Surfbird		B				M	M, NB
Red Knot	M	B				M	
Sanderling		B				M, NB	M, NB
Semipalmated Sandpiper	B					M	
Western Sandpiper	B					M	
Least Sandpiper	B, M		B			M	
White-rumped Sandpiper	B, M						
Baird's Sandpiper	B, M	B				M	B
Pectoral Sandpiper	B, M					M	
Sharp-tailed Sandpiper	M					M	
Rock Sandpiper	B	B				M, NB	M, NB
Dunlin	B, M					M, NB	
Stilt Sandpiper	B, M					M	
Buff-breasted Sandpiper	B, M						
Short-billed Dowitcher	B, M		B			M	
Long-billed Dowitcher	B, M					M	
Wilson's Snipe	B, M		B			M	
Red-necked Phalarope[5]	B				B, M	M	
Red Phalarope[5]	B				B, M	M	

[1] Includes dwarf shrub meadows, salt grass meadows, wet meadows, and grass fields.
[2] Includes ephemeral ponds.
[3] Includes ephemeral mudflats.
[4] Includes rivers, shorelines, and artificial gravel sites.
[5] Both phalarope species are also associated with sea ice edge during migratory/staging period.

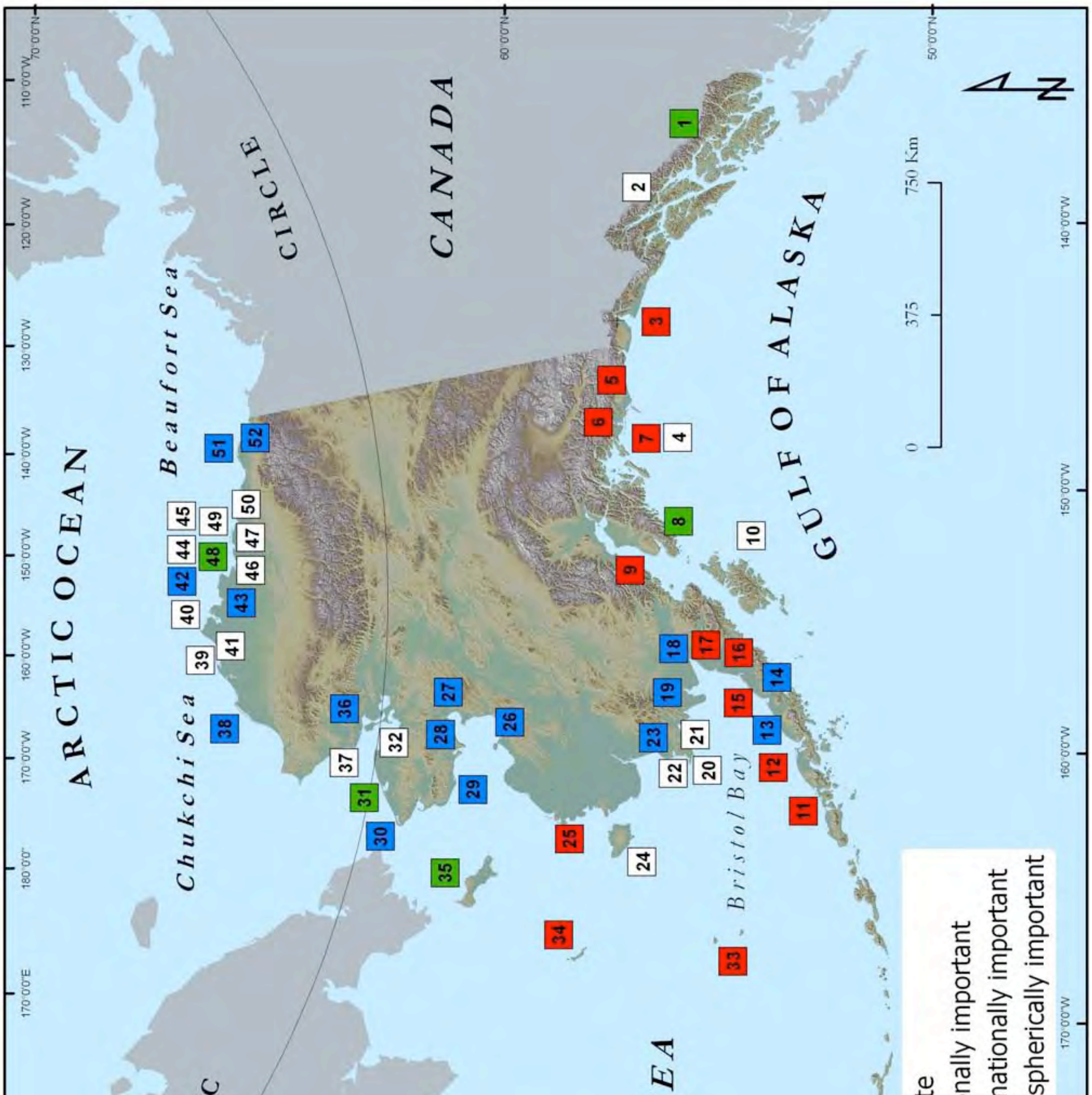
Appendix 5. Important shorebird sites within each Bird Conservation Region (BCR) of Alaska. Key species that occur at each site and major periods of seasonal use are listed. Numbers of shorebirds at each site derived from published references when available; in absence of published estimates, numbers derive from unpublished works and expert opinion of Alaska Shorebird Group. Level at which each site qualifies for WHSRN Hemispheric (H), International (I), or Regional (R) levels is shown, relative to criteria based on total number of shorebirds or percent of population of key species that occur there. Most sites have been designated as Important Bird Areas. Site numbers cross-reference locations on map following table. Data compiled by R. Gill, Jr., T. L. Tibbitts, and C. M. Handel (pers. comm.).

					WHSRN Classification	
No.	Site[1]	Key Species[2]	Seasonal Use[3]	No. of shorebirds[4]	Pop. Size[5]	% of Pop.[6]
BCR 5: Northern Pacific Rainforest						
1	Stikine River Delta	WESA	SP	s 100,000	I	H?
2	Mendenhall Wetlands	WESA, RUTU, SURF, LESA, DUNL	SP, S, A, W	f 10,000	R?	
3	Yakutat Forelands	MAGO, WESA, DUNL, LESA	SP	f 100,000	I	H
4	Middleton Island	WESA, BLTU, LESA, PAGP	SP, S, A, W	s 1,000	R?	
5	Controller Bay	WESA, DUNL	SP, S	s 100,000	H	H
6	Copper River Delta	WESA, DUNL, REKN, SBDO, LBDO, BBPL	SP, S	s 100,000	H	H
7	North Montague Island	SURF, BLTU	SP, W	s 10,000	R	H
BCR 4: Northwest Interior Forest						
8	Kachemak Bay	WESA, SURF, ROSA	SP, S, W	f 100,000	I	
9	Cook Inlet[7]	ROSA, WESA, SBDO, HUGO	SP, S, A, W	s 100,000	H	H
BCR 2: Western Alaska						
10	Kodiak Island[8]	WESA, DUNL, RNPH	SP, S, A, W	s 1,000	R?	
11	Izembek-Moffet Lagoons	ROSA, DUNL, WESA, LESA	S, A	s 10,000	R-I?	H
12	Nelson Lagoon/ Mud Bay	DUNL, WESA, ROSA, BARG, WHIM	S, A	s 100,000	I-H?	H
13	Seal Islands	DUNL, WESA, ROSA, RNPH	S, A	f 10,000	R-I?	
14	Port Heiden	DUNL, WESA, ROSA, RNPH, BARG	S, A	f 100,000	R-I?	
15	Cinder-Hook Lagoons	MAGO, DUNL, ROSA, BARG,	S, A	s 10,000	R-I?	H
16	Ugashik Bay	MAGO, DUNL	S, A	f 10,000	R	H
17	Egegik Bay	BARG, DUNL	S, A	s 10,000	R	H
18	Kvichak Bay	DUNL, BBPL, PAGP	S, A	s 10,000	R	
19	Nushagak Bay	DUNL, WESA, BBPL, PAGP	S, A	s 10,000	R	
20	Nanvak Bay	DUNL, WESA, ROSA, LESA, RNPH	S, A	f 10,000	R?	
21	Chagvan Bay	DUNL, WESA, ROSA, LESA	S, A	f 10,000	R?	
22	Goodnews Bay	DUNL, WESA	S, A	f 10,000	R?	
23	Carter Bay	HUGO, DUNL, WESA, ROSA	S, A	f 10,000	R	R?
24	Nunivak Island[8]	ROSA, DUNL, WESA	S, A	f 10,000	R?	I?
25	Yukon-Kuskokwim Delta[7]	DUNL, WESA, ROSA, REKN, BTCU, BARG, BLTU, LBDO, RNPH, HUGO	SP, S, A	s 100,000	H	H
26	Stebbins-St. Michael	SESA, DUNL, RNPH, LBDO	S, A	s 10,000	R-I?	
27	Norton Bay	DUNL, SESA, WESA, RNPH	S, A	f 10,000	R	
28	Golovin Lagoon	DUNL, SESA, WESA, RNPH	S, A	f 10,000	R	
29	Safety Sound	DUNL, SESA, WESA, RNPH	S, A	f 10,000	R	
30	Lopp Lagoon	WESA, DUNL, SESA	S, A	s 10,000	R	
31	Shishmaref Inlet	WESA, DUNL, PAGP	S, A	f 100,000	I	
32	Cape Espenberg	WESA, SESA, DUNL	S, A	f 10,000	R?	

Appendix 5 continued.

BCR 1: Aleutian/Bering Sea Islands						
33	Pribilof Islands	ROSA	SP, S, A	f 10,000	R	H
34	St. Matthew Island	ROSA	SP, S, A	s 1,000		H
35	St. Lawrence Island	ROSA, REPH	SP, S, A	s 1,000		I-H?
BCR 3: Arctic Plains and Mountains						
36	Noatak River Delta	DUNL, WESA, SESA, LBDO	SP, S, A	s 10,000	R-I?	
37	Krusenstern Lagoon	RNPH, LBDO, WESA, SESA, PESA	SP, S, A	f 10,000	R?	
38	Kasegaluk Lagoon	DUNL, REPH	SP, S, A	f 10,000	R	
39	Peard Bay	REPH	S, A	s 1,000	R?	
40	Elson Lagoon	REPH	S, A	f 10,000	R?	
41	Meade River[8]	SESA, LBDO, RNPH	S	f 10,000	R?	
42	Barrow and Admiralty Bay[8]	SESA, PESA, DUNL, LBDO, REPH	S	s 100,000	I?	
43	Teshekpuk Lake – Dease Inlet[8]	PESA, BBPL, AMGP, LBDO, DUNL, SESA	SP, S	s 100,000	R-I?	
44	Ikpikpuk River	AMGP, BBPL, BARG, SESA, STSA, LBDO	S	s 10,000	R?	
45	Ikpikpuk River Delta	BBPL, RUTU, SESA, PESA, DUNL, REPH	S	s 10,000	R?	
46	Cape Halkett[8]	PESA, DUNL, LBDO, REPH	S	f 10,000	R?	
47	Kogru River Delta	PESA, DUNL, REPH	S	s 1,000	R?	
48	Colville River Delta	DUNL, SESA, RNPH	S, A	s 10,000	R	
49	Simpson Lagoon	REPH, RNPH, DUNL	S, A	f 10,000	R?	
50	Prudhoe Bay	SESA, PESA, DUNL, REPH, RNPH, BBSA	S	f 10,000	R?	
51	Northeast Alaska Lagoons and Coastal Area[8]	SESA, RNPH, DUNL, PESA, BBPL STSA, RUTU, LBDO, SAND, AMGP	S, A	s 10,000	R-I?	
52	Arctic NWR Coastal Plain[8]	PESA, SESA, RNPH, AMGP, REPH, DUNL	SP, S	s 10,000	I	

[1] Sites in bold have been designated within the Western Hemisphere Shorebird Reserve Network (WHSRN), and Izembek Lagoon is designated as a Wetland of International Importance by the RAMSAR convention.
[2] Species that are numerically dominant; those in bold qualify a site in the WHSRN program based on percentage of population supported.
[3] Seasonal use by key species: SP = Spring, S = Summer, A = Autumn, W = Winter.
[4] Number of shorebirds estimated to use a site annually: f = few (≤3) or s = several (≥4). E.g., s 10,000 = ≥40,000 shorebirds.
[5] Hemispheric (H) supports >500,000 shorebirds annually, International (I) supports >100,000 annually, Regional (R) supports>20,000 annually. A question mark indicates that qualifying information is needed.
[6] Hemispheric (H) supports >30% of a species' flyway population, International (I) supports >10%, Regional (R) supports >1%. A question mark indicates that qualifying information is needed.
[7] Large site that encompasses several smaller, discrete sites, each of which meets WHSRN criteria.
[8] Large site or discrete region over which the combined shorebird numbers meet WHSRN criteria.


ARCTIC OCEAN
Beaufort Sea
Chukchi Sea
CANADA
ARCTIC CIRCLE
RUSSIA
BERING SEA
Bristol Bay
GULF OF ALASKA
0
375
750 Km
N
Important shorebird site
Site qualifying as regionally important
Site qualifying as internationally important
Site qualifying as hemispherically important

Appendix 6. Key organizations and agencies for conservation of Alaska shorebird populations.

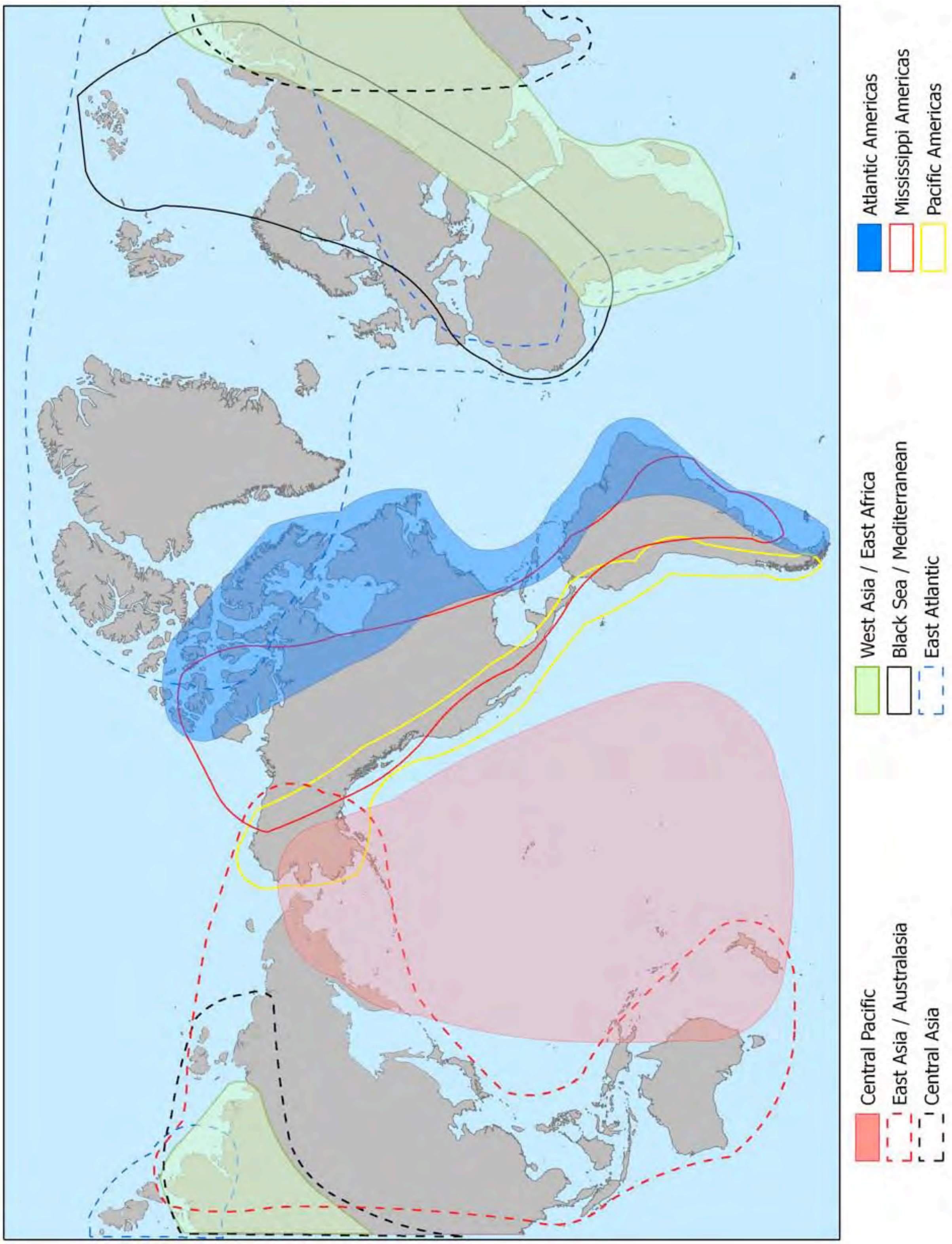
	Organization	Program Website[1]
International	Australasian Wader Study Group	www.awsg.org.au
	East Asian-Australasian Flyway Partnership	www.environment.gov.au/biodiversity/migratory/waterbirds/flyway-partnership
	Global Flyway Network	www.globalflywaynetwork.com.au
	International Breeding Conditions Survey	www.arcticbirds.ru
	International Wader Study Group	web.uct.ac.za/depts/stats/adu/wsg
	Pacific Shorebird Migration Project	www.prbo.org/cms/424
	Shorebird Research Group of the Americas	www.shorebirdresearch.org
	Shorebird Sister Schools Program	sssp.fws.gov
	South Pacific Regional Environment Program	www.sprep.org
	Western Hemisphere Shorebird Reserve Network	www.whsrn.org
	Wetlands International	www.wetlands.org
Regional	Birds Australia	www.birdsaustralia.com.au
	Black Oystercatcher Working Group	www.whsrn.org/shorebirds/conservation_plans.html
	Boreal Shorebird Monitoring Plan	alaska.fws.gov/mbsp/mbm/shorebirds/pdf/boreal_species_assessment_dec_04.pdf
	Buff-breasted Sandpiper Working Group	www.whsrn.org/shorebirds/conservation_plans.html
	Canadian Shorebird Conservation Plan	www.cws-scf.ec.gc.ca/mbc-com
	Hudsonian Godwit Working Group	www.whsrn.org/shorebirds/conservation_plans.html
	Manomet Center for Conservation Sciences	www.manomet.org
	Marbled Godwit Working Group	www.whsrn.org/shorebirds/conservation_plans.html
	U.S. Shorebird Conservation Plan Council	www.fws.gov/shorebirdplan
	Western Sandpiper Working Group	www.whsrn.org/shorebirds/conservation_plans.html
	Wildlife Conservation Society	www.wcs.org/international/northamerica/pacificwest
Alaska	Alaska Bird Observatory	www.alaskabird.org
	Alaska Department of Fish and Game	www.wildlife.alaska.gov
	Alaska Maritime Refuge	alaskamaritime.fws.gov
	Audubon Alaska	www.audubonalaska.org
	Bureau of Land Management	www.blm.gov/ak/st/en/fo/fdo.html
	North Slope Borough	www.co.north-slope.ak.us/departments/wildlife
	Prince William Sound Science Center	www.pwssc.org
	University of Alaska-Fairbanks	www.iab.uaf.edu
	U.S. Fish and Wildlife Service	alaska.fws.gov/mbsp/mbm/shorebirds/shorebirds.htm
	U.S. Forest Service	www.fs.fed.us/r10
	USGS Alaska Science Center	alaska.usgs.gov/science/biology/shorebirds/
	Yukon Delta National Wildlife Refuge	yukondelta.fws.gov/

Appendix 7. Nonbreeding areas and primary migratory flyways of shorebird species commonly occurring in Alaska. Definitions and map of flyways from Boere and Stroud (2006) except Central Pacific flyway, which is based on transpacific migration of Bristle-thighed Curlew, Bar-tailed Godwit and other species (Marks et al. 2002; Gill et al. *in press*; R. Gill, Jr., unpubl. data).

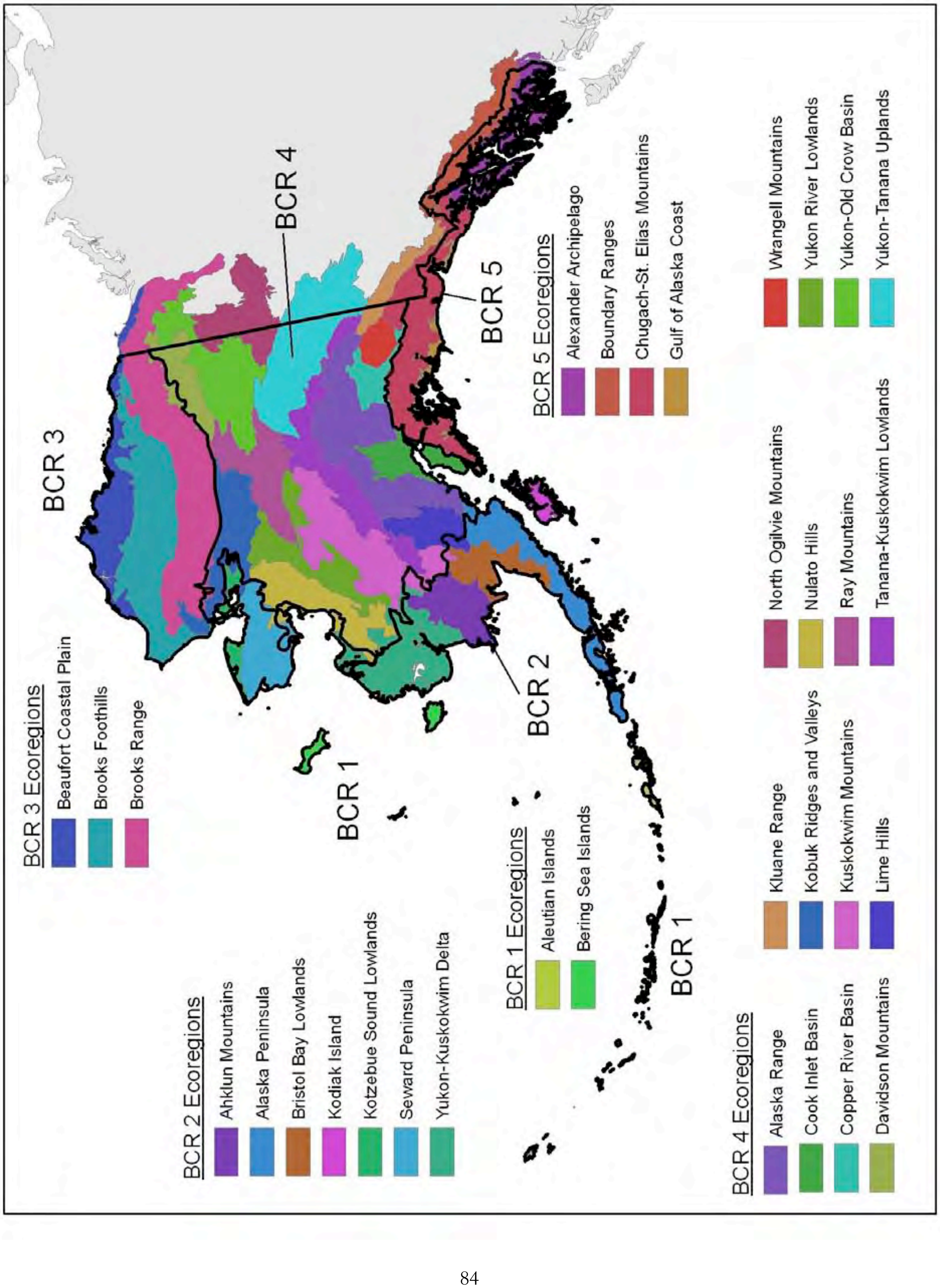
Nonbreeding Area	Species	Primary Migratory Flyway
Pacific North America	Black Oystercatcher	Pacific Americas
	Black Turnstone	Pacific Americas
	Rock Sandpiper	Pacific Americas
The Americas	Black-bellied Plover	Pacific Americas
	Semipalmated Plover	Pacific Americas & Mississippi Americas
	Killdeer	Mississippi Americas
	Spotted Sandpiper	Mississippi Americas
	Solitary Sandpiper	Mississippi Americas
	Greater Yellowlegs	Atlantic Americas
	Lesser Yellowlegs	Mississippi Americas & Atlantic Americas
	Whimbrel	Pacific Americas & Atlantic Americas
	Marbled Godwit	Pacific Americas
	Ruddy Turnstone	Central Pacific & Pacific Americas
	Surfbird	Pacific Americas
	Red Knot	Pacific Americas
	Sanderling	Pacific Americas
	Semipalmated Sandpiper	Mississippi Americas
	Western Sandpiper	Pacific Americas
	Least Sandpiper	Mississippi Americas
	Dunlin (*pacifica*)	Pacific Americas
	Stilt Sandpiper	Mississippi Americas
	Short-billed Dowitcher	Pacific Americas
	Long-billed Dowitcher	Mississippi/Pacific & Atlantic Americas[1]
	Wilson's Snipe	Missisipi Americas
	Red-necked Phalarope	Pacific Americas
	Red Phalarope	Pacific Americas
South America	American Golden-Plover	Mississippi/Atlantic Americas[2]
	Upland Sandpiper	Mississippi Americas
	Hudsonian Godwit	Mississippi/Atlantic Americas[2]
	White-rumped Sandpiper	Mississippi Americas
	Baird's Sandpiper	Mississippi Americas
	Pectoral Sandpiper	Mississippi Americas
	Buff-breasted Sandpiper	Mississippi Americas
Oceania/East Asia/ Australasia	Pacific Golden-Plover	Central Pacific
	Wandering Tattler	Central Pacific
	Bristle-thighed Curlew	Central Pacific
	Bar-tailed Godwit	East Asian-Australasian/Central Pacific[3]
	Sharp-tailed Sandpiper	East Asian-Australasian
	Dunlin (*arcticola*)	East Asian-Australasian

[1] Northbound migration uses Mississipi Americas flyway; southbound uses Pacific and Atlantic Americas flyways.
[2] Northbound migration uses Mississipi Americas flyway; southbound uses Atlantic Americas flyway.
[3] Northbound migration uses East Asian-Australasian flyway; southbound uses Central Pacific flyway.

Appendix 7. Continued.



Appendix 8. Ecoregions of Alaska (Gallant et al. 1995, Nowacki et al. 2001) relative to boundaries of Bird Conservation Regions (BCRs).



Alaska Shorebird Group

ASG