CONSERVATION PLAN FOR THE SANDERLING

(*CALIDRIS ALBA*)

Version 1.1

February 2010

Laura X. Payne[1]

NOTE about Version 1.1:

The only difference between Version 1.1 (February 2010) and Version 1.0 (October 2009) is the addition of a Spanish executive summary.

Conservation Plan Author:

[1] School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington 98125, USA; lxp@u.washington.edu.

Conservation Plan Editor:

Meredith Gutowski, WHSRN Executive Office, Manomet Center for Conservation Sciences, P.O. Box 1770, Manomet, Massachusetts 02345, USA; mgutowski@manomet.org.

For further information:

Manomet Center for Conservation Sciences: www.manomet.org

Western Hemisphere Shorebird Reserve Network: www.whsrn.org

Financial Contributors:

National Fish and Wildlife Foundation

Acknowledgements

Thanks to the thousands of International Shorebird Survey (ISS) volunteers for collecting data on shorebirds in the Americas, and to Brian Harrington for ISS vision, leadership, and maintenance. Thanks to Lisa Schibley for assistance with ISS data transfer and in finalizing Appendix V (the major Sites Table), and to Holly Payne for Spanish translation of the Latin American Sanderling Questionnaire. Gerard Beyersbergen, Roberto Carmona, Susannah Corona, Arne Lesterhuis, and John Stanton offered useful insights, and Joe Buchanan provided extensive and constructive comments (and valuable references), improving this plan. In addition, Meredith Gutowski offered generous guidance, patience, and helpful feedback throughout.

Recommended Citation:

Payne, Laura X. 2010. Conservation Plan for the Sanderling (*Calidris alba*).Version 1.1. Manomet Center for Conservation Sciences, Manomet, Massachusetts.

Cover Photo:

Sanderling at Farallon, Panama, December 2005. *Source:* www.wikipedia.org, User: Mdf

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Sanderling (*Calidris alba*) is a small shorebird that breeds in the high arctic and migrates to temperate, tropical, and south-temperate beaches. In North America, the Sanderling is classified as a Species of High Concern because of its significant population declines, widespread habitat loss, and the threats it faces during the nonbreeding seasons (migration and winter).

The Sanderling has a circumpolar breeding distribution, however there is little morphological differentiation among breeding populations. In contrast, some differentiation of individuals occurs on the nonbreeding range. Only one race of Sanderling is recognized. This species uses three major migration flyways in the Americas: Pacific, Central, and Atlantic.

The largest North American concentrations of Sanderlings occur during spring migration, where tens of thousands of birds gather on the mid-Atlantic coast (coastal beaches of Delaware Bay) and at shallow alkaline lakes in the Canadian Prairies (Saskatchewan). Other large spring concentrations also occur on the central coast of North Carolina (Dinsmore *et al*. 1998, Walters 1984); on outer coastal sandy beaches of central Oregon, and southern Washington (Myers *et al*. 1984b, 1984b); and in Alaska (Isleib 1979).

Fall migration in North America is more protracted, extending from mid-July to late October (or November), with birds being generally less aggregated in space. However, some Sanderlings aggregate in Massachusetts (up to 17,000 individuals), New Jersey (8,000), Virginia (several sites with 17,000), Texas (8,400), and Washington (10,000) (International Shorebird Survey database). Otherwise, Sanderlings spread out during fall, moving through important sites along the Great Lakes shorelines and all along Pacific and Atlantic coastlines. During winter, Sanderlings are dispersed, and a pronounced site fidelity in most locations and territoriality by many individuals likely influence population structure (Myers *et al*. 1988).

Sanderlings need explicit conservation planning for several reasons:

- *Population declines*;
- *Widespread habitat loss*. Their principal habitat is wide-open sandy beaches and barrier islands, which are threatened by development and chronic human disturbance;

- *Global climate change and sea-level rise*, which places even greater stress on coastal habitats. Global climate change will continue to alter conditions on the breeding grounds (e.g., timing and availability of food resources, predation pressure, and competition), and at migration stopovers (due to sea-level rise and droughts), with unknown consequences for this species.
- *Threats during nonbreeding seasons*. Threats exist at most sites where Sanderlings occur, and include: habitat loss, alteration of habitat (e.g., beach stabilization, beach 'nourishment', mechanized beach raking, and sand excavation for construction), widespread recreational disturbance, and pollution – especially oil pollution, as this species occurs mainly on marine shorelines during the nonbreeding season. Agrochemicals and plastic bi-products are also a likely threat, although their effects are not yet understood; and
- *Harvesting of primary food source at migration sites by humans* (e.g., Horseshoe Crab eggs).

Conservation activities recommended to address these threats are:
- Identification and protection of existing habitat;
- Management of and education at existing protected areas to reduce disturbance;
- Management of Horseshoe Crab harvest to ensure adequate food for migrating shorebirds;
- Work towards new legislation to reduce pollution (including greenhouse gases);
- Increase regulations (e.g., beach closures, leash laws) where necessary.

The relative importance of these threats to the Sanderling during different life stages is not yet well understood, and a better understanding is necessary if we are to achieve the greatest impact of conservation and management actions. However, it is clear that the habitat preference by Sanderlings (i.e., sandy beaches) puts them at risk due to constant disturbance from humans, as well as from (oil) pollution, development pressure, various beach stabilization/aesthetic activities, and sea-level rise.

Sanderlings share habitat with other coastal specialist shorebirds (especially Whimbrel and Willet) and many other coastal species both marine and terrestrial, and conservation efforts for Sanderlings will benefit other species. In some areas, the Sanderling is a key 'umbrella' species, such as along the Pacific coast of South America where it is the most common coastal shorebird species from Peru to Chile. Conservation of the Sanderling would benefit waterbirds and other coastal species along the entire southern part of its wintering range.

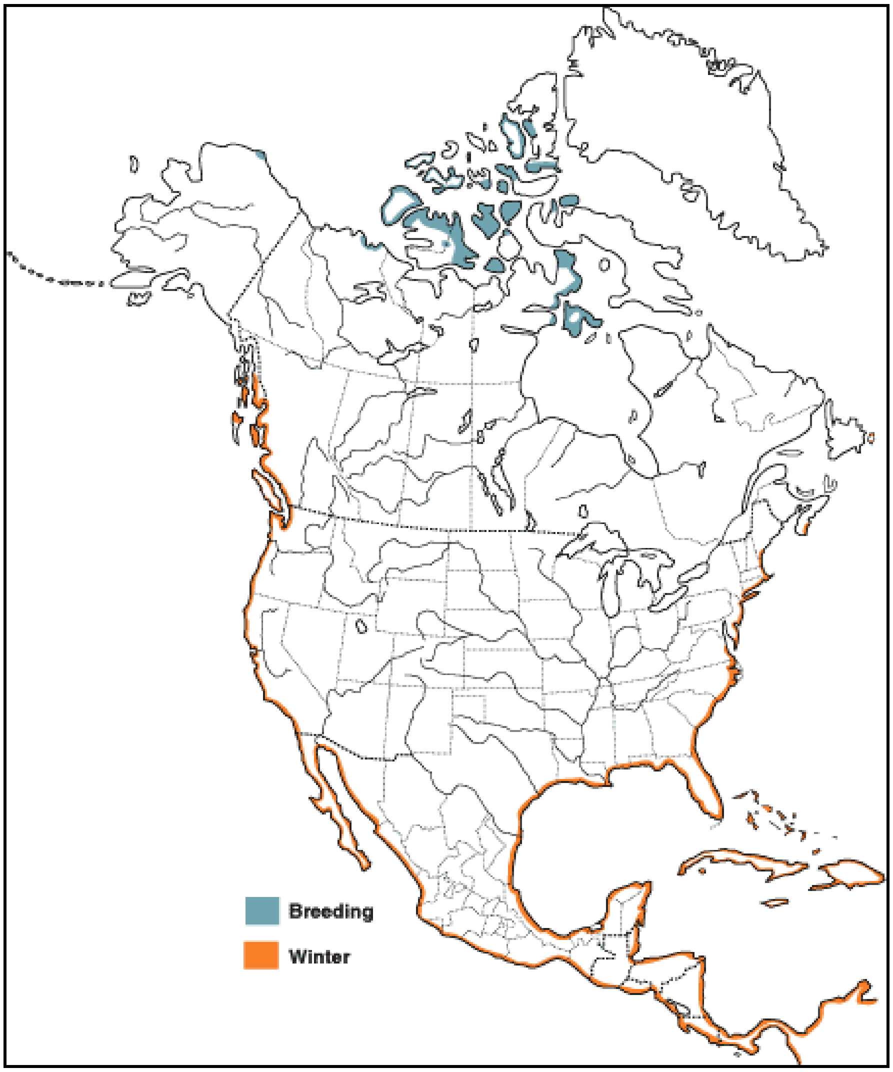

Figure 1. Distribution of the Sanderling in North and Central America and the western West Indies. This species also breeds from Greenland through northern Europe and Asia, and winters in the eastern West Indies and in South America (see Figure 2).

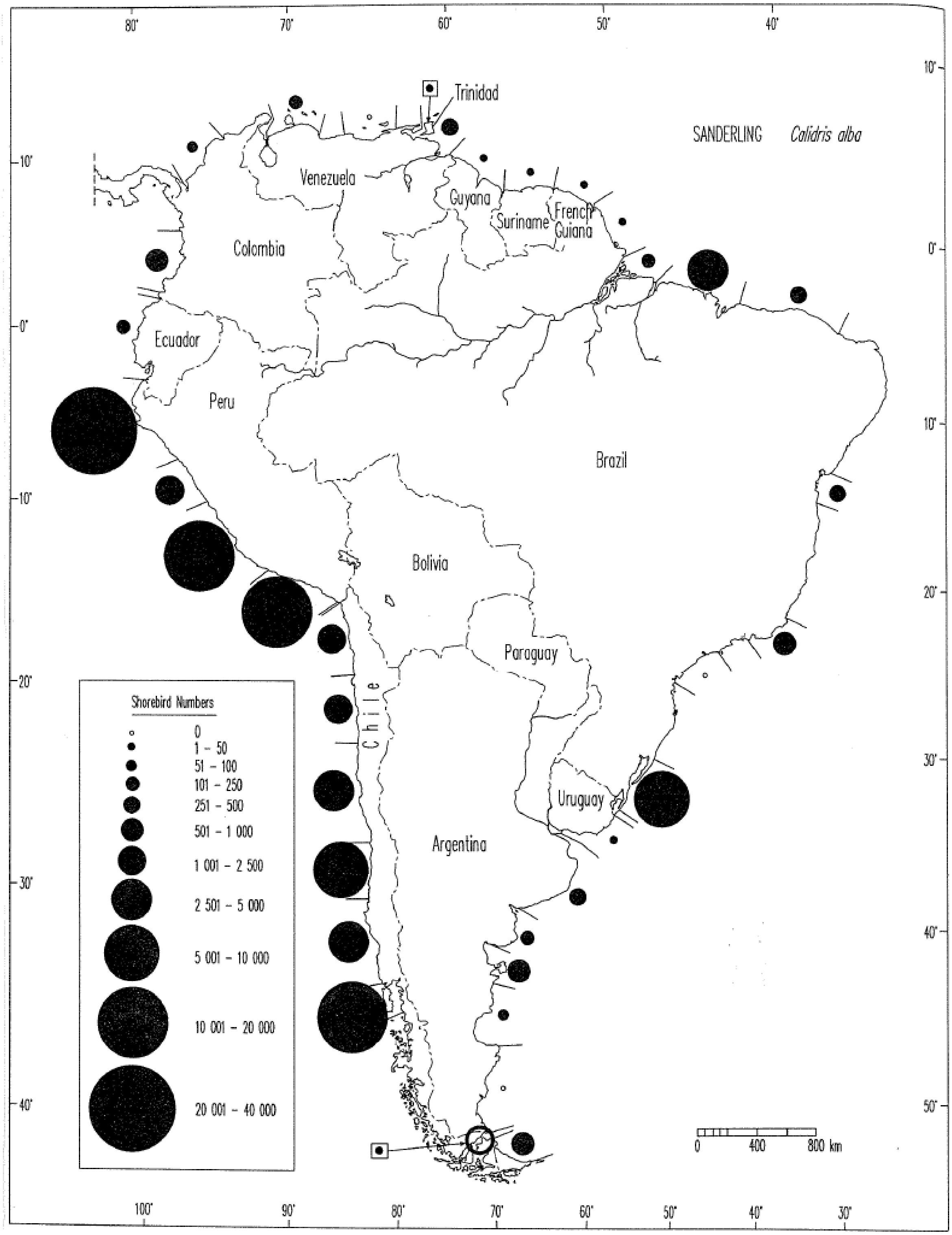

Figure 2. Distribution and abundance of the Sanderling in South America, based on aerial surveys conducted in the 1980s (*Source:* Morrison and Ross 1989, Atlas of Nearctic Shorebirds on the coast of South America, Vol. 1.)

RESUMEN EJECUTIVO

El *Calidris alba* es un ave playera pequeña que reproduce en el alto ártico y migra a las playas templadas, tropicales y sur-templadas. En Norteamérica, el *C. alba* está clasificado como una Especie de Gran Preocupación a causa de la disminución significativa de la población, por pérdida generalizada del hábitat, y las amenazas que enfrenta durante la temporada no reproductiva (migración y en el invierno).

El *C. alba* tiene una distribución circumpolar en el período reproductivo, sin embargo hay poca diferencia morfológica entre las poblaciones. Ocurre una diferencia entre los individuos en el rango de no reproducción. No se reconocen subespecies de *C. alba*. Esta especie utiliza tres rutas principales de migración hacia las Américas: el Pacífico, el Centro y el Atlántico.

Las concentraciones más grandes de *C. alba* en Norteamérica ocurren durante la migración de primavera, donde decenas de miles de aves se reúnen en el centro de la Costa Atlántica (en las playas costeras de la Bahía de Delaware) y en lagos alcalinos poco profundos en las Praderas de Canadá (Saskatchewan). Otras grandes concentraciones en la primavera también ocurren en la costa central de Carolina del Norte (Dinsmore *et al.* 1998, Walters 1984); en el exterior de las playas costeras de arena en el centro de Oregon y sur de Washington (Myers *et al.* 1984b, 1984b); y en Alaska (Isleib 1979).

La migración de otoño en Norteamérica es más prolongada, se extiende desde mediados de julio hasta finales de octubre (o noviembre), y las aves están de menores congregaciones. Sin embargo, algunas *C. alba* congregan en Massachusetts (hasta 17.000 individuos), en Nueva Jersey (8.000), en Virginia (varios sitios con 17.000), Texas (8.400), y Washington (10.000) (base de datos de la Encuesta Internacional de Aves Playeras). Por otro lado, los *C. alba* dispersan durante el otoño, pasando por sitios importantes a lo largo de las costas de los Lagos Grandes y por las costas del Pacífico y el Atlántico. Durante el invierno, los *C. alba* están dispersos, y muchos individuos en la mayoridad de los lugares muestran una fuerte fidelidad al sitio y una territorialidad que influyen la estructura de la población (Myers *et al.* 1988).

Los *C. alba* necesitan la planificación clara de conservación por varias razones:

- *Descenso de las poblaciones;*
- *Pérdida generalizada del hábitat*: Su principal hábitat son playas de arena abiertas e islas barreras, los cuales se ven amenazados por el desarrollo y la perturbación humana;

- *El cambio climático global y el incremento del nivel del mar:* Lo cual genera una mayor presión sobre los hábitats costeros. El cambio climático continuará alterar las condiciones en las áreas de reproducción (ej., el tiempo y la disponibilidad de recursos alimenticios, la presión de depredación, y competencia), y en los sitios de paradas de la migración (debido al incremento del nivel del mar y las sequías), con las consecuencias desconocidas para esta especie.
- *Amenazas durante la temporada de no reproducción:* Las amenazas existen en la mayoría de sitios donde *C. alba* ocurre y incluyen: la pérdida de hábitat, alteración del hábitat (ej., estabilización de la playa, "alimentación" de la playa, rastrillar las playas mecánicamente, y la excavación de arena para construcción), perturbación generalizada de actividades recreativas, y contaminación—especialmente por derrames de petróleo, ya que esta especie principalmente ocurre en las costas marinas durante la temporada de no reproducción. Agroquímicos y bi-productos de plásticos son también una amenaza, aunque sus efectos reales se desconocen aún.
- *La cosecha por parte del humano de la principal fuente de alimentación en los sitios de migración* (ej., los huevos de *Limulus polyphemus*).

Las actividades de conservación recomendadas para hacer frente a estas amenazas son:

- Identificación y protección del hábitat existente;
- El manejo además los programas de educación en las áreas protegidas para reducir las perturbaciones;
- El manejo de la cosecha de *Limulus polyphemus* para garantizar la alimentación suficiente para las aves playeras durante la migración;
- Trabajar en pro de una nueva legislación para reducir la polución (incluyendo los gases que contribuyen al cambio climático).
- Aumento en las regulaciones donde sea necesario (ej., el cierre de las playas, o restricciones sobre los animales domesticados en las playas).

La importancia relativa de estas amenazas para los *C. alba* durante las etapas de su vida aún no se entienden completamente; y se necesaria una mejor comprensión de eso si queremos lograr un gran impacto con gestiones y acciones de conservación. Sin embargo, está claro que por causa del hábitat preferido por los *C. alba* (playas de arena), las poblaciones se encuentran peligro por el constante perturbación del humano, así como contaminantes (petróleo), gran presión de desarrollo, varias actividades en las playas con fines de estabilización o paisajísticos, y el incremento del nivel del mar.

Los *C. alba* comparten hábitat con otras especies de aves playeras costeras (especialmente con *Numenius phaeopus* y *Tringa semipalmata*) y muchas otras especies costeras marinas y terrestres; por eso, los esfuerzos de conservación para los *C. alba* beneficiarán a estas otras especies. En algunas zonas, el *C. alba* es una especie "sombrilla," como a lo largo de la costa Pacífica de Suramérica donde la está la más común de especies de aves playeras costeras desde Perú a Chile. La conservación del *Calidris alba* beneficiará las aves acuáticas y otras especies costeras a lo largo de toda la parte sur de su rango invernado.

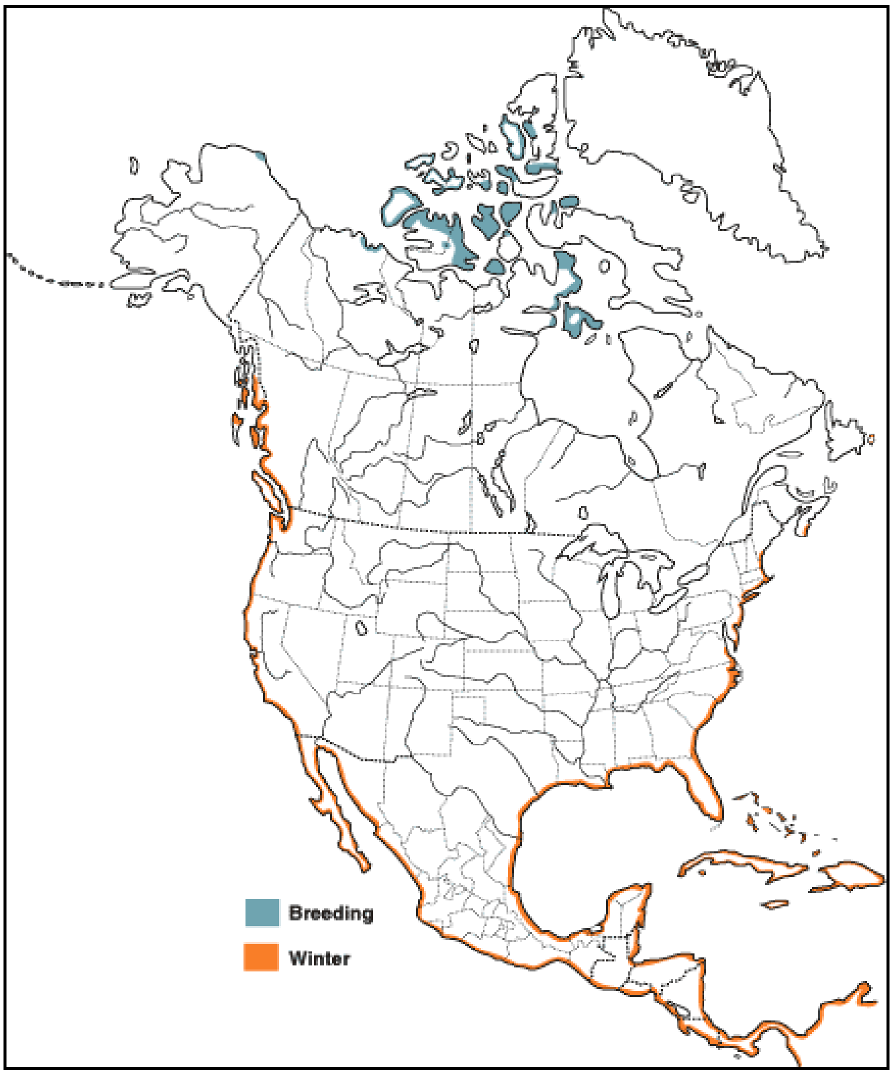

Figura 1. Distribución del *Calidris alba* en Norteamérica, Centroamérica, y el oeste de las Indias Occidentales. Esta especie también se reproduce desde Groenlandia a través del norte de Europa y Asia, y pasa la temporada de invierno en el este de las Indias Occidentales y en Suramérica (ver Figura 2).

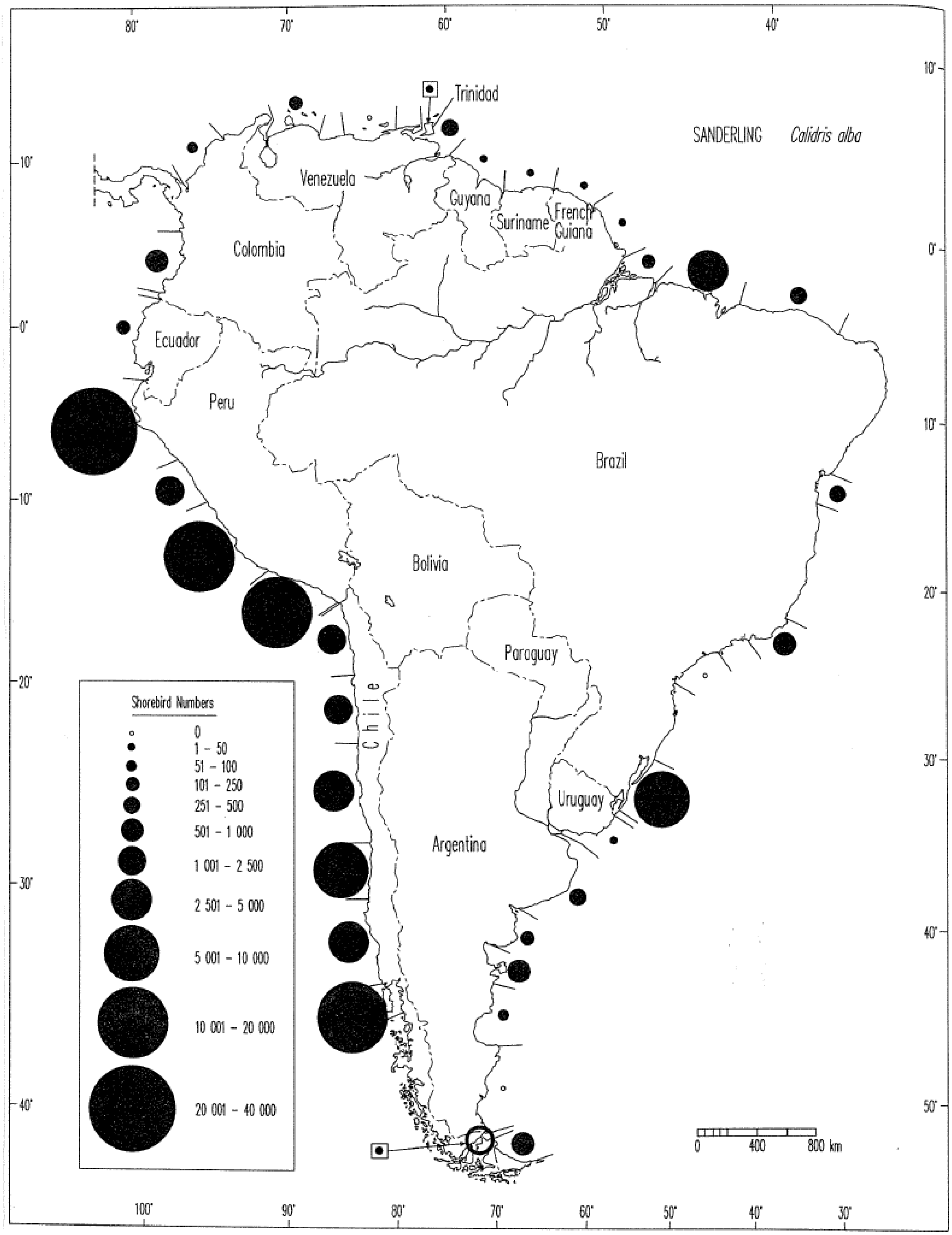

Figura 2. Distribución y abundancia de *Calidris alba* en Suramérica, basado en las encuestas aéreos realizados en la década de 1980 (Fuente: Morrison y Ross 1989, Atlas de las Aves Playeras Neárticas de la costa de Sudamérica, Vol. 1).

PURPOSE

This document focuses on the Sanderling in the Americas, especially North America. Future revisions will seek to include more complete information for Latin American regions as it becomes available. The present plan covers our current knowledge of Sanderling distribution, life history, and population sizes and trends. In addition, the plan describes and lists current threats and management needs, and outlines suggested conservation actions.

STATUS AND NATURAL HISTORY

Most of the research on Sanderlings has focused on them during the nonbreeding season, with the most extensive work being on foraging behavior, spacing, and population structure (Myers 1981, 1983b, 1984; Myers *et al*. 1979a, 1979b, 1981; Pitelka *et al*. 1980), as well as physiology on migration and the wintering grounds (Castro *et al*. 1989, 1992; Castro and Myers 1990, 1993). More recent studies have noted apparent rapid declines in regional populations, with the apparent cause being habitat degradation and increasing recreational use of sandy beaches (MacWhirter *et al*. 2002).

The Sanderling is the well-known, small, plump sandpiper of sandy ocean beaches, most often seen running along at the edge of incoming and receding waves. Less often, Sanderlings occur at sand/mudflats, lagoons and inland lake shores, or intertidal rocky shores. They feed on aquatic and terrestrial invertebrates, such as small crustaceans and bivalve mollusks, and less frequently on small polychaete worms, insects, and talitrid amphipods (MacWhirter *et al*. 2002). Although Sanderlings are North America's most widespread maritime shorebird during winter, local numbers are usually small. Their wintering range is extraordinarily wide, spanning 100^{o} latitude and encompassing most temperate and tropical beaches in the Americas (MacWhirter *et al*. 2002). Sanderlings winter between 50^{o}N and 50^{o}S on the Pacific Coast (southern British Columbia to southern Chile), and between 42°N and 50°S on the Atlantic Coast (Massachusetts to Southern Argentina).

The Sanderling breeds across the high arctic, with highest numbers occurring in the Canadian Arctic archipelago, Greenland, and high-arctic Siberia (MacWhirter *et al*. 2002). Sanderlings nest either as single pairs or in loose colonies, and lay four eggs in a ground nest typically situated in exposed, well-drained tundra. Eggs hatch after 23–27 days, and both sexes may incubate, brood, and attend fledged offspring. However, mating systems vary among populations (ranging from monogamy to serial polyandry), so sexual roles vary depending on the mating system. For instance in arctic Canada (but not in Greenland), Sanderlings may rear two broods per season—the male rears the first brood, and the female rears the second (MacWhirter *et al*. 2002).

Chicks hatch within a day of their nest mates and are precocial; all leave the nest together within a day of (and usually ≥12 hours after) hatching. Chicks follow the parent to a moist feeding area, where they feed on surface-dwelling insects (Myers 1988). One or both parent(s) remain with the chicks until all are fledged (Pienkowski and Green 1976) or until chicks have reached near-sustained flight (≥15 days). Over that time period, the family may move up to 3 kilometers or more from the nesting site (MacWhirter *et al*. 2002). Sanderling juveniles fly well by 17–21 days; until then, they are especially vulnerable to ground predators, then to aerial predators thereafter (e.g., jaegers). At fledging, most parents leave offspring, and juveniles gather together in small flocks of 4–15 individuals (Pienkowski and Green 1976, Meltofte 1985). In arctic Canada, juveniles do not migrate until after the adults (Myers 1988; MacWhirter *et al*. 2002).

During migration, Sanderlings are locally common on the Pacific, Atlantic, and Gulf coasts of North America, and along (sandy) shorelines of lakes within the Great Plains region; they are uncommon or rare in the Intermountain West (MacWhirter *et al*. 2002; Paulson 1993). Their main coastal prey consists of sandy beach invertebrates, especially hippid crabs and isopods; at inland sites they eat bivalve mollusks and a variety of invertebrates. During spring migration in the United States, peak numbers occur on the Atlantic coast of Florida and in Delaware Bay, where Sanderlings feed extensively on Horseshoe Crab eggs during their 4-week stopover (Castro *et al*. 1989, Castro and Myers 1993, MacWhirter *et al*. 2002). Peak numbers are lower in the fall, and occur primarily along New England, mid-Atlantic, and Pacific coasts.

During winter, most Sanderlings migrate to Central and South American beaches (Figure 2); however, many winter regularly along the Pacific, Atlantic, and Gulf coasts of North America. Along the Pacific coast of South America, the largest numbers of Sanderlings coincide with areas where ocean upwelling is highest, likely because these areas support higher invertebrate populations (Bertochi *et al*. 1984, Morrison 1984, Myers *et al*. 1985).

Individuals differ in extent of site fidelity, but many demonstrate strong inter- and intra-annual site fidelity (less so in juveniles). Many individuals rarely leave an area, whereas others move in and out regularly. Wintering Sanderlings may conduct ≥60% of their activities (Peru) and spend ≥95% of their time (California) within the same 5 kilometers of beach (Myers 1984, Myers *et al*. 1988). In coastal central California, individuals spend most of the winter within a small (< 10-kilometer) stretch of beach, and rarely change wintering areas between years (Myers *et al*.1988, MacWhirter *et al*. 2002). Similar patterns of high winter site fidelity have been recorded on the North Carolina coast (Dinsmore *et al*. 1998). However in Peru, site fidelity is lower and individuals range more broadly during winter (Myers 1988).

Although wintering populations differ in extent of territoriality, some individuals of either sex may be strongly territorial in the intertidal zone, as well as on sandy beaches above the high-tide mark. Otherwise, individuals tend to roam in conspecific, non-territorial flocks (MacWhirter *et al*. 2002). On the Washington coast, Sanderlings forage and roost in conspecific flocks, or in mixed-species flocks at mid- and higher tides when other species (typically Dunlins) are present (J. Buchanan, pers. comm.).

Yearling Sanderlings molt on the wintering grounds and migrate to the breeding grounds after the adults (Ferns 1980), and likely do not breed until their second year, although quantitative data are lacking (Meltofte 1985).

Adult survivorship averages 83% (Evans and Pienkowski 1984, MacWhirter *et al*. 2002), and Sanderlings typically live a decade or longer—oldest known age is 13 years (Boates and McNeil 1984). However, mortality by avian predators can be locally significant. For example, a Merlin (*Falco columbarius)* killed 14% of the more than 130 local winter resident Sanderlings near San Francisco, California (Page and Whitacre 1975); Peregrine Falcons (*Falco peregrinus*) killed approximately 3% of a local winter population along the Peruvian coast (Bertochi *et al*. 1984, Castro *et al*. 1988).

MORPHOLOGY

A small, plump sandpiper, the Sanderling ranges in mass from 40–110 grams, varying with season, geographic location, and sex (Myers 1988). Typical winter mass ranges from 45–60 grams, and females are typically larger than males (Myers *et al*. 1985, Castro *et al*. 1992). Body mass of Sanderlings is highest during migration (especially spring) when the birds accumulate substantial fat deposits at staging areas (Myers 1988). Birds wintering in North America (New Jersey, Texas) tend to have larger linear dimensions than birds wintering in South America (Peru, Panama; Castro *et al*. 1992).

TAXONOMY

A single race breeds across the arctic (e.g., Canada, Greenland, Siberia), with very little variation in body size and plumage across the circumpolar range (MacWhirter *et al*. 2002). Most North American breeders winter in South America (both coasts), as well as along Pacific and Atlantic coasts of North and Central America. Although the extent and details of such movements remain unknown, some wintering populations use predictable and distinct migratory routes, suggesting that there may be some separation of populations (MacWhirter *et al*. 2002).

POPULATION ESTIMATE AND TREND

Historically in North America, Sanderlings were considered a game bird among beach gunners, and unregulated hunting between 1870 and 1927 probably reduced their populations (Page and Gill 1994). Following the market-gunning period, Sanderling increased in abundance in Massachusetts (Hill 1965). It is unknown whether subsistence hunting south of the United States currently affects their populations (Senner and Howe 1984).

Global population estimates for the Sanderling are uncertain but reported as 660,000 by the Canadian Wildlife Service (Audubon Watch List 2007), and 620,000–700,000 in the World Bird Data Base (BirdLife International 2009).

The North American population of Sanderling is estimated with low confidence (i.e., likely to be in the right order of magnitude, but based on broad-scale surveys which do not allow for precise estimates) at 300,000 individuals, roughly 140,000 (low confidence) of which may breed in the Canadian Arctic and the remainder across Eurasia (Morrison *et al*. 2000). Current maximum count estimates (with low confidence) by flyway are: Pacific 50,000; Central 130,400; and Eastern 99,000 (Appendix I, Canadian Shorebird Conservation Plan) (Donaldson *et al*. 2000, Morrison *et al*. 2001).

Trends in migratory shorebird populations are notoriously difficult to detect, due to data limitations of broad-based surveys (i.e., variable effort over space and time). The most recent effort examines southbound migration of shorebirds through the Atlantic and Midwest regions of

North America, where data are sufficient to permit more rigorous analyses (Bart *et al*. 2007). Within these regions, Sanderlings showed a non-significant decline along the Atlantic flyway (3.2% per year) during the period 1974–1998. In the Midwest flyway, Sanderling numbers showed no significant change (but a non-significant increase of 1.9% per year) over the same time period (Bart *et al*. 2007).

Other analyses of various data sets indicate predominantly declining (or less often, stable) trends in Sanderling abundance across migratory flyways and on wintering grounds (Gill *et al*. 1995; J. Buchanan unpubl. data). The extent (and in some cases, certainty) of population trajectories has yet to be determined, and design and maintenance of improved monitoring schemes should be a major priority to enable population status evaluation for this species.

Canadian populations appear to be either declining or stable (Morrison 1993), with Quebec migrants showing slight declines between 1970 and 1995 (Cyr and Larivée 1995). Records from fall migration in eastern Canada (the Maritimes Shorebird Surveys) indicate a significant decline in Sanderling abundance between 1974 and 1979, an increase between 1980 and 1985, and no significant change between 1986 and 1991. These declines and increases may reflect an abrupt transition from severe inclement weather on the breeding grounds (during the1970s), followed by a period of less severe weather (1980s). Sanderling abundance also appears to have declined significantly (1974 to 1998) in the Canadian Maritime Provinces as well as in Quebec (1976 to 1998), and in Ontario (non-significantly) between 1976 and 1997 (Morrison *et al*. 1994).

In the United States east of the Rocky Mountains, Sanderling abundance has been declining. International Shorebird Survey (ISS) data indicated a significant decline (mean annual change of -13.7%, cumulative decrease 80.2%) between 1974 and 1983 (Howe *et al*. 1989; Gill *et al*. 1995) along the Atlantic flyway. Spring-migration counts of Sanderlings also declined in Delaware Bay between 1986 and 1992 (Clark *et al*. 1993). Peak spring and fall counts in Monomoy, Massachusetts, declined by an order of magnitude (approximately 30,000 to 3,000) since the 1950s (Veit and Petersen 1993).

During winter, Christmas Bird Counts (CBCs) indicate declining or stable populations between 1959 and 1988, with significant declines in California (3.7% per year) (Sauer *et al*. 1996) and especially (-13.7 % annually) along the Atlantic coast from 1974 to 1982 (Appendix 2, Canadian Shorebird Conservation Plan; Donaldson *et al*. 2000). On the outer coast of

Washington, Sanderling populations appeared to have been stable and/or possibly increasing between 1983 and 2005 (J. Buchanan, unpubl. data); Christmas Bird Count data indicated a modest increase in regional wintering numbers for the Pacific Northwest between 1974–1988 (Paulson 1993), but it is unclear if this represents a true population increase. The wintering population in southwest Florida appears to have been stable from 1959 to 1988 (T.H. Below unpubl. data). Overall, although Sanderling populations wintering on the Atlantic Coast appear to be declining with some consistency, there is uncertainty regarding Pacific Coast wintering populations, which do not yet show an obvious, region-wide decline (though analyses are limited).

Data from Latin America and the Caribbean are limited but signal declines. Sanderlings declined steadily during a 5-year study conducted in Chile between 1987 and 1991 (Tabilo *et al*. 1996, Myers 1988). The CBC data from 1959 to 1988 indicate a significant decline in Suriname (1.3% per year) (Sauer *et al*.1996). Wintering populations in Cuba (ca. 1,000 total) are reported as stable (Acosta-Cruz and Mugica-Valdes 2006).

DISTRIBUTION

The Sanderling is one of only 10 North American breeding shorebird species with a widespread nonbreeding distribution (Brown *et al*. 2001).

Breeding Range

In the Americas, the Sanderling breeds on high-arctic tundra (approximately 64° – 85°N), mainly on islands in the Canadian Arctic archipelago, especially Prince of Wales Island, Nunavut (Manning and MacPherson 1961). Sanderlings rarely breed in northwestern Northwest Territories (MacWhirter *et al*. 2002) or Alaska (Pitelka 1974, Armstrong 1995).

In Canada, Sanderlings breed on Queen Elizabeth Island, Northwest Territories / Nunavut, on Prince Patrick Island (Mould Bay), Lougheed Island, Melville Island, south Bathurst Island, Cornwallis Island, and the Grinnell Peninsula of Devon Island. Sanderlings nest in low densities on Ellesmere Island and Axel Heiberg Island (Parmelee and MacDonald 1960). Within the District of Franklin, Sanderlings nest on Banks Island, Northwest Territories (Collinson Point, Sachs Harbor), southeast Victoria Island, Prince of Wales Island, King William Island and Somerset Island. Sanderlings are found on Bylot Island and north Baffin Island, Nunavut (near Nanisivik, Strathcona Sound; Godfrey 1986). In mainland Canada, Sanderlings breed on Boothia and Melville Peninsulas, and Southampton Island, Nunavut; they rarely breed in the Northwest Territories (Bathurst Peninsula, Franklin Bay; MacWhirter *et al*. 2002) (Figure 1).

Nonbreeding Range

In the summer, nonbreeding birds occur south of the breeding range (Figure 1).

<u>During migration:</u> Despite their broad winter distribution and locally modest numbers, Sanderlings are quite aggregated during spring migration, relying on several major staging areas to complete their lengthy migrations to the high arctic. Major North American staging areas include the outer coastal sandy beaches of southern coastal Washington to central Oregon (Myers *et al*. 1984b, 1984b), and (possibly) Prince William Sound, Alaska, on the Pacific Coast; alkaline lakes in interior Saskatchewan, Canada (Beyersbergen and Duncan 2007, Beyersbergen unpubl. data); and Delaware Bay—especially the lower New Jersey region (Dunne *et al*. 1982, Clark *et al*. 1993) and the central coast of North Carolina (Dinsmore *et al*. 1998, Walters 1984) on the Atlantic Coast. Smaller numbers of Sanderlings also consistently stop on migration throughout the Texas Gulf coast and Florida.

Less is known about Sanderling distributions on migration in South America. However, surveys indicate that Lagoa do Peixe, Brazil, is a major staging area in spring (Morrison and Ross 1989), and that birds use the Pacific and Atlantic coastlines of South America during both migrations.

During fall migration, Sanderlings are more dispersed in North America, using both Pacific and Atlantic coastlines, to a lesser extent, the U.S. and Canadian interior. In the United States, they occur in the thousands in New Jersey (Burger *et al*. 1977), Massachusetts, the Outer Banks of North Carolina (Dinsmore *et al*. 1998, Myers 1988), Virginia, Texas, and Washington (MacWhirter *et al*. 2002, and ISS data), and in Saskatchewan, Canada (Beyersbergen and Duncan 2007, Beyersbergen 2009); they occur in the hundreds in many other locations.

<u>Wintering grounds:</u> The majority of Sanderlings that breed in North America winter in Central and South America between the latitudes of the Tropics of Cancer (23.5^{o} N) and Capricorn

(23.5^{o} S). However, a subset winters in North America, especially along the Pacific, and also along the Gulf and southeast Atlantic Coasts, and along sandy beaches in Central America (Morrison 1984, Myers *et al*. 1985, Morrison and Ross 1989). The primary wintering grounds span the vast Pacific coasts of Peru to Chile and, to a lesser extent, the southeast Atlantic and north coasts of Brazil.

Information is incomplete for Mexico and Central America. However, it is known that Sanderlings are present (although relatively rare) during winter along the Gulf coast of Mexico (Howell and Webb 1995); they are present in Bermuda and relatively common in the West Indies (Raffaele *et al*. 1998).

Sporadically, wintering Sanderlings are recorded as far north as ice-free sub-arctic regions of Alaska (Godfrey 1986, Root 1988, Gill and Senner 1996), or New England (along the Atlantic Coast), but these observations are rare (MacWhirter *et al*. 2002).

ABUNDANCE

Breeding

Approximately 300,000 Sanderlings are estimated to occur in the Americas—140,000 of which are estimated to breed in the Canadian Arctic and the remainder across Eurasia (Morrison *et al*. 2000). Sanderlings use fairly clustered breeding areas (Paulson 1993), though often at lower densities than other sandpipers (Myers 1981). Surveys from the 1950s in Canada indicated 65,000 individuals on Banks Island, Northwest Territories, and 70,000 on Prince of Wales Island, Nunavut, and adjacent islands (Manning *et al*. 1956, Manning and MacPherson 1961). Nest densities vary among years, ranging from 1–3 pairs/km^2 on Bathurst Island (Parmelee 1970, Mayfield 1983) and Greenland (Meltofte 1985, Boertmann 1994).

Migration

During fall migration, Sanderlings occur in the thousands at a number of sites in the United States and Canada. Along U.S. coasts, these include a dozen sites in Massachusetts, and several each in New Jersey, Virginia (barrier islands), North Carolina, Florida, Texas, Washington, Oregon, and California. Sanderlings also occur in the hundreds at many locations along the Pacific, Atlantic, and Gulf coastlines, as well as on the shores of the Great Lakes. In

Canada during fall, Sanderling are known to be abundant in Quebec (thousands), Ontario (hundreds to thousands), and New Brunswick (hundreds to thousands).

During spring migration, Sanderlings occur in larger aggregations (tens of thousands) at several sites including Delaware Bay, New Jersey (~33,000), the north coast of Oregon (Contreras 2003), and especially the shallow, saline/alkaline lakes of the Canadian Prairies (50,000–100,000 at Quill Lakes and Chaplin/Old Wives Lakes in Saskatchewan). In Canada, Sanderlings occur in the thousands in Alberta and Saskatchewan; and in the United States in Massachusetts, Virginia, Texas, Oregon, and Washington. They also occur in the hundreds at many sites along the Pacific, Atlantic, and Gulf coastlines and the shores of the Great Lakes.

Nonbreeding

In midwinter along the contiguous U.S. Pacific coastline (north of Mexico), Sanderling densities range between 30–40 birds/km of beach, with higher densities near estuaries and on beaches more than 5 kilometers long (Myers *et al*. 1984b, MacWhirter *et al*. 2002). High numbers occur along the Pacific coast of Washington (Buchanan 1992 and unpubl. data, MacWhirter *et al*. 2002), Oregon, and California (except between Point Arena and Bodega Bay, or around Los Angeles), with highest California densities around Humboldt and Monterey Bays (Root 1988, MacWhirter *et al*. 2002). In interior California, small numbers occur at Hollister and Salinas sewage ponds, but are otherwise extremely rare (MacWhirter *et al*. 2002). The Atlantic Coast hosts slightly lower winter densities than the Pacific, and its highest densities occur in New Jersey and northern North Carolina. In Florida, Sanderlings are abundant along the Canaveral National Seashore and Merritt Island National Wildlife Refuge (NWR). They are less abundant on the Florida Gulf Coast (Crystal River to Naples), and they occur in modest concentrations in Texas (e.g., at Aransas NWR) (MacWhirter *et al*. 2002).

In Mexico and Central America, Sanderlings occur in lower densities (2–7 birds/km or less), on long stretches of beach abutting open desert; on beaches near bay/lagoon systems, Sanderling densities are approximately 6–7 birds/km, compared to 1.9 birds/km on rocky coastlines (Schick *et al*. 1984). Several thousand to ten thousand Sanderlings have been counted during aerial surveys in Baja California (Page *et al.* 1987). However, in the coastal estuaries of Sinaloa, Mexico (Ensenada de Pabellones, Estero de Urias, and Huizache-Caimanero), only a few Sanderlings (< 3 birds/km) are found, sporadically (G. Fernandez, pers. comm.).

Roughly 1,000–5,000 Sanderlings are winter residents in Cuba, more commonly along its West and Central coasts than its Atlantic coast (Acosta-Cruz and Mugica-Valdes 2006). In Panama, the Sanderling is an uncommon transient and winter resident; approximately 1,000 may be found along its Pacific coast (Butler *et al*. 1997; Angehr 2005). Occasionally, the Sanderling may be present here during summer.

The estimated wintering population of Sanderlings for South America is 110,000 – 112,000 individuals, based on coastal aerial surveys conducted in the mid 1980s (Morrison and Ross 1989). The majority of the wintering Sanderlings (88% of continental total, or approximately 96,800 birds) occurred along sandy beaches of the Pacific Coast, with Peru and Chile together hosting 99% of the population (approximately 66,000 and 30,000, respectively; Morrison and Ross 1989). The highest wintering densities of Sanderlings in the Western Hemisphere (>100 birds/km) were found on beaches of central and southwest Peru and northwest Chile (Bertochi *et al*. 1984, Myers *et al*. 1984a, 1985). Sanderlings were the most abundant small shorebird on Pacific Coast beaches of South America, comprising 94–100% of small waterbirds encountered along the vast stretch of coastline that extends from northern Peru to southern Chile/Chiloe Island (Morrison and Ross 1989).

Fewer Sanderlings (and lower densities) occur along the Atlantic (approximately 9,300 birds) and northern (approximately 4,400 birds) coasts of South America, with 69 birds/km in southern Brazil near Lagoa do Peixe (Rio Grande do Sul), and 25 birds/km in northern Brazil near Sao Luis (Morrison and Ross 1989).

MIGRATION

Many Sanderlings migrate in an elliptical (clockwise) pattern, heading south along the Eastern flyway during fall, but returning north along Central and Western flyways in spring. Most birds wintering on the Pacific coast of South America complete this elliptical migration pattern, using the eastern flyway during southbound migration (although some birds pass through coastal Texas), and the central or western flyways during northbound migration (MacWhirter *et al*. 2002).

Southbound

During the fall passage through North America, most Sanderlings occur on Pacific, Atlantic, and Gulf Coast beaches (Myers *et al*. 1990, MacWhirter *et al*. 2002). Fall migration occurs over an extended period of time, from mid-July until late October. On the high-arctic breeding grounds, non- and failed-breeders begin forming flocks in late June (Meltofte 1985). By mid-July to mid-August, most adults have departed; juveniles follow a month later, in late August to early September (Hayman *et al*. 1986, Johnson and Herter 1986). A few adults linger well into September, with juveniles (Parmelee 1970, MacWhirter *et al*. 2002).

Migratory routes between breeding and wintering areas are incompletely understood. However, three major flyways are described for the species in North America:

<u>Western</u>. Along the North American Pacific Coast (British Columbia to California), southward movement to the wintering grounds begins in July and continues through mid-October, typically peaking in mid-August to mid-October. Juveniles arrive and reach their peak level of abundance about a month after adults (MacWhirter *et al*. 2002). Most birds wintering along the North American Pacific Coast use this flyway during southbound migration. And, although information for Mexico is still accumulating, migrating Sanderlings are known to stop along the Pacific coast of Baja California Sur in Guerrero Negro in August, and at Laguna San Ignacio in October (R. Carmona, pers. comm.).

<u>Central</u>. Fall migration through the Canadian Prairies region involves fewer birds than spring; Sanderlings pass through the interior of Canada and the United States (e.g., Saskatchewan, Manitoba, Indiana, Missouri, Texas) between mid-July and mid-October (one month later in Texas), with adults preceding juveniles by about 6–7 weeks (MacWhirter *et al*. 2002). Most birds breeding in the Canadian arctic use this flyway during southbound migration.

<u>Eastern</u>. Fall migration takes place from mid-July to early November, with peak numbers in August and September. During migration along the eastern flyway (e.g., Massachusetts, Great Lakes coast, New Jersey, North Carolina, Florida), adults precede juveniles by about a month. Birds destined for wintering grounds on the Atlantic coast of South America use this entire Atlantic Coast flyway during southbound migration (Castro and Myers 1987). Southbound migrants appear in Rio Negro, Argentina, in November (Gonzalez 1996).

Birds leaving the Canadian arctic migrate primarily through the Canadian Prairies region, from the Great Lakes southward and all along the Atlantic Coast. Sanderlings are fairly common along the Great Lakes and some inland lakes (Sherony 1998), but they are relatively uncommon along the St. Lawrence River (Bourget 1993) and east of Ontario, where they are mainly fall transients, particularly in Labrador, Newfoundland, and the Maritimes (Godfrey 1986, MacWhirter *et al*. 2002). Modest numbers (daily maxima in the hundreds) occur in Ontario and New Brunswick; Sanderling numbers reach the low thousands in Quebec, during fall (Important Bird Areas of Canada 2009).

The timing of the peak passage of southbound Sanderlings spans several months. Sanderlings migrating through Costa Rica are present from mid-August through October (Stiles and Skutch 1989). Southbound adults begin arriving in Peru and Chile in late August and early September, followed by juveniles in early October (Hughes 1979, Myers *et al*. 1985, Sallaberry *et al*. 1996).

Northbound

Northbound migration occurs between March and June, and the timing of the peak passage of Sanderlings varies by latitude. Spring migrants move through Rio Negro, Argentina, in March (Gonzalez 1996); Peru in mid-April (Hughes 1979, Castro *et al*. 1988); Costa Rica from mid-March through May (Stiles and Skutch 1989); and through the United States in May (Myers *et al*. 1990).

<u>Western</u>. Spring migration takes place during a narrower timeframe than does the fall migration: between late March and early June, with peak numbers present from late April to late May. Many Sanderlings heading north along the North American Pacific Coast originate from wintering grounds on the Pacific coast of South America. Important northbound stopovers include beaches in northwest Oregon, southwest Washington (Myers *et al*. 1984b), and possibly still Prince William Sound in Alaska (important in the 1970s; Isleib 1979). Additionally, on the Pacific coast of Baja California Sur (Mexico), Sanderlings that have wintered in Guererro Negro depart between March and April; others stop at Guerrero Negro in March, and at Laguna San Ignacio in April (R. Carmona, pers. comm).

<u>Central</u>. Spring migrants pass through the North American interior (United States and Canada) between late April and early June, with peak numbers in May (late May in Canada). Most of the Sanderling wintering on the Pacific coast of South America migrate north through

the Central flyway, moving up the Texas Gulf coast and across the prairies (Myers *et al*. 1984a, 1985, 1990; Castro and Myers 1987).

Eastern. Most of the birds wintering along the Atlantic coast of South America, as well as a small portion of those from the Pacific coast, use this eastern flyway. During spring, Sanderlings migrate relatively quickly up the Florida Atlantic coast (their timing differs on the Florida Gulf coast) and the Carolinas during mid-March to early April. Birds stage at Delaware Bay (New Jersey) and pass through Massachusetts during May and early June. Spring peak numbers occur in mid- to late May. The most important stopover site on this flyway is Delaware Bay, where Sanderlings feast on Horseshoe Crab eggs during a brief 2-week window.

MAJOR HABITATS

Breeding

Sanderlings nest in the high arctic on coastal tundra, peninsulas, and islands, where precipitation is less than 2.5 cm/year (Cramp and Simmons 1983). Characteristics of typical nesting areas range from well-vegetated moist sites, to gravel slopes or dry flats with sparse to no vegetation. Most nests are found on stony ridge tops, gentle slopes, and/or level alluvial plains, often within 0.5 kilometers of wet tundra, ponds, and/or lakes (MacWhirter *et al*. 2002).

Migration

During the nonbreeding season throughout its extensive range, this species occurs predominantly on sandy ocean beaches. Favored sites include hard-packed sandy beaches, but Sanderlings also use tidal mudflats (especially those with a moderate sand component), and rocky coastlines. Otherwise, on migration through the Canadian Prairies region (mainly in spring), Sanderlings use sandy beaches along shallow, saline or alkaline lakes/wetlands; elsewhere, they occur along margins of lakes, ponds, streams, and reservoirs (Godfrey 1986, Andrews and Righter 1992, Dickson and Duncan 1993). Sanderlings roost mainly on sand or cobble beaches above the wave-splash zone, or (less often) on slightly elevated sites, such as salt-marsh hummocks (MacWhirter *et al*. 2002). In Chaplin Lake, Saskatchewan, Sanderlings regularly roost on dikes associated with a Sodium sulphate mining operation (G. Beyersbergen pers. comm) (*Note:* Sodium sulphate is mainly used for the manufacture of detergents and paper pulping).

Nonbreeding

Sanderlings occur in a variety of habitats during the nonbreeding ("winter") season. Prime winter habitats include coastal sandy beaches of the Pacific and Atlantic Coasts; less often, Sanderlings use tidal sand-flats and mudflats, as well as shores of lakes and rivers (Myers and Myers 1979, Myers *et al* 1979a, Connors *et al* 1981). Uncommonly, Sanderlings may be found on rocky shores, sloughs, river mouths, or (rarely) sewage treatment plants.

In Mexico, Sanderlings occur mainly along sandy beaches and salt lagoons, and less frequently at estuaries or rocky coasts (Howell and Webb 1995). In Peru and Chile—the primary wintering area for this species—many of the major concentrations of Sanderlings were found either near coastal lagoons or river mouths, or on long desert coastlines where prevailing oceanographic features (e.g., Humboldt Current) created productive feeding zones (Morrison and Ross 1989). Along the Pacific coast of South America, the rugged geomorphology associated with the Andes translates into isolated wetlands (often coastal lagoons) separated by large distances of rugged but relatively unproductive coastline (Morrison and Ross 1989).

CONSERVATION STATUS

Globally, but especially within the Western Hemisphere, the Sanderling has been recognized by numerous organizations as a species that warrants close scrutiny due to its conservation status. Globally, the Sanderling is listed on the China-Australia Migratory Bird Agreement (CAMBA 1986). At the global scale, the IUCN Red List (BirdLife International 2008) currently classifies Sanderling under the category of "Least Concern," however the IUCN specifies that Global classification may not reflect status within certain regions (e.g., Western Hemisphere).

Within North America, the Canadian Shorebird Conservation Plan considers the Sanderling a Species of High Concern (Donaldson *et al*. 2000); however the Sanderling is not listed on the Committee on the Status of Endangered Wildlife in Canada list (COSEWIC).
In the United States, the Sanderling is protected by the Migratory Bird Treaty Act and is considered a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS 2002). The U.S. Shorebird Conservation Plan ranks North American (but not global) populations

of the Sanderling as a Species of High Concern (Brown *et al*. 2001) (Appendix I – III). The Sanderling is listed as a Declining Yellow species on Audubon's 2007 Watch List.

Regionally, the Sanderling appears on a number of special concern lists. It is a Species of Concern on the Prairie Conservation Action Plan of World Wildlife Fund Canada (Dickson and Duncan 1993). In the Prairie Canada Shorebird Conservation Plan, Sanderling is listed as a species of High Conservation Concern as a passage migrant (Gratto-Trevor *et al*. 2001). The USFWS lists the Sanderling as a Bird of Conservation Concern in several Bird Conservation Regions (BCRs) within the Central Flyway, including: Great Basin (BCR 9), Northern Rockies (BCR 10), Prairie Potholes (BCR 11), and Badlands and Prairies (BCR 17).

Sanderlings are listed as a Species of Conservation Concern on most coastal states' State Wildlife Action Plans, for example Florida, North Carolina, Texas, Virginia, and Washington, among others (State Wildlife Action Plans 2009). State Wildlife Action Plans provide valuable and current information regarding conservation issues and management needs that relate to species of concern and their habitats within each state.

POPULATION GOAL(S)

The U.S. Shorebird Conservation Plan gives a tentative population target of 1,500,000 and to restore Sanderling numbers to their 1972 levels (Brown *et al*. 2001). However, current population estimates (300,000) have low confidence (i.e., are likely to be in the right order of magnitude, but are based on broad-scale surveys which do not allow for precise estimates). Given this uncertainty, it is hard to establish an informed goal at this time, but it may be prudent to establish one when more information is available. Meanwhile, efforts may be aimed at:

- Improving monitoring schemes so that population estimates are more attainable/precise;
- Investigating status of Sanderling populations along flyways and on the wintering grounds;
- Halting regional or range-wide declines;
- Evaluating and establishing population goals based on carrying capacity (with and without habitat restoration efforts).

CONSERVATION SITES

The Sites Table (Appendix V) identifies those sites or areas known to support the greatest numbers of Sanderlings throughout their annual cycle. Generally, these sites have hosted at least 1,000 Sanderlings during migration and/or at least 500 during winter -- representing ≥1% of the estimated flyway or wintering population. Although Sanderlings aggregate at some sites during migration (especially in spring), they are quite dispersed during fall migration and throughout the nonbreeding season. Therefore, it is imperative to consider regions of importance to Sanderlings when creating conservation plans, and not just numeric hotspots (such as those in Appendix V; see also Tables in Appendix IV). Hotspots, while very important, only encompass brief portions of their annual cycle, and do not, by themselves, solidify habitat needs for this species. As Sanderlings are quite dispersed during the nonbreeding season, their protection (as well as for other shorebirds that disperse during [at least some of] migration) requires that we take a broader approach to 'site' identification than the standard Western Hemisphere Shorebird Reserve Network (WHSRN) approach. Such a broad approach poses a logistical challenge to conservationists, simply due to the many sites involved (as opposed to a handful of key sites). However, Sanderlings are highly visible, easy to monitor along linear stretches of beach, appealing to the public (charismatic), and their habitats are readily identified. Further, they are excellent "indicator species" for monitoring the health of coastal ecosystems, and key "umbrella species." Hence, conservation and management practices for Sanderling would provide benefits to a host of other species that rely on the coastal zone, as well.

BREEDING SITES

Sanderlings nest in relatively low densities across their breeding range, so identifying and describing specific breeding sites is not appropriate for this species. Rather, the information below highlights general regions of known importance to the Sanderling during the breeding season.

Sanderlings breed in the high arctic, approximately between latitudes 64–85°N (Figure 1.). In North America, approximately 140,000 birds breed principally on islands in the Canadian arctic archipelago, especially Prince of Wales Island, Nunavut, and adjacent islands (estimated at 70,000 individuals in the 1950s), and on Banks Island, Northwest Territories (70,000 in the 1950s; Manning *et al*. 1956, Manning and MacPherson 1961; Morrison *et al*. 2000). Sanderlings also breed on Bathurst Island, Nunavut in variable but relatively low nesting densities (1–3 pairs/km^2 depending on year; Parmelee 1970, Mayfield 1983). Recent studies confirm that Creswell Bay, Nunavut, is an important breeding site for Sanderlings (Latour *et al*. 2005). Creswell Bay is the most northern large area of exceptional shorebird breeding density in the Canadian arctic islands, and marks the northern limit of the Sanderling's breeding range (Latour *et al*. 2005).

MIGRATION SITES

Sanderlings aggregate at some sites during migration (especially spring), but are more dispersed during fall migration. Listed below are the sites where many Sanderlings aggregate during migration along the U.S. Atlantic coast (especially Delaware Bay), the Canadian interior (especially Saskatchewan), and, to a lesser extent, the U.S. Pacific coast (Oregon and Washington).

In preparation for developing the Conservation Plan for the Sanderling, the author analyzed International Shorebird Survey (ISS) records for Sanderlings (1974–2005). Although ISS data offer the most complete picture of shorebird distributions in the Western Hemisphere, there are some inconsistencies in the data set (as there are in most volunteer-run data efforts). For instance, the number of times each site is surveyed, and consequently, our certainty about Sanderling use at each site. Hence, the data are presented in a transparent way, by survey period (decade) and number of years surveyed, arrayed by site. Tables 1, 2, 3, and 4 in Appendix IV contain the categorized results by season (spring; fall) and length of time surveyed (1–4 years; 5+ years); Tables 5 and 6 (Appendix IV) contain results for winter. The purpose for including these tables is twofold: 1) to highlight a number of sites that are known to be important to the Sanderling during migration (knowing that in subsequent versions of this plan we will include other sites not captured by the ISS, especially likely for sites outside the United States); and 2) to present the best available information on Sanderlings in a way that enables managers to better understand, and then prioritize, their management/conservation efforts.

Other data sources consulted for Version 1.0 of this plan include the World Bird Data Base (2009) Important Bird Areas of Canada (2009); subsequent versions of the plan should consult each state's Important Bird Area list (available online), as well as the Important Bird Areas of Mexico (available online). These resources highlight additional sites of potential and/or recent importance to Sanderlings (although data quality is variable), as well as local conservation issues. For U.S. sites, see Audubon: Important Bird Areas (online); for all other sites, see BirdLife International: Important Bird Areas (online).

The collection of sites listed below is intended as a starting point towards identifying those beaches/sites most important to the Sanderling during migration and winter. However, it is an incomplete list for several reasons: 1) it does not include all important sites (some sites not surveyed by ISS may have been inadvertently omitted); 2) it does not include many sites that host lower numbers (i.e., hundreds, as opposed to thousands of birds); and 3) some of the sites listed below have not been censused recently, so a priority should be to revisit and reevaluate sites not visited since 2000 to determine current importance to Sanderling.

NOTE: Sites that have reported 1,000 or more Sanderlings during migration are listed below. See Tables 1, 2, 3, and 4 (Appendix IV) for further information. Sites below with an asterisk (*) denote WHSRN Sites.

Atlantic Coast (Canada and United States)

New Brunswick, Canada**:** *Fall migration*: Several sites in the *Bay of Fundy report several thousand migrating Sanderlings during fall. Average one-day peaks include ~500 Sanderlings (1970s and 80s) at Quaco Bay (northern coast of Bay), and >750 on the tide flats of Shepody Bay (western head of the Bay) in 1990 (Lock *et al*. 1994; Important Bird Areas of Canada 2009).

Quebec, Canada**:** *Fall migration*: Barre de Portneuf, a 4.5-kilometer sandbar, is an important fall migratory stopover for several thousand Sanderlings in the St. Lawrence River estuary, with a high count of ~7,200 in 1993 (Important Bird Areas of Canada 2009). Batture aux Alouettes and the mouth of Saguenay River (on the north shore of the St. Lawrence River) recorded 2,800 Sanderling during fall migration 1989 (DeRepentigny 1999, Important Bird Areas Canada 2009).

Massachusetts beaches, USA**:** *Fall migration*: Several beaches in Massachusetts regularly host Sanderlings (thousands), such as Plymouth Beach (peak count >2,500), *Monomoy NWR (peak 5,000), and South Beach Island in Chatham (>10,000; ISS data).

***New Jersey and Delaware - Delaware Bay, USA**: Spring migration. The few coastal beaches of Delaware Bay (especially in the lower New Jersey region) represent the most important spring staging area for Sanderlings on the North American Atlantic Coast. Approximately 38,000 Sanderlings stop here to feed on Horseshoe Crab (*Limulus polyphemus*) eggs in New Jersey and Delaware (Myers *et al*. 1990, Clark *et al*. 1993). *Fall migration*: Several beaches in New Jersey have supported Sanderlings (hundreds to thousands) during fall migration, such as Great Egg Harbor, Wildwood, and Brigantine beach (ISS data, and Burger *et al*. 1977).

***North Carolina - Outer Banks, USA*:** Approximately 35,000–40,000 Sanderlings migrate through here annually (Myers 1988). North Beach was of special importance to Sanderlings during both migrations in 1992–93 (Dinsmore *et al*.1998). *Spring migration*: The Outer Banks (228-kilometer extent) hosts densities ranging from approximately 30 to 50 birds/km (Dinsmore *et al*.1998), and as high as 150–175 Sanderlings/km (size of area uncertain; see Walters 1984). The total estimate for spring migration was approximately 9,700 Sanderlings in 1992–93 (Dinsmore *et al*. 1998). *Fall migration*: Fall densities reach 68 birds/km (average 51 birds/km) and usually exceed spring densities, and peak fall numbers exceeded 11,200 individuals (Dinsmore *et al*. 1998). The total estimate for fall was approximately 28,500 individuals for 1992–93 (Dinsmore *et al*. 1998).

***Maryland-Virginia Barrier Islands, USA*:** *Spring migration*: Peak numbers of Sanderlings at Chincoteague NWR have exceeded 10,000 birds (1980s). *Fall migration*: Peak numbers of Sanderlings at Chincoteague NWR, Back Bay NWR and False Cape Beaches exceed 10,000 individuals.

Interior (Canada, United States), and Gulf Coast

***Saskatchewan, Canada*:** A number of shallow saline/alkaline lakes in this region host the highest Sanderling counts in the Western Hemisphere (i.e., >100,000) during spring migration (sites listed below). Other shallow lakes in the region whose shorelines host several thousand Sanderlings during spring migration include Sounding Lake (high count 3,000), Miquelon Lake (3,000), Gooseberry Lake (3,000), and Chappice Lake (4,500)(Important Bird Areas Canada 2009; Morrison *et al*. 1995; Wershler 1987).

***** ***Area including Chaplin Lake, Old Wives Lake, Reed Lake (Sask., Canada)*****:** *Spring migration*: These shallow saline/alkaline lakes (e.g., especially their sandy shorelines) represent major staging grounds for Sanderlings, and may support more than 50% of the Western Hemisphere population. Chaplin Lake and Old Wives Lake (surveyed collectively) reported annual peak 1-day counts exceeding 100,000 birds during spring1987, 1993, and 1994 (a three-year average of 55,000 was later apportioned to each lake) (Beyersbergen and Duncan 2007, Beyersbergen and Duncan 1995, Morrison *et al*. 1995). Frederick Lake, adjacent to Old Wives Lake, is also included as important by the World Bird Data Base (2009).

***** ***Quill Lakes (Sask., Canada)*****:** *Spring migration*: Collectively, some 60,000 and perhaps more than 100,000 Sanderlings pass through the Quill Lakes region each spring (Alexander and Gratto-Trevor 1997, Dickson and Duncan 1993, Smith 1996).

Blaine Lakes (Sask., Canada)**:** *Spring migration*: These shallow saline lakes in central Saskatchewan recorded a peak of 10,000 Sanderlings in May 1989 (Morrison *et al*. 1995).

Alberta, and west-central Saskatchewan**:** A major staging area, Reflex Lake has hosted ≥6,000 Sanderlings in recent years (June 1995 and 2001) and 20,000 in May 1989 (MacWhirter *et al*. 2002, Beyersbergen 2009). Several other lakes within the Manito Lake Area of west-central Saskatchewan and adjacent Alberta (also includes Freshwater Lake, Wells Lake, Colette Lake and Cipher Lake) report thousands of Sanderlings during spring migration (Morrison *et al*. 1995). Other lakes in Alberta that support a few thousand Sanderlings in spring include Miquelon Lake (3,000 in 1971), and Metiskow Lake and Sunken Lake in eastern Alberta (2,000 in 1988)(Important Bird Areas Canada 2009).

Texas coast (USA)**:** *Spring and fall migration*: Peak numbers at *Padre Island National Seashore exceed 5,000.

Pacific Coast (Canada, United States)

Tens of thousands of Sanderlings migrate along the U.S. Pacific Coast. Estimates of seasonal regional totals for Sanderlings at 56 Pacific Coast wetlands (surveyed between 1988 and 1995) were about 32,500 for spring migration and about 44,300 for fall (Page *et al*. 1999).

British Columbia, Canada**:** Sanderlings occur in moderate numbers in British Columbia, and several sites report hundreds to low thousands of Sanderlings during migration: McIntyre Beach and Rose Spit (Queen Charlotte Islands) report 1,300 (in 1985) to 2,000 (in 1977) during migration (Campbell *et al*. 1990). Long Beach, BC has reported hundreds of Sanderlings during fall migration, with high counts of 500 (September 1982) and 600 (September 1985) (Paulson 1993).

Washington, USA - beaches on southern coast**:** These beaches support thousands of Sanderlings during spring and fall migration (Buchanan 1988, Evenson and Buchanan 1997). *Spring migration*: Southern Washington beaches represent an important staging area during spring; combined with Oregon beaches, more than 28,800 Sanderlings were recorded in this region during spring 1983 (Myers *et al*. 1984b), with densities reported as 185 Sanderling/km. Leadbetter Point, spring peak numbers exceed 1,000 (ISS data). Olympic-North Beach: a high count of >7,100 Sanderlings in late April/early May 1983 (Myers *et al*. 1984b). Grayland Beach: approximately 2,400 during late April/early May 1983 (Myers *et al*. 1984b). Longbeach: > 3,800 Sanderlings were counted here in spring 1983 (Myers *et al*. 1984b). *Fall migration*: Longbeach Peninsula is an important staging area and has supported thousands of Sanderlings each fall, such as 213.5 Sanderlings/km (7,900 total birds) on 30 August, 1993 (Buchanan and Evenson 1997, J. Buchanan, unpubl. data). Leadbetter Point fall peak numbers exceeded 5,000 during fall (1970s, ISS data), and 4,000 for two weeks in September and October 1978 (see Paulson 1993); Copalis/Ocean Shores fall counts included 1,000 birds in 1979 (Paulson 1993) and >1,000 in the 1990s (ISS data) (Myers *et al*. 1984b).

Oregon - north coast sandy beaches**:** Oregon's sandy beaches represent a major staging area on the North American Pacific Coast (Myers *et al*. 1984a, 1984b); combined with Washington beaches, more than 28,800 Sanderlings were recorded in this region during spring 1983 (Myers *et al*. 1984b). *Spring migration*: High counts include the following: South jetty of Columbia River: 30,000 in 4.8 kilometers of beach in May 1978 (Paulson 1993); Clatsop Beach: approximately 12,000 Sanderlings (472/km) were reported here in late April/early May in 1983 (Myers *et al*. 1984b); Sunset Beach: 20,000 in May 1977 (Paulson 1993); Oregon Dunes National Recreation Area supported at least 5,000 Sanderlings in exceptionally high densities (117 to 158 birds/km) during late April/early May 1983 (Myers *et al*. 1984b). *Fall migration:*

Clatsop Beach reportedly hosted about 80,000 Sanderlings between 23 July and 6 August 1983 (Contreras 2003). Oregon Dunes National Recreation Area supported >18,000 Sanderlings during 1993 (Platt and Goggans 1993).

Mexico, Central and South America

***Baja California, Mexico*:** Counts at two sites, *Guerrero Negro/Ojo de Liebre and to a lesser extent *Laguna San Ignacio, showed an influx of hundred/s of Sanderlings during fall (August 2006) and spring (March 2007/April 2008) migrations, temporarily increasing winter numbers there (R. Carmona, unpubl. data).

***Costa Rica*:** Two sites are listed as each hosting 5,000 Sanderlings during migration: Pacuare, coastal wetlands and Migratory Bird Corridor, and Cahuita, Gandoca-Manzanillo, and Migratory Bird Corridor (World Bird Data Base 2009).

**** Lagoa do Peixe, Brazil*:** *Spring migration*: This coastal lagoon is a major staging site for Sanderlings on the Atlantic coast of South America. Counts reported in the 1980s regularly exceeded 6,000 Sanderlings in spring, just prior to their departure for North America (Morrison and Ross 1989).

***Rios Sergipe and Vaza-Barris, Brazil*:** The lower reaches of these rivers form a system of freshwater wetlands grading into mangrove swamps. The mangroves shelter thousands of migrating shorebirds, especially Sanderlings (DeLuca *et al*. 2006).

***Iguape-Cananeia Estuary, Brazil*:** One of the largest estuaries in southeast Brazil, this system of channels, islands, and mudflats are isolated from the sea by two islands, Ilha Comprida and Ilha do Cardoso. Ilha Comprida is an important stopover area for migrating shorebirds, especially Sanderlings (DeLuca *et al*. 2006; number of Sanderlings not specified).

***La Coronilla-Barra del Chuy, Uruguay*:** This site (on the central coast of Uruguay) reportedly hosts 3,000 Sanderlings during migration (World Bird Database 2009).

NONBREEDING (WINTERING) SITES

Although the Sanderling is the most widespread maritime shorebird in the Western Hemisphere during the nonbreeding season, Sanderlings are fairly dispersed and numbers tend to be small locally throughout most of their winter range (e.g., coastal Argentina; Blanco *et al*. 2006). Sanderlings winter along most beaches in the temperate and tropical Americas, spanning over 100^o in latitude, from 50^{o}N on the Pacific Coast (southern British Colombia) and 43°N on the Atlantic Coast (southern Maine) south to 50°S (southern Chile and southern Argentina) (Myers *et al*. 1985, Castro and Myers 1987, Myers *et al*. 1990). However, most Sanderlings winter in one of three regions: the Pacific coasts of Peru and northern Chile (where high densities in areas not listed below reach 25–60 birds/km); the U.S. Pacific coast (Washington to southern California); and the southeast Atlantic coast of Brazil (Morrison 1984, Myers *et al*. 1985, Morrison and Ross 1989).

Atlantic and Gulf Coasts (United States)

The sites listed below were surveyed by the ISS between 1972–2005, and hosted several thousand wintering Sanderlings during that period. Other ISS-surveyed sites with winter estimates of >1,000 Sanderlings occur in Florida, Georgia, Maine, Maryland, Massachusetts, North Carolina, and Virginia (See Table 5).

Florida coast**:** Sanibel Island reported several thousand Sanderlings in the 1990s, with winter counts in the hundreds in the 1970s and ’80s (ISS data).

Massachusetts beaches**:** Five hundred to several thousand Sanderlings winter in South Beach, Chatham, as reported in the 1990s (ISS data).

New Jersey beaches**:** Brigantine Beach (in the 1970s) and Wildwood (in the 2000s) each reported >5,000 Sanderlings during winter months (ISS data).

North Carolina**:** Pea Island NWR (during1970s) and Clam Shoal/Bird Island (during 2000s) hosted >1,000 Sanderlings during winters (ISS data).

Virginia**:** False Cape Beaches regularly reported monthly maxima in excess of 500 Sanderlings, and peak counts >5,000 in the 1980s and 1990s (ISS data). Chincoteague NWR reported thousands of wintering Sanderlings in the 1970s and '80s (ISS data).

Central America and the Atlantic Coast of South America

Information on South America is from Morrison and Ross (1989) and DeLuca *et al*. (2006), unless noted otherwise. These sites are reported as being important to Sanderlings; however, further information is needed to verify the number of birds using each site.

Costa Rica**:** The Nicoya Gulf mangroves and coastal areas is listed as hosting 3,000 Sanderlings during winter (World Bird Data Base 2009).

Argentina**:**

Peninsula Valdes: Aerial surveys in the 1980s indicated that ~1,300 Sanderlings (14% of the Atlantic Coast total) occur on Peninsula Valdes beaches (Morrison and Ross 1989). Several hundred Sanderlings were present on Flechero Beach on the eastern shore of Golfo San Jose during the winter of 1980–81 (October to January; L. Payne, unpubl. data).

Coastal beaches of Buenos Aires Province: A dozen coastal beaches surveyed in the Buenos Aires Province supported hundreds of Sanderlings during the boreal winter (December–February, 2000–02). The four beaches with the highest Sanderling densities lie between Miramar and Punta Alta: Arena Verdes (155 birds/km); Costa Bonita (58 birds/km), Monte Hermoso south (51 birds/km) and San Cayetano beach (23 birds/km)(Blanco *et al*. 2006; Morrison and Ross 1989).

Brazil**:**

**Lagoa do Peixe:* This 34,000-hectare shallow, brackish-to-saline lagoon is also a Ramsar Site (no.603) and a National Park. The more than 6,600 Sanderlings counted here by Morrison and Ross (1989) represented 71% of the Atlantic Coast total. Densities on the coast near Lagoa do Peixe reached 69 birds/km.

Rio de Janeiro Coastal Lagoons: This area contains a chain of 11 coastal lagoons between the cities of Rio de Janeiro and Cabo Frio. Some have high salt concentrations. Mudflats and eutrophic areas attract "large numbers of shorebirds, especially Sanderling" (DeLuca *et al*. 2006).

Lagoa dos Patos: This site represents the largest freshwater lagoon in Brazil, and includes a 220-kilometer beach that stretches from its mouth to the Brazil/Uruguay border. This high-productivity area represents "one of the main wintering areas for Sanderling." (DeLuca *et al*. 2006).

Pacific Coast (Canada, United States, Mexico)

Tens of thousands of Sanderlings winter along the U.S. Pacific Coast. Estimates of seasonal regional totals for Sanderlings at 56 Pacific Coast wetlands (surveyed between 1988 and 1995) was ~34,800 for winter (Page *et al*. 1999). The sites listed below recorded between 500 to several thousand wintering Sanderlings. Other sites along the North American Pacific Coast with lower winter estimates (hundreds) occur in many locations, including British Columbia (e.g., Ladner, Vancouver, and Chesterman Beach; Paulson 1993), and numerous sites in Oregon, Washington, California, and Baja California (Mexico).

***Washington beaches, USA (especially outer, southern coast)*:** Three extensive sandy beaches along the southern Washington coast (Ocean Shores, Grayland, and Long Beach), support the vast majority of wintering Sanderlings in Washington (Myers *et al*. 1984b, Buchanan 1992, Buchanan and Evenson 1997, and Buchanan unpubl. data). These beaches are separated by two large estuaries (Grays Harbor and Willapa Bay). Counts for important beaches in Washington state include: Copalis/Ocean Shores: Over 1,000 Sanderlings were recorded at Ocean Shores in the 1990s (ISS data); several thousand (or more) Sanderlings typically winter here (Buchanan 1992); Grayland: several thousand Sanderlings typically winter here (Morrison 1984b, Buchanan 1992); Long Beach: several thousand Sanderlings typically winter here (Morrison 1984b, Buchanan 1992); Leadbetter Point: CBC data report about 300 (during mid 1970s) to 650 Sanderlings (during late 1980s). ISS data include counts of 500 Sanderlings in the 1970s; Olympic-North Beach: Regular counts exceed 2,000 (Myers *et al*. 1984b, Buchanan 1992);

*Grays Harbor: Approximately 1,400 to 2,800 Sanderlings are present in winter, with high counts reported as ~3,300 (November 1982) and ~3,800 (December 1985) (Paulson 1993); Sequim-Dungeness: Counts at this beach (on the Straight of Juan de Fuca) have ranged from about 50 (during mid 1970s) to 650 (late 1980s; see Paulson 1993).

Oregon beaches, USA: These beaches typically support hundreds to thousands of wintering Sanderlings. For instance, counts during 1974–1988, based on 5-year averages of Christmas Bird Counts (summary from Paulson, 1993), include: *Columbia River estuary: high winter count of ~5,900 in December 1983; Florence: high winter count of ~3,200 in December 1984; Tillamook Bay, OR: Counts averaged 900 to 1,100 during 1974–1988; Yaquina Bay, OR: Counts averaged 500 during 1974–1988; Coos Bay, OR: Counts ranged from about 300 (during mid 1980s) to 1,800 (late 1980s). A winter high count at Coos Bay was ~5,200 in 1985.

***California beaches, USA*:** Sand beaches on the northern California coast are used by large numbers of wintering shorebirds. Sites hosting thousands of Sanderlings are listed below; sites hosting more modest numbers (hundreds) include Bodega Bay, Morro Bay, and the Santa Maria River Mouth (Hickey *et al*. 2003). Monterey Bay: Thousands of Sanderlings winter in Monterey Bay, including reports of 6,800 (about 79 birds/km) between November 2002 and April 2003 (Neuman *et al*. 2008). Tomales Bay: Hundreds to thousands of Sanderlings were reported at Tomales Bay in the winter months, throughout the 1980s and 1990s; ISS data) (Kelly 2001). *Humboldt Bay: Hundreds to thousands of Sanderlings winter here (Colwell 1994, Colwell and Sundeen 2000, Danufsky and Colwell 2003, MacWhirter *et al*. 2002).

***Baja California, Mexico*:** Aerial surveys of the entire shoreline of Baja California's west coast during winter yielded ~4,000 Sanderlings in February 1992 (Morrison *et al*. 1992) and 10,260 in December 1983 (Schick *et al*. 1984). A combination of ground and aerial surveys between 1991 and 1994 reported only 2,800 Sanderlings for the region, however the authors believe this to be an underestimate because of the study's focus on wetlands rather than on sandy beaches (Page *et al*. 1997).

Sites with hundreds of Sanderlings include: *Bahia Magdalena: ~350 in February 1992 (Page *et al*. 1997); Laguna Figueroa: ~210 in January 1992 (Page *et al*. 1997); Estero de Punta Banda:

~100 in February 1991 (Page *et al*. 1997), and Punta Cabra sandy beaches, several hundred between September 1990 and October 1991 (LopezUriarte *et al*. 1997).

Sites with 500 to several thousand Sanderlings include: *Ojo de Liebre, Guerrero Negro: Aerial and ground surveys of Guerrero Negro lagoon reported ~450 in February 1992 and ~1,950 in January 1994 (Page *et al*. 1997); other estimates include an average of 750 wintering Sanderlings (range ~450 to ~1,780); birds are present from July until March/April (R. Carmona, unpubl. data from 2006–07). *Laguna San Ignacio: A high count of ~540 in January 1992 (Page *et al*. 1997); however, recent winter counts (2007–08) were much lower (tens; R. Carmona, unpubl. data).

Pacific Coast (Central and South America)

An estimated 88,000 Sanderlings were counted during winter aerial surveys of the Chilean and Peruvian coastline in 1985 and 1986, respectively (Morrison and Ross, 1989).

***Chile*:** The following principal wintering areas for Sanderlings in Chile are based on aerial surveys conducted in 1985 (Morrison and Ross 1989) unless otherwise noted. Other important wintering areas (besides those listed) include the area around Mejillones, in northern Chile.

Chiloe Island (1,432-kilometer extent): 10,200 Sanderlings (10% of Pacific Coast total) were surveyed in this area; the north coast of Chiloe Island near Coulin held 2,500 Sanderlings;

Río Maipo rivermouth: 2,500 to 10,000 Sanderlings (World Bird Data Base 2009);

Valparaiso Coastline (545-kilometer survey sector, central Chile): 8,400 Sanderlings (5.4% of Pacific Coast total);

Coastline south of Concepcion: (southcentral Chile) 4,500 Sanderlings recorded in 881 kilometers;

La Serena beaches: (northcentral Chile) 4,400 Sanderlings recorded in 846 kilometers.

***Peru*:** Information was gathered during aerial surveys conducted in 1986 (Morrison and Ross 1989) unless otherwise noted.

Northern beaches, Chiclayo Coastline: 31,600 Sanderlings (32% of Pacific Coast total of 98,200 Sanderlings) were counted in 872 kilometers. *Several areas were important within this survey sector*: Sechura Coast: The mean density for the Sechura desert coastline was 117 birds/km, with 186 birds/km near the northwest end of the Sechura Desert beach. Pacasmayo (11,000 Sanderlings) reported densities up to 278 birds/km.

Lima Coastline (792 kilometers): this region held 18,800 Sanderlings (19% of Pacific Coast total). Within this survey sector, the Rio Pisco mouth recorded the highest density of Sanderlings in South America, with 1,095 birds/km, involving large roosting flocks (7,700 birds) in a short survey sector (7.03 kilometers).

Mollendo Coastline (684 kilometers) held 14,200 Sanderlings. Within this survey sector in southern Peru, densities reached 242 birds/km near the Peru/Chile border.

Chimbote Coast: 2,200 Sanderlings in 426 kilometers.

North Coast of South America (from Morrison and Ross (1989) and DeLuca *et al*. (2006)).

Approximately 4,400 Sanderlings were counted along the North Coast of South America during winter aerial surveys in the period 1982–86 (Morrison and Ross 1989).

***Brazil*:** Hundreds to thousands of Sanderlings winter on Brazil's north coast. Specifically:

North-central Brazil coast (between Sao Luis and Amazonas Delta): 3,100 were surveyed here in the winter of 1986 (Morrison and Ross 1989).

Pará Coast and Amazonas Delta: Along the southern border of the mouth of the Amazon, huge flocks of Sanderlings are a common sight on the coast (DeLuca *et al*. 2006).

Goiabal / Piratuba in the Amazon Delta is listed as hosting 3,000 wintering Sanderlings (World Bird Data Base 2009).

Northeastern coast (near Sao Luis): approximately 400 Sanderlings (8.7% North Coast total of ~4,400); densities here reached 25 birds /km.

Venezuela*:** approximately 500 Sanderlings were reported on the ***Orinoco Delta (11% North Coast total).

CONSERVATION THREATS

Sanderlings face a number of conservation threats especially during the nonbreeding season. Because the Sanderling is a relatively long-lived species with low reproductive rates, even small changes in adult survival can have significant impacts on its population dynamics. Hence, it is imperative to understand and target those factors that may potentially affect (or already be affecting) adult survival.

The most likely threats causing declines in Sanderling are:

1) Habitat loss and degradation;
2) Human disturbance;
3) Contaminants and disease;
4) Climate change
5) Predation

HABITAT LOSS AND DEGRADATION

Coastal habitats (particularly sandy beaches), upon which Sanderlings rely for most of their lifecycle, are being heavily developed and fragmented by human activities. Since the early 1900s, more than 50% of U.S. coastal wetlands have been lost, with much heavier losses in certain states, for example New Jersey, North Carolina, Florida (Helmers 1993) and most of California. Habitat impacts are occurring at two scales: specific and widespread. At the specific scale, habitat loss (e.g., from development) or habitat degradation (e.g., oil spills) at important staging areas could have potentially catastrophic impacts. However, no less damaging is the cumulative effect of widespread alterations occurring throughout the nonbreeding range from small-scale, piecemeal development or conversion of habitat (Morrison and Ross 1989). These widespread threats will increase as human population and pressures on coastlines increase. Hence, a prudent conservation strategy for Sanderlings must likewise target sites at two scales – sites that host large numbers of birds (i.e., especially in migration), and those that host moderate numbers throughout the nonbreeding range.

Habitat loss has particularly significant implications for Sanderlings during migration—a time when they must put on fat to fuel their long flights—and also in winter (stressful weather). The potential cost during migration is clear: without enough fuel (fat), Sanderlings may not be able to complete the next leg of their journey, may arrive on breeding grounds with too few resources to breed, or may not survive. On the wintering grounds (e.g., California, North Carolina, and Peru), many individuals exhibit strong site fidelity and spend most of their time (or return to) the same 5- to 10-kilometer stretch of beach year after year (Myers *et al*. 1979a, Connor *et al*. 1981, Myers *et al*. 1988, Dinsmore *et al*., 1998). Thus, the loss of even small stretches of coastline could alter social dynamics of local winter populations, with potentially harmful (although currently unknown) consequences. Further, winter storms (especially in the Northern Hemisphere) reduce feeding opportunities and increase energy requirements of Sanderlings. Consequently, the loss of important habitat may carry a higher cost in areas subject to frequent, stressful weather events (e.g., coasts of North America).

In South America, threats to internationally important shorebird areas are many. Some examples include: oil pollution along coasts, industrial/port developments in north-central Brazil; forestry development in southern Brazil (where sediment loading from increased run-off reduces prey availability on sand flats); tourism developments in northern Argentina (potential for increased human-related disturbances); and wetland drainage and developments in Peru (Morrison 1984, Morrison *et al*. 1987, Myers *et al*. 1987a, 1987b; Morrison and Ross 1989).

Key migration staging areas in the interior also face conservation threats. Dramatic losses of wetlands in the Canadian Prairies region and U.S. interior, from wetland drainage, dike creation, and water diversion projects, may be harming Sanderling populations—especially during drought periods, which are projected to increase with climate change (Dickson and Duncan 1993, MacWhirter *et al*. 2002). Continual development pressure on Great Lakes shorelines is a persistent threat to Sanderling habitat in interior Canada and the United States.

Sanderlings are also threatened by the direct reduction in food supply at major stopover sites. Along the U.S. mid-Atlantic coast (e.g., Delaware Bay), for example, the apparent decline in Horseshoe Crabs (due to harvesting for bait) is likely impacting migratory Sanderlings and other shorebirds that rely on crab eggs to fuel their flights to the breeding grounds (MacWhirter *et al*. 2002).

At many other beaches throughout the nonbreeding range, physical manipulation of the sand/beach surface reduces prey availability and may also reduce cover for night roosting (e.g., by removing wrack). For instance, beach “re-nourishment” projects (i.e., adding sand to a sandy beach for stabilization and aesthetic purposes), beach scraping (removal of the top ~12” of sand, for commercial construction projects), and mechanized beach raking (removal of seaweed and other debris for aesthetic purposes) all alter the sand composition, prey abundance, and other attributes of the habitat, and likely impact Sanderlings and other organisms as well (e.g., nesting sea turtles). These practices are common along U.S. coasts, although their impacts on invertebrate populations and their predators (i.e., shorebirds) are largely unstudied. Fortunately, however, some habitat loss and most habitat degradation is reversible. Means of reversal can be through habitat restoration or though improved/altered management practices, e.g., timing of certain practices with relation to wildlife needs, and ensuring/requiring comparable sediment particle size in imported sediments (a habitat characteristic that influences Sanderling distributions; Danufsky and Colwell 2003) (Drut and Buchanan 2000).

Within the breeding range, habitat loss and degradation are also issues, albeit from less visible threats. High-arctic breeding habitat is far from most human habitation and development, however global climate change impacts are exaggerated there and may disrupt prey availability and nesting habitat of Sanderlings (see Climate Change, below).

Several other types of habitat degradation occur in many parts of the nonbreeding range:

Exotic invertebrates, plants, and vertebrates. The introduction of exotic marine invertebrates into coastal and interior waters may impact shorebirds prey populations. Exotic plants may alter sand roost characteristics, such as through changes in dune communities or dune dynamics, or through changes in algal communities, and/or may cause changes in foraging areas (tidal flats) or susceptibility to predation.

Utility lines: Many bird species, including shorebirds, have died from in-flight collisions with utility lines (e.g., Kitchin 1949, Bevanger 1994, Brown and Drewien 1995, Janss and Ferrer 1998). The placement of utility lines next to intertidal areas where shorebirds forage and roost degrades habitat quality, by incurring an added source of mortality (Kitchin 1949, Buchanan 2000). Additionally, utility lines or poles adjacent to foraging areas may become perches for avian predators, potentially facilitating predation impacts (see Research and Monitoring Needs), as Peregrine Falcons favor higher perch sites with better visibility and easy access to prey (Dzialak *et al*. 2007).

Wind turbines: Shorebird mortality has been documented at wind turbine sites in the United States and the Netherlands (Buchanan 2000). Certain regions (e.g., U.S. Pacific

Northwest) are experiencing rapid expansion of turbine complexes to meet growing energy needs. If complexes of turbines were to be installed along shorebird flight corridors, mortality could be significant. Care in choosing the locations of complexes of this promising alternative energy source will be important in minimizing shorebird mortality.

Noise disturbance: Human activities that cause extremely loud noises disrupt shorebirds. Examples include waterfowl hunting (associated shotgun blasts), and aircraft traffic and military activities, which disturb shorebirds (Smit *et al*. 1987, Koolhaas *et al*. 1993, Smit and Visser 1993).

HUMAN DISTURBANCE

At many sandy beaches, chronic human disturbance—if left unmanaged—could cause reduced habitat use or even abandonment by Sanderlings, with potentially serious consequences. Some clarification is in order. Unlike *habitat loss* (which in this document refers to a physical change to the habitat resulting in a permanent decrease in habitat quality), or *habitat degradation* (refers to a reversible decrease in quality), *human disturbance* (a temporary disturbance caused by the presence of humans/human-related activities) may influence whether habitat in a particular area is used effectively, or used at all, by a particular species. Prudent and innovative management efforts are needed to ensure that the habitats upon which Sanderlings rely are not only present, but also usable.

During most months of the year (i.e., all but breeding season), Sanderlings occupy shoreline habitats that are also used by humans for recreation and other activities, exposing Sanderlings to frequent human disturbance. Human activities such as beach recreation can interfere with the ability of Sanderlings to forage and rest. Human disturbance varies in intensity and among different sites and times of the year. However, it is so widespread and in many places is a chronic source of disruption to Sanderlings (i.e., in heavily populated areas) that it merits topical consideration.

Off-road vehicles, people on foot, and especially unleashed dogs (Thomas *et al*. 2003) frequently—even if unintentionally or playfully—disturb Sanderlings. While individual events or people may not appear to cause much harm, our impact on the environment has steadily grown such that today it is the cumulative, continual presence of multiple human-related disturbances that are compromising the quality of the Sanderling's feeding and resting sites. Wherever humans recreate on beaches, people and dogs are a potentially significant source of disturbance to Sanderlings. Unleashed dogs (and some people) may enthusiastically chase flocks of shorebirds; while this and other disturbances vary from periodic to continual, day after day (and cumulatively) they translate into reduced feeding and resting time for Sanderlings. The energetic requirements of migration are substantial, and the energy that Sanderlings expend to continually flee from humans and dogs, combined with the simultaneous loss of opportunity for feeding or resting, may result in reduced fitness overall for Sanderlings.

Several studies have quantified these impacts. In Plymouth Beach, Massachusetts, vehicular traffic reduced the use of this important staging area (for sandpipers) by up to 50%, and increased human and vehicle disturbance led to a shift in roost sites or to departure altogether (Pfister *et al*. 1992). On Virginia beaches, increased human activity levels translated into increased time spent flying (or in maintenance behaviors) and less time roosting; Sanderling abundance declined with increasing off-road vehicle abundance (K. Forgues, unpubl. data). In Florida during winter, as beaches became more crowded with people, Sanderlings' foraging time decreased, and birds moved to areas with fewer people and/or foraged more at night (Burger and Gochfeld 1991). These and other studies (e.g., Klein *et al*. 1995, Roberts and Evans 1993, Burger and Gochfeld 1991, Thomas *et al*. 2003) indicate that at sites where shorebirds are heavily disturbed by humans, shorebirds spend less time foraging and resting, with potentially substantial energetic costs. Specifically, reduced feeding and resting could result in lower energy stores (i.e., reduced lipid deposition), potentially interfering with the ability to migrate, with subsequent breeding success, and possibly even with survival.

Other obvious forms of disturbance include personal motorized watercraft such as jet skis, which have been shown to disturb roosting shorebirds in Washington (see Buchanan 2000). However, such disturbances could be greatly reduced by employing buffer distances such as those determined for other shorebirds (e.g., a minimum distance of between 80–100 meters from motorized watercraft; Rodgers and Schwikert 2002). Even quiet forms of recreation such as kayaking, kite-surfing, windsurfing, wave surfing, or fishing can cause disturbance to Sanderlings. These activities usually require associated disruptions such as driving vehicles along beaches, rigging or assembling equipment (poles/boards/boats) near the water, entering/exiting the ocean, and recreating near the shoreline (either on land or in water).

Contaminants and Disease

Throughout migration and winter, Sanderlings are frequently exposed to a variety of pollutants. On the wintering grounds and in some migration areas, pesticides and various chemicals and petroleum products have the potential to harm Sanderlings. Plastic pollution (plastic particles) is widespread in the marine environment and deleterious to waterbirds (although not known for Sanderlings) (Buchanan 2000). At interior migration staging grounds (e.g., Canadian Prairies), avian cholera and avian botulism outbreaks can cause significant mortality to migrating shorebirds (adults and juveniles), although most botulism outbreaks occur during the warm summer months when fewer Sanderlings are present.

Oil Pollution

Due to the prevalence of time spent foraging in marine environments, Sanderlings are at greater risk from oil pollution than many other shorebirds (Burger 1997). The potential for oil contamination exists throughout the nonbreeding range, extending from North America to the southernmost tip of South America where there are oil development operations in the Tierra del Fuego region of Argentina and Chile (Morrison and Ross 1989). As the demand for oil continues, and oil tanker traffic increases (along with the failure to regulate the safety of oil tanker hulls), so will oil spills. A single, ill-timed oil spill at a key stopover site such as Delaware Bay, New Jersey—one of the most important staging areas for Sanderlings and one of the largest oil tanker ports in North America—could substantially degrade or possibly eliminate the spring food supply for migrating Sanderlings.

Chemicals, Heavy Metals, and other Contaminants/Toxins

Many of the locations important to the Sanderling are near areas receiving agricultural runoff, industrial waste, and urban runoff. Numerous contaminants have been detected in the tissues of shorebirds (see references in Buchanan 2000) including the Sanderling, in which both low (cadmium, mercury, selenium, copper) and high (chromium) concentrations were found on migration grounds in New Jersey (Burger *et al*. 1993) and on the wintering grounds in Chile (Vermeer and Castilla 1991). Organochlorines, heavy metals, and other contaminants that may pose a danger to shorebirds occur throughout the nonbreeding grounds, including in Washington and California (Schick *et al*. 1987) and along the Pacific coast of South America (Myers 1988, Tabilo *et al*. 1996, MacWhirter *et al*. 2002), as well as in the Guianas (Morrison and Ross 1989). Sublethal effects of these agricultural and urban pollutants (including organochlorines, organophosphorus insecticides, heavy metals, and plastics), have not been studied. Contaminants may be a serious threat to Sanderlings wherever concentrations are high or persistent.

Industrial and agricultural contaminants in food sources may be especially dangerous to shorebirds. As the fat from these food sources is burned during migratory flights, the contaminants are released in high doses. This potentially reduces a bird's ability to refuel or to escape predators at a subsequent stopover site. (Butler *et al*. 2004).

Disease

Diseases may play an important role in influencing population trends of the Sanderling. Increasingly, water quality and quantity have become an issue at shallow lakes in the Canadian Prairies region and the United States (Great Lakes). The frequency and intensity of toxic outbreaks (e.g., avian botulism) has increased in recent years, presumably due to warmer water temperatures (global climate change) and shallower waters (water manipulation for agriculture, or extended drought-like conditions concurrent with global warming).

Avian botulism outbreaks cause widespread die-offs of waterbirds, claiming tens of thousands of shorebirds (Strauman 1996), among many other species. Although historical records of avian botulism outbreaks are very common, specific information on shorebird die-offs from these events is limited because shorebirds are rarely identified to species.

Some of the shallow lakes that serve as major staging areas for the Sanderling in spring have experienced increased rates of botulism (Adams *et al*. 2003) and associated waterbird mortalities. However, at present, most botulism outbreaks occur during the fall migration period (and at select wetlands), at a time of year when Sanderlings are more dispersed.

CLIMATE CHANGE

It is important to include a section on climate change in this plan despite uncertainties around potential climate change impacts. The reasons are twofold: 1) climate change is here; current levels of carbon dioxide in the atmosphere will continue to influence the climate (and landscape) for decades, even as new policies are put into place to reduce new inputs; and 2) in many cases, climate change will not manifest itself as a new and independent management challenge. Rather, it will likely exacerbate existing concerns (many, already priorities), such as conflicts over water supplies during summer (e.g., shallow lakes in the Canadian Prairies region), or conflicts over how to share beaches used by recreationalists and wildlife (because sea-level rise will likely reduce beach habitat – and the human population will continue to grow).

Working to decrease vulnerability to existing problems (those likely to be affected by climate change) may reduce vulnerability to future climate change. A key question to consider in any planning process is whether the decisions being made are robust given what is known (and unknown) about climate variability and change in a given region (Climate Impacts Group 2009). Would management decisions involving traditional assumptions still meet their intended objective if conditions became more variable and/or fell outside the assumed boundaries? To be most effective, the potential impacts of climate change need to be recognized and considered, even as existing management concerns are being addressed.

A prudent approach to dealing with climate change is a) to direct research towards understanding the impacts of climate change on the Sanderling in various parts of its range, in order to better understand—and be able to inform management about—the factors at play; and b) to address current stresses on Sanderlings, independent of climate change, in order to build flexibility and robustness into management and conservation planning/schemes. Such a two-fold approach would improve our ability to manage for climate change impacts, whatever those may be, and would also better equip us to deal with the climate variability (and stresses) already being experienced.

Hence, emphasis should remain on improving current laws and management of natural resources, while balancing these against the longer-term needs/effects of climate change. Ultimately, planning for climate change and variability requires that we build the capacity necessary to efficiently manage climate impacts before and as they occur. Resource planners should be open to routine re-evaluation of practices and policies in light of known and projected climate-change impacts (Climate Impacts Group 2009).

Effects on breeding grounds

Climate change is particularly affecting high arctic areas, and could pose an important threat to the Sanderling, a high arctic breeder. For instance: significant effects would be expected if changes in temperatures eliminated nesting habitat and altered topography, thereby affecting the total area available for breeding, as well as food supply (Myers 1988); or, if timing of the food supply became de-coupled from the Sanderling's breeding cycle; or, if predation pressure on shorebirds increased due to a climate-change induced decline in the populations of a predator's (e.g., Arctic Fox) primary prey (e.g., lemmings; Piersma and Lindstrom 2004).

Effects during nonbreeding season

Migration routes and schedules are closely timed with seasonally abundant food resources and tidal regimes. Climate change impacts could decrease productivity at a site, reduce habitat availability indirectly (e.g., via sea-level rise), increase predation risk (Cresswell *et al*. 2009), or de-couple Sanderlings from their food resources during migration. Sanderlings may have limited capacity (flexibility) to adapt to these changes, and it is unknown whether they would be able to alter their migration routes or schedules, especially in regions with few alternative habitats and already heavily impacted coastal ecosystems. In addition, climate-change induced sea-level rise is projected to decrease habitat availability as sandy beaches are encroached upon by the rising ocean, and/or as artificial beach structures (such as beach re-nourishment projects) are increased to counteract rising oceans. On the prairie landscapes of interior North America, climate change is expected to increase the duration and intensity of droughts, with increased drying, a greater demand for water, and probable losses of wetlands.

Although the effects of climate change on wildlife remains uncertain, it is clear that the Sanderling and its habitats are already stressed, independent of climate change. Therefore, the additional stresses from climate change (or from an increase in climate variability) will simply intensify the need to better manage existing populations and habitats.

PREDATION

Shorebirds are relatively long-lived species with low reproductive output and high adult survival (> 80%, for Sanderlings). Consequently, factors that reduce adult survival could be potential drivers of population declines, and must be addressed. Furthermore, mortality by avian predators can be locally significant on shorebirds, e.g., a Merlin killed 14% of a wintering population (of >130 Sanderlings) in California (Page and Whitacre 1975).

The recovery of avian predators (e.g., Peregrine Falcons) on the North American landscape has occurred over the past couple of decades in response to DDT bans, and has influenced migratory behavior of some shorebird species (Ydenberg *et al*. 2004). For instance, shorebirds appear to alter feeding strategies to reduce predation risk (Pomeroy 2006, Pomeroy *et al*. 2006), and to expend greater energy responding to disturbances by falcons. For example, in Boundary Bay, BC, shorebirds maintain sustained flight for 2–4 hours at a time, rather than roosting, during high tides (Dekker and Ydenberg 2004). Although the frequency of persistent predator disturbances is unknown (and most high-tide roost disturbances may not be as extreme as Boundary Bay), those factors that deplete shorebird energy reserves (or cause mortality directly) are added stresses. This stress is especially a concern during migrations or extreme weather, or where and when alternative roost sites and feeding grounds are not available.

Although a restored predator-prey balance is natural, in today's fragmented and developed landscape shorebirds have fewer alternative locations at which to feed, and predators may have more alternative (artificial) perches from which to stage surprise attacks on their prey (with potentially substantial, though unknown, consequences). Future research should seek to elucidate the relationship between landscape features and predation rates, and to understand whether predation is a key factor in Sanderling declines.

CONSERVATION STRATEGIES AND ACTIONS

GENERAL OVERVIEW AND CHALLENGES

During spring migration, many Sanderlings aggregate at a handful of locations, placing a large proportion of the population at a few sites—and at risk from stochastic events. However, during fall and winter, Sanderlings are more widely dispersed; where aggregations occur, the numbers are smaller than in spring (though in some cases, still considerable). This poses a different, but no less daunting, challenge of overcoming the logistics and cost of identifying and protecting multiple sites of various sizes. Sanderlings require purposeful protection from two directions: protection of targeted "hot spots" (especially for spring migration), and broad protection of multiple sites (for fall migration and winter). A broader approach will help to ensure that neither a large proportion of the species's population is lost to or impacted by a single stochastic event, nor that the species "falls through the conservation cracks" because it is quite dispersed and therefore logistically challenging to protect.

However, Sanderlings are an excellent “umbrella species” for coastally dependent species. They have declining populations, are sensitive to factors that limit many other species (e.g., human disturbance, pollution) (Piersma and Lindstrom 2004), are responsive to management that removes limiting factors, and are relatively easy to identify and monitor (Granfors and Niemuth 2005). With directed efforts, the conservation of Sanderling habitats would benefit many other coastal species as well, such as in South America, where the Sanderling is the most abundant shorebird for >3,000 kilometers of Pacific coastline (from Peru southwards; Morrison and Ross 1989.

CONSERVATION OF IMPORTANT HABITATS

Ensuring that this species has adequate habitat in which to feed and rest during the nonbreeding season (i.e., the time of year when it overlaps with humans) will require a concerted effort at many sites. Fortunately, a number of conservation efforts already target or include shorebirds (including the Sanderling) in their habitat protection or management plans, such as the Ramsar Convention, Western Hemisphere Shorebird Reserve Network (WHSRN), North American Waterfowl Management Plan (NAWMP) Joint Ventures, Ducks Unlimited, Canadian Shorebird Conservation Plan (regional and national plans), U.S. Shorebird Conservation Plan (regional and national plans), Mexican Shorebird Conservation Strategy, numerous federal and state agencies, and nongovernmental organizations (i.e., The Nature Conservancy, and others). These conservation and management strategies identify important conservation issues and areas of great conservation value. Implementation of these conservation actions, however, remains a challenge. Additional effort is needed to identify barriers to, and opportunities for, protecting important migration and wintering sites for the Sanderling. Because Sanderlings use open beach habitats, and these areas are of considerable recreational and commercial importance to humans as well, the need for a careful and targeted strategy is important. Several important components in developing such a strategy include conducting a review of efforts expended to protect coastal sites, including the barriers encountered and (especially) those case studies with successful outcomes; and approaching conservation/management solutions from a ‘common ground’ viewpoint through investment in innovative/creative solutions, and using outreach and education more effectively. A shift in perspectives is necessary to loosen deadlocks (where they occur) and to develop effective, long-term approaches.

IMPLEMENTATION OF BENEFICIAL MANAGEMENT PRACTICES

In several parts of the Sanderling's range, management practices are being implemented, either voluntarily or through legislation, for the benefit of this and other coastal shorebird species. Some examples follow.

In 2008, legislation was passed in New Jersey to place a moratorium on Horseshoe Crab harvesting (for bait) along certain Delaware Bay beaches and adjacent waters until shorebird recovery targets are met (Senate Bill 1331). The majority of weight-gain by migrating shorebirds in Delaware Bay is from crab eggs (Tsipoura and Burger 1999; Haramis *et al*. 2007). This legislation follows numerous legal measures already in place to limit Horseshoe Crab harvest in order to maintain this crucial food supply for Sanderlings and other shorebirds (New Jersey Annotated Codes 2001).

In New Jersey, the Division of Environmental Protection established emergency procedures to be used in the event of chemical spills in nearby shipping lanes during critical migratory periods (Myers 1988). Delaware Bay is a crucial stopover site for a myriad of shorebirds, and was the first Western Hemisphere Shorebird Reserve Network Site (in 1985) (Myers *et al*. 1987b).

On the Atlantic Coast, management practices intended for Piping Plovers are benefiting other shorebirds, including Sanderlings. In response to human-caused disturbances to shorebirds on beaches, some managers are extending the various protections and closures that were in place for plovers. For example, on coastal habitat around Boston, Massachusetts, protections remain in place even after plover chicks have fledged in order to accommodate the migratory shorebirds arriving in July and August. Hundreds of small shorebirds, including Sanderlings, take advantage of enclosures and wrack left on even very small areas (S. Corona, pers. comm.).

In other areas throughout the Sanderling's nonbreeding range, numerous management efforts have been proposed or are in effect. On the Pacific Coast, beneficial management actions include control and/or removal of exotic vegetation, active restoration and enhancement, water-level management to benefit shorebirds, and a variety of outreach strategies to limit human disturbance and increase public awareness (Drut and Buchanan 2000). In Washington, the state government has funded an additional tug boat to respond to navigational emergencies by oil tankers, in the event that the tankers lose power and could possibly run aground, thereby incurring a massive oil spill (J. Buchanan, pers. comm.). This simple solution offers an important benefit to coastal wildlife, and might be a useful protective measure in other states with similar circumstances.

At Delaware Bay, between 1982–2002 there were targeted efforts to raise awareness and reduce human disturbance (caused by wildlife photographers and bird watchers) of migrating shorebirds, including Sanderlings. This has resulted in the effective removal of the vast majority of disruptions by wildlife enthusiasts on the New Jersey side of Delaware Bay (Burger *et al*. 2004).

In Canada, the Great Lakes Water Quality Agreement of 1987 (between the United States and Canada) will benefit shorebirds indirectly through several associated initiatives aimed at improving habitat: the Binational Toxics Strategy (working to eliminate persistent toxic substances in the Great Lakes), and the Lake Ontario Lakewide Management Plan (working toward maintaining, restoring, and enhancing diverse biological communities for a number of shoreline areas (also see Ross *et al*. 2003).

In Ontario, the framework of the Ontario Living Legacy Land Use Strategy (2000) for future land and resource management on Crown lands has identified the shorelines on Lake Superior and Lake Huron as a unique resource of global significance. Approximately 3,000 kilometers of shoreline and adjacent lands have been designated Heritage Coastline (Ross *et al*. 2003).

At the multinational scale, proposed management by Wetlands for the Americas (now Wetlands International) includes protecting against loss of key habitat, and reducing chronic disturbance at sites traditionally used by ≥1,500 Sanderlings simultaneously. Additionally, management actions by the North American Waterfowl Management Plan (NAWMP) (est. 1986), and land purchases through the North American Wetlands Conservation Act (NAWCA) also benefit shorebirds, including Sanderlings.

SHIFTING CONSERVATION APPROACHES: A 'COMMON GROUND' PARADIGM

Taking a problem-solving, common-ground approach is crucial to achieving the tricky balance between meeting wildlife (in this case, Sanderling) and human needs. Although this approach is becoming more common, it is not yet standard practice. Traditional approaches may inadvertently pit beach users against wildlife, resulting in conflict, resentment, and closedmindedness against the opposing viewpoint, resolvable only through regulatory measures. However, such an approach will not work over the long run, because it does not change people's values or will; it only holds the tide at bay, while further dividing stakeholders. Although in many cases imposed enforcement may turn out to be the necessary immediate path forward, in many other cases (or over the long run), the situation will improve under an approach that treats each local challenge as an opportunity for creative problem-solving based on shared principles and values. For example, State Wildlife Action Plans frame the issue of listing endangered species as an outcome that no one wants; it is costly in time and money, and it imposes restrictions on landowners. Given that no one wants that outcome, what innovative collaborations between the government, private agencies, and landowners might we come up with to prevent declining species from entering that (unwanted) category? The result has been powerful and effective; the public *wants* to do the right thing, creative solutions are exciting and meaningful to be a part of, and meanwhile, the wildlife—and the public—benefit.

A similarly creative approach is being employed to resolve competing shorebird and agriculture needs for water/wetlands in the Pacific Northwest. Spearheaded by the U.S. Fish and Wildlife Service, The Nature Conservancy, and other partners, the two projects are seeking to provide alternative habitats for shorebirds while offering benefits to farmers. The Walking Wetlands project in the Klamath Basin (Oregon/California; U.S. Fish and Wildlife Service), and the Farming For Wildlife project in the Skagit Valley (Washington; The Nature Conservancy) are such examples. In the Skagit Valley, The Nature Conservancy leases fields from farmers for 3 years on a rotating basis, during which time the leased fields are flooded with constant sheet water (5–10 centimeters deep) to benefit shorebirds. The flooded fields have successfully attracted tens of thousands of migrating and wintering shorebirds, while reducing pesticide, herbicide, and fertilizer inputs to the watershed. Farmers are compensated in the short-term (via the leasing fee), and benefit in the long-term: the fields have much higher crop yields, have 40% higher nutrients, fewer weeds, and 95% less disease after the 3-year flooding cycle; also, farmers gain the additional benefit of the opportunity to enter the elite organic market (as organic certification requires 3 years without pesticides). This project has grown quickly (more than 6,000 acres now participate in the Klamath) and has gained wide support among farmers. These projects provide several important lessons: 1) wetlands and agricultural lands can be integrated in ways that maintain ecological integrity as well as the economic well-being and sustainability of surrounding rural communities; and 2) with the right innovative idea ("frame"), formerly opposed stakeholders can be transformed into partnerships in which wildlife and other interests do not just coexist, they thrive.

Such open-minded, innovative approaches are needed to find effective solutions to other wildlife-human challenges, such as balancing human and wildlife use at beaches. Beyond finding the right frame (a crucial and challenging first step), the required ingredients are a sense of shared commitment, responsibility, and stewardship by beach users, visitors, and wildlife advocates, alike. Citizen science may play an important role in this process. Creating collaborations with unlikely partners is beneficial, as open-mindedness and cross-pollination can yield powerful solutions not always possible with traditional/familiar partners. Wildlife/habitat managers can help generate positive enthusiasm and a sense of importance for the search for a solution, by sharing the challenge with local organizations and the public, and by inspiring interest in, and appreciation for, shorebirds. Educational materials can use powerful metaphors to describe wildlife on our beaches—such as a legacy we are honored to have inherited, and one we must pass on, intact, to future generations (this metaphor increases our willingness to be responsible and to make compromises). Academic (and other institutions) can give better support and incentives to researchers so that they may focus their work not only on studying a species/habitat, but also on sharing their knowledge (and passion for) 'their' species with the public at large (Nadkarni 2004). A more generous treatment of knowledge by academia and other researchers would help broaden the base of people who appreciate—but have never had the opportunity of studying—wildlife such as shorebirds *and* might one day help save them.

EDUCATION AND PUBLIC INVOLVEMENT

Educational opportunities and outreach

Education and outreach can and must play a critical role in improving the fate of the Sanderling and other beach-dependent shorebirds. In areas where migrating Sanderlings co-occur with beachgoers (e.g., at key sandy beaches along the Pacific, Atlantic, Gulf, and Great Lakes coasts), site-specific educational efforts are needed. These materials should seek to inspire visitors about Sanderlings, invite the public to participate in citizen science opportunities, and emphasize desired outcomes regarding visitor management and landowner outreach. Additionally, managers need institutional support in order to acquire better training in how to identify shorebirds, how to manage habitat for shorebirds, and how to better manage human and other disturbance (e.g., vehicles, joggers, fishers, walkers, photographers, bird watchers, water-sport recreationalists, pet owners, etc.), especially through outreach and effective partnerships.

Several examples of suggested educational opportunities for visitors (e.g., in the North Atlantic Region; Clark and Niles 2000), some of which may also reduce human disturbance, include: providing viewing platforms (informative plaques, spotting scopes); providing onsite outreach at shorebird concentration areas (to minimize impacts by recreational viewers and wildlife watchers); and providing educational information on shorebirds, including links to online information (e.g., to Western Atlantic Shorebird Association, WASA – a website for shorebird-based info; or to the Shorebird Sister Schools Program (SSSP)). Other ways of addressing the community in general include informational flyers, birding trips, presentations within the community, outreach at local environmental fairs, and articles in newspapers and newsletters.

In all of these cases, it is most meaningful when the public is *actively engaged* in activities that involve caring for wildlife and wildlife habitat – such as inviting the public to help keep track of shorebirds (i.e., citizen science), helping clean up local beaches, facilitating schools in coastal areas to establish “sister school” relationships with children in other coastal communities (or states/countries) based on sharing Sanderlings, and so on. Although passive information is beneficial and has the advantage of reaching a wider audience, active investment of one’s time and energy can shift attitudes on a deeper level and build a more permanent support base for the temporary inconveniences managers must ask the public to endure (such as beach closures). Annually organized shorebird-related events (e.g., shorebird/waterbird festivals, during migration) are excellent opportunities for raising awareness and building public involvement in and support for wildlife. This is also a good opportunity for connecting people and spreading interest/values across a diverse community, as well as connecting people that might not ever attend a bird festival). For example, organizers could invite businesses that might benefit from a temporary increase in visitors (e.g., book stores, photographic equipment store, latte stands, etc.) to highlight or associate their products with an upcoming or ongoing bird festival.

Educational messages

Educational content should inform viewers about the Sanderling, and cover the ecological basics, such as:

- Sanderlings require specific habitats to complete their life cycle (e.g., beaches, shallow lakes);
- There are three critical phases in a Sanderling's lifecycle when specific habitat needs must be met: breeding, staging (migratory), and nonbreeding (wintering);
- Many Sanderling habitats currently face threats from habitat loss and degradation, such as from agricultural and urban development, and human disturbance.

Educational messages should convey the need for adequate food and resting resources during migration and winter, such as the need for adequate and ecologically healthy populations of Horseshoe Crabs in the mid-Atlantic region (the crab eggs are a key food source during spring migration). Due to their reliance on sandy beach habitat and sensitivity to various stressors, Sanderlings are good indicators (i.e., umbrella species) for monitoring the health of coastal ecosystems, and the affects of global climate change.

Educational messages should also seek to inspire viewers about Sanderlings (e.g., via their spectacular migrations), build public interest and compassion, and embody positive human values. Some examples are provided in the Regional Shorebird Plans (e.g., Drut and Buchanan 2000, Hickey *et al*. 2003, and others; see U.S. Shorebird Conservation Plan website). Other useful language and perspectives on caring for wildlife (i.e., managing wildlife as a legacy) are outlined in the State Wildlife Action Plan overview (on the Internet). Appropriate metaphors can be powerful tools for drawing-in additional public interest or for shifting public attitude towards wildlife; for example, Sanderlings are elite athletes and experienced globe-trotters, members of the 'global economy' long before we joined. The parallel between Horseshoe Crabs and sea turtles is also compelling (since both come ashore in spring tides to breed), as is the notion that Horseshoe Crabs are 'living fossils' (their ancestors dating back before the dinosaurs; Clark and Niles 2000). Finally, because Sanderlings use—and rely upon—habitats that span the entire Western Hemisphere, they link people and countries together. Their persistence requires that we invest in our own future and work together—to reduce pollution and harmful contaminants, to reduce and contain our human impacts, to address climate change, to ensure that wild areas remain, and to increase cooperation among countries and communities. If we can work together to ensure that Sanderlings continue to occur on our coasts and shorelines, they will be our evidence that we are carrying on the legacy, and taking responsibility for the effects (intended and unintended) of our human footprint.

MEASURES TO REDUCE AND MANAGE HUMAN IMPACT

To reduce threats to the Sanderling and other beach-reliant shorebirds, new regulations must be drafted and implemented. These regulations should better manage (i.e., prevent or reduce) human disturbances and minimize risks to shorebirds and their food supply at key beaches during peak migration and winter, especially for those sites with high winter concentrations (e.g., Washington/Oregon beaches). Examples of specific regulations include:

- Area closures or restrictions (to beachgoers, dogs, vehicles, private watercrafts) at key foraging and roosting sites during peak migration;
- Specifications for construction, traffic, etc., of oil tankers, to lower probability of oil spills;
- Regulations to direct rapid and effective response to oil spills;
- In the mid-Atlantic region, regulatory measures to establish and maintain adequate and healthy populations of Horseshoe Crabs.

Drafting new regulations is often a major hurdle and can cause significant conflict in communities where opportunities to access or recreate at beaches are being reduced. It is therefore essential to invest in building broad public support for wildlife through innovative educational approaches, involving the public in caring for their beaches and wildlife whenever possible, and improving meaningful wildlife viewing opportunities for the public. It is equally important to maintain a proactive and flexible approach to drafting new regulations, where necessary, to help minimize such conflicts.

SET MANAGEMENT OBJECTIVES AND PRIORITIES

Rangewide

In all parts of the Sanderling's range, the agencies and organizations responsible for managing its habitat should set specific objectives directed at maintaining or increasing current

Sanderling populations on managed lands. Specific management goals will vary by region and by site, but should contribute to the overall objective of increasing Sanderling populations. Range-wide monitoring efforts for Sanderlings need to be coordinated to better inform conservation strategies and measure success or failure of conservation actions.

Priorities for Sanderling conservation include identifying important habitats for foraging and roosting, protecting and (where necessary) managing food resources, reducing human disturbance, and reducing contaminants. General management objectives should include training land managers to identify shorebirds, manage habitat for Sanderlings, and minimize or prevent disturbance; and coordinating management among public lands (e.g., impoundments among states/refuges).

Areas with Sanderling habitat should be prioritized for conservation within each flyway, region, and state. Disturbance should be reduced and managed through landowner outreach, visitor management, regulations, and area restrictions/closures (for recreational disturbance such as Personal WaterCraft and ATV users, beachgoers, dogs), and new regulations should be created where necessary.

In areas where oil spills are likely (for example, North Atlantic Region), improved oil spill response is needed—and is attainable by conducting planning and simulations, monitoring and quantifying habitat and food resources prior to spill (as preparation for quantifying the direct and indirect effects of spills), and conducting post-spill surveys to accurately quantify spill damages (Clark and Niles 2000).

Other types of contaminants should be reduced as well. In the case of dredged materials, improved dredging practices that address placement and quality of dredged material is needed (Clark and Niles 2000). In addition, the reduction of agricultural chemicals throughout the range would potentially improve the long-term viability of this species and many others.

And finally, structural modifications that are likely to be put into place as beaches erode or as sea level rises need to be considered in terms of their potential impact on the Sanderling and other coastal species (e.g., beach re-nourishment projects).

Region-specific

Regional objectives and priorities for shorebirds are outlined in Regional Shorebird Conservation Plans and Joint Venture Plans. Regional Plans are available for Alaska, Northern

Pacific Coast, Southern Pacific Coast, U.S. Pacific Islands, Intermountain West, Northern Plains/Prairie Potholes, Central Plains/Playa Lakes, Upper Mississippi River/Great Lakes, Lower Mississippi Valley/Western Gulf Coast, Southeastern Coastal Plains/Caribbean, and the Northern Atlantic (to access Regional Plans, see the U.S. Shorebird Conservation Plan website). Joint Venture Shorebird Implementation Plans are currently available for the Central Valley, Northern Great Plains, Playa Lakes, Prairie Potholes, and Upper Mississippi River/Great Lakes (also available via the U.S. Shorebird Conservation Plan website).

Some examples of priorities (from the U.S. Regional Plans) that apply to the Sanderling are listed below; however, Regional Plans should be consulted for complete lists. The subset below is intended to highlight several recurring themes, as well as to provide a few examples of regional specificity.

North Atlantic Region (Clark and Niles 2000). Conservation planning in this region requires placing special attention on establishing and maintaining ecologically healthy populations of Horseshoe Crabs in the mid-Atlantic region (through working with regulatory agencies, researchers, and commissions), and investing in planning and simulations for oil spill response. In addition it will be important to:

- Identify and manage sufficient foraging and roosting habitat (intertidal complexes and impoundments) to maintain and enhance regional populations important in the region for shorebird species with overlapping requirements: Sanderling, Ruddy Turnstone (*Arenaria interpres*), Semipalmated Sandpiper (*Calidris pusilla*), Short-billed Dowitcher (*Limnodromus griseus*), Black-bellied Plover (*Pluvialis squatarola*), and White-rumped Sandpiper (*Calidris fuscicollis*).
- Acquire land through partnerships to protect and manage habitat that benefits shorebirds (including the Sanderling) as well as other coastal wildlife species.

Southeastern Coastal Plains–Caribbean Region (Hunter *et al*. 2000):

- Provide high-quality managed habitat to support the Sanderling through better management of impounded wetlands;
- Reduce and limit human disturbance of Sanderlings to tolerable levels using disturbance management throughout the year.

Upper Mississippi/Great Lakes Region (Joint Venture Area) (de Szalay *et al*. 2000):

- Set regional goals for amount of habitat to be maintained/protected/restored, e.g., begin by setting aside a minimum of 1,500 hectares beach habitat for foraging and resting Sanderlings and other beach-using shorebirds during peak migration periods.

Northern Pacific Coast Region (Drut and Buchanan 2000):

- Determine the current population status of the Sanderling within the region, and monitor this species to determine long-term trends;
- Determine the potential impacts of environmental contaminants on the health of shorebird populations;
- Improve communication among and within resource management agencies about shorebird needs and management techniques.

Southern Pacific Coast Region (Hickey *et al*. 2003):

- Increase migratory and wintering populations of all key shorebird species in the region using protection, restoration, enhancement, and management;
- Minimize future introductions of non-native invertebrates and plants;
- Ensure adequate low-disturbance roost sites.

HABITAT RESTORATION AND CREATION

Habitat restoration is not an adequate substitute for safeguarding existing wetlands (Buchanan 2000). However, in cases where further habitat loss is inevitable, there is potential for habitat restoration or creation to possibly mitigate environmental impacts. Information regarding the effectiveness of restoration efforts is limited, and restoration approaches carry risks. However, some suggestions may increase probability of success (from Buchanan 2000):

- *Develop site-specific strategies for restoration projects* – Consider site characteristics such as tidal, wind pattern, sea swell, and substrate conditions (marine environment) or local water, soil, and vegetation conditions/requirements (freshwater);
- *Create new sites at least 5 years prior to modification of natural habitat* - Artificially created sites should accommodate all displaced birds, initiating this process at least 5

years before the planned modification of natural habitat (Davidson and Evans 1987; Buchanan 2000). This 5-year period is needed to: 1) identify suitable sites; 2) acquire, design, and construct mitigation features at sites; 3) allow suitable sediments to settle and stabilize; and 4) allow time for colonization of sufficient densities of invertebrate prey species (Davidson and Evans 1987).

- *Evaluate shorebird use of artificial impoundments* - Artificially created sites may be very important to shorebirds, and should be evaluated using the same approach as for undisturbed sites (Warnock and Takekawa 1995).
- *Create adequate roost sites* – Although most shorebirds (including the Sanderling) appear to prefer beaches (or salt marshes) as roost sites, they also use dredge-spoil islands and other human-created areas. Artificial sites should provide shelter from strong winds or sea swell, and be open with flat tops and gently sloping sides (to allow for effective scanning for predators; Metcalfe 1984).
- *Manage artificial (freshwater) sites during fall migration* – During fall migration, shorebirds use draw-downs, flooded agricultural lands, and artificial fish ponds. Gradual draw-downs in shallow [0–5 centimeters (0–2 inches) deep] flood pools should be interspersed with exposed saturated soils and should be maintained for the duration of fall migration.
- *Maximize invertebrate production at artificial (freshwater) sites* – Artificial impoundments will be most effective if site features maximize invertebrate production and shorebird foraging efficiency.

RESEARCH AND MONITORING NEEDS

Research and monitoring needs for North America are highlighted in numerous state, regional, and national shorebird planning documents, and by the Shorebird Research Group of the Americas (SRGA website). Regional Plans of the U.S. Shorebird Conservation Plan describe comprehensive as well as regionally focused research needs; other documents highlighting research needs for the Sanderling include habitat Joint Ventures and State Wildlife Action Plans.

Research priorities important to the survival of the Sanderling include:

- determining limiting factors on breeding, migration, and wintering grounds;

- identifying food/roost resources and habitat requirements;
- determining population trends for all flyways (requires improved monitoring scheme);
- determining energetic and nutritional requirements; and
- questions that address management-related issues.

HABITAT REQUIREMENTS

Given persistent threats to Sanderling habitat (coastal/ beach development, habitat degradation, sea-level rise, pollution, and human disturbances), research efforts should be directed towards fully understanding habitat requirements, behavioral plasticity, and identifying feeding and roosting areas during migration and winter. What prey and roost resources are available to Sanderlings, and does the availability of those resources vary seasonally? How does habitat use vary with increased predation/disturbance pressure? What is the availability of alternative sites, should currently important sites be lost? Efforts should be made to map and classify habitats at a range of spatial scales, in order to potentially link shorebird survival and use of habitat with landscape structure (Fernandez and Lank 2008). Given this species's tendency to disperse during the nonbreeding season (and the potentially important social role of that dispersal), habitat requirements should not be set according to minimum energetic requirements (i.e., by providing a few hotpots), but rather by including important key sites as well as multiple sites of moderate use/importance.

FOOD

To protect Sanderling food resources, research is needed to determine optimal management techniques for promoting invertebrate (prey) resources; to develop a better understanding of invertebrate management; and to develop and implement long-term monitoring of significant prey populations (in selected areas). In the mid-Atlantic region, it is necessary to understand how to maintain adequate and ecologically healthy populations of Horseshoe Crabs (Clark and Niles 2000).

Additionally, research is needed to quantify the before/after effects (short- and long-term) of various standard beach manipulation practices (e.g., beach scraping, beach nourishment, and beach raking) on invertebrate prey populations.

A potential issue of importance on the North American Pacific Coast (Washington, Oregon, and parts of California) is the rate at which Sanderlings acquire their essential food intake during winter, when storms can last several days or more and limit (or even prevent) foraging by Sanderlings. How does food intake vary with weather? If stormy conditions pose a significant constraint to Sanderling mass accumulation, the need to manage human disturbance would increase, given its potentially compounding effect on Sanderling survival (during stressful conditions).

DANGERS (POTENTIAL AND KNOWN):

Research is needed to illuminate the current and potential dangers to Sanderling populations, with the explicit purpose of clarifying the actual threat and reducing those threats:

Habitat alteration

- Determine the effects of habitat alterations such dredging, beach replenishment, and other activities;
- Identify factors that may limit the quality of stopover habitat

Contaminants

- Determine the effects of contaminants on Sanderling prey;
- Determine the effects of contaminants on Sanderling and other shorebirds;
- Examination of sublethal effects of pesticide and other contamination on migratory performance.

Oil spills

- Monitor/quantify habitat and food resources prior to spill as preparation for quantifying the direct and indirect effects of spills;
- Conduct post-spill surveys to accurately quantify spill damages;
- Improve oil trajectory models;
- Effect of oiling on the duration of migratory stopovers, likelihood of disruption or cessation of further migration, mortality during migration, and reproduction.
- Physiological effects on Sanderlings and other shorebirds from ingesting oil products while preening after being contaminated from a spill.

Predation

- Feeding and danger ecology: understanding limiting factors – i.e., where, when, and how much predation on Sanderling limits their populations (Fernandez and Lank 2008);
- Determine effects of the increase in predator populations. These increases may cause migrating and wintering shorebirds to avoid some sites and decrease their stopover time at others (Butler *et al*. 2003, Lank *et al*. 2003).
- Effect of habitat structure (perch availability and perch attributes) on falcon disturbance and predation rates (see Dzialak *et al*. 2007). The location of high, well-situated predator perches could affect the survival of prey populations in open habitats (Andersson *et al*. 2009), and perches are increasingly (though inadvertently) being provided by human development projects (e.g., well-situated, tall telephone poles next to prime foraging areas). If these perches facilitate increased predation rates, then it would benefit Sanderlings and other shorebirds if planned development projects were guided to place structures away from shorebird areas.

Human-caused Disturbance

- Determine effects of human-caused disturbance; in assessing human disturbance impacts, measure the impacts of human disturbance on *fitness* rather than on the severity of behavioral responses (Yasue 2006).
- Determine minimum buffer distance to maintain and enhance shorebird use of foraging and roosting areas.

POPULATIONS

Status and dynamics

- Develop and improve spatially explicit flyway-level monitoring programs (coordinated ones, such as the Program for Regional and International Shorebird Monitoring [PRISM]), during migration and winter.
- As PRISM is being developed/implemented, expand existing surveys within an analytical framework, and strengthen collaborative networks of researchers/observers to facilitate

flyway-scale monitoring scheme for the Sanderling and other shorebirds (during migration and winter);

- o Quantify relationship between counts and population estimates;
- o Determine lengths of stay (turnover rates) at stopover areas to permit calculation of population estimates;
- o Estimate the extent to which populations have declined;
- o What factors drive population trends? (need data from South America and from Atlantic Coast wintering populations).

<u>Population separation and overlap:</u>

- o To what extent do birds mix or segregate between breeding populations, migration routes, and wintering areas? Identify any population-specific needs.

<u>Variability among populations:</u>

- o How much variability (in mating systems, reproductive behavior, timing, migration distance, etc.) exists among and within populations?

WINTERING GROUNDS

The Sanderling has an extensive wintering range throughout the Americas. It is the most common shorebird along most of the Pacific coast of South America (from the equator southward), and occurs along many sandy beaches between Peru and Chile. However, with few exceptions (i.e., parts of California), Sanderlings are poorly studied on their wintering grounds. Important areas for research include understanding the distribution of age and sex classes during winter; and understanding habitat use, site fidelity, and flexibility to adapt to new sites during winter.

MIGRATION

<u>Timing and routes:</u> Migration routes and schedules are closely timed with seasonally abundant food resources. How flexible are migration routes?

Climate change impacts: Climate change could have uneven impacts on the Sanderling (since, as a long-distance migrant, it is subject to distant events) and on its prey supply (subject to local events), which could potentially de-couple Sanderlings from their food supply at certain key sites (e.g., timing of Horseshoe crab eggs at Delaware Bay, or drying of saline lakes in interior regions). If this were to happen, Sanderlings may have limited flexibility for adaptation to altered schedules or routes. Climate change could also influence other important factors during migration, such as predation or susceptibility to disease.

BREEDING GROUNDS

There is ample evidence that high arctic areas are experiencing strong effects of climate change, and these effects may potentially threaten the Sanderling. How is climate change influencing habitat on the breeding grounds? Are Sanderlings resilient to these changes, or are their distributions shifting and/or is breeding productivity changing? Will climate change result in new species interactions, ones that might impact the Sanderling (e.g., through competition, predation, disease)? And importantly, will there be a loss of the prey base as habitat structure changes in response to altered (drying) weather patterns? Further research is needed to understand Sanderling reproduction and survival in the changing High Arctic.

SOCIAL ECOLOGY (AND ITS IMPORTANCE TO CONSERVATION)

Sanderlings commonly occur in a range of group sizes – singles, tens, hundreds, thousands, and even tens of thousands. Their occurrence in a wide range of flock sizes is unusual for shorebirds, as most species tend to occur in more consistent (less variable) flock sizes. Research is needed to understand the importance of social structure in Sanderling (and other shorebird) populations. For instance, what is the structure and survival importance of social systems? How stable and how flexible are social structures? Is the distribution of age and sex classes during winter socially driven or maintained? Furthermore, does habitat loss disrupt social structure beyond the obvious loss of food resources, translating into reduced fitness? If so, conservation efforts that consider sites as interchangeable (i.e., food resources only), or that consistently target sites that accommodate large aggregations of birds—but do not attempt to protect the smaller sites—may not succeed in halting population declines.

VARIABILITY AND UNCERTAINTY

Several large-scale questions are important from both a conservation and ecological perspective: What is the overall stability and predictability of the systems in which the Sanderling occurs (change in landscape, change in predation, change in food resource, change in climate)? How variable are the environmental conditions faced by Sanderlings through time (seasons, years) and space (across sites, states, continents, hemispheres)? How do Sanderlings respond to environmental uncertainty? And, are there predictable strategies?

MANAGEMENT-RELATED NEEDS

The primary management considerations for Sanderlings are to provide enough habitats with enough food and safety at each location. Specific research needs related to management include those mentioned above, as well as some related to the timing of management actions:

- Determine lengths of stay (turnover rates) at stopover sites to help target management actions;
- What factors affect length of stay? And, can management alter this beneficially?
- Identify factors that may limit the quality of stopover habitats. For instance, if sand is to be extracted (e.g., in Washington state), or deposited (e.g., beach nourishment), is there a season when these actions can be done with minimal impact (i.e., summer?) Or perhaps, might the size and spacing of extraction/deposition areas be evaluated prior to manipulation?

ENERGETICS

Given the energetic requirements for an itinerant lifestyle (i.e., completing spectacular migrations twice a year), it is crucial that Sanderlings have an adequate food supply at migration stopover sites, with adequate roosts (for resting), and safety from disturbances and dangers (predation, pollution, excessive/chronic human disturbance). Research is needed to estimate the amount of food/roost resources needed for a Sanderling to build up fat, under different scenarios (i.e., with and without disturbance). The amount of fat can be converted into estimates of the distances a bird can fly—and therefore can provide insights into the food resources and habitat needs of the species at stopover sites.

However, the use of energetics in shorebird conservation planning carries a word of caution. Because conservation takes place within a limited framework (limited funds, time, and effort), conservationists are often asked to define a certain minimal goal, such as to identify the minimum number of important sites needed to meet an objective (i.e., that a species of interest may complete its migration). Although this approach has conceptual appeal for its simplicity, it is an inappropriate guiding framework for Sanderling (or shorebird) conservation for several important reasons: 1) stopover sites host a mix of individuals that originate from different locations and that are headed to different destinations (and therefore, only the furthest potential destination should be considered the 'minimum' distance); 2) many Sanderling habitats are experiencing increased levels of disturbance or dangers, and hence Sanderling will likely expend additional effort and energy in order to build up fat reserves (even if an 'adequate' food supply is present); and 3) any biggest-bang-for-the-buck approach invariably selects sites that host large numbers of birds; while this appears most efficient from a conservationist's standpoint, it does not take into consideration the potential importance of maintaining 'smaller' sites (to enable spatial segregation among and within species), given that some species (e.g., aggregated) may fare better than others (e.g., dispersed) if crowded into a small set of sites. Finally, despite uncertainties as to effects on specific locations, in the age of climate change we may no longer have much room for error. We may find ourselves in the coming decades engaging in some serious hands-on actions to save this and other species. Hence, it is prudent to target a conservation approach that, while ambitious, is most likely to support their ecology and spread out the risk due to stochastic events.

MONITORING

In North America, Sanderling (along with other shorebird species) populations have been monitored by the International Shorebird Survey since the mid 1970s. Regional monitoring efforts that record Sanderlings also include the Canadian Maritime Shorebird Survey, the Pacific Flyways Project (active during the 1980s along the Pacific U.S. Coast), the Western Shorebird Survey (initiated in 2000), the Western Atlantic Shorebird Association (currently active along the U.S. Atlantic), and the South Atlantic Migratory Bird Initiative (SAMBI), among others. In addition, individual researchers have gathered multiple years of data on the Sanderling in specific parts of its range, for example in Arcata and Bodega Bay, California; Delaware Bay, New Jersey; the Outer Banks of North Carolina; and the Washington coast. Recommendations made in Version 1.0 of this document are based mainly on the International Shorebird Survey data scheme (emphasis on United States) and, as such, are incomplete. Future versions of this Sanderling Conservation Plan will expand geographically to include other data sets for a more comprehensive perspective.

In response to the recognized need for standardized survey efforts, the Program for Regional and International Shorebird Monitoring (PRISM) was launched as the blueprint for shorebird monitoring efforts in the United States and Canada. It is intended to provide reliable information on the distribution, abundance, and population trends of shorebirds. A top priority for Sanderling conservation continues to be to improve monitoring schemes, in order to enable robust estimates of population trends; PRISM is a crucial (and substantial) step in that direction, although it does not replace existing schemes (i.e., ISS). However, ideally, other sites should continue to be monitored (albeit in a more standardized fashion) to supplement PRISM efforts and to provide wider coverage throughout the nonbreeding range.

An option that merits consideration is to organize and refocus non-PRISM monitoring efforts (such as ISS, or other) to incorporate a rotating panel design. In such a design, a set number of 'key' sites are monitored every year, and additional rotating sets are identified for monitoring at lower frequencies (e.g., every few years). Such a set-up would require greater logistical investment up front (to coordinate participant efforts), but once up and running, would offer critical improvements over the current (non-PRISM) set-ups, because it would provide consistent sampling in space and time, increasing confidence in both population trend analysis and the identification of important sites.

CONSERVATION TIMELINE

By 2010

- Create a Sanderling Working Group that includes participants from across the Western Hemisphere;
- Develop a plan to revisit and evaluate ISS sites that were important to the Sanderling at some point in the past, but have not been surveyed since the 1990s;

- Explore feasibility of, and then develop, a continent-wide monitoring scheme (by flyway) and monitoring schedule for improving population trend detection and site identification. This could be done perhaps by employing a rotating panel of ISS and other sites. Monitoring should occur during migration and winter;
- Develop strategy for better managing human disturbance at beaches where Sanderlings occur, including a think-tank approach to finding creative solutions (including nontraditional partners);
- In conjunction with a strategy for managing human disturbance, develop educational messages and materials, and (at/near important shorebird/Sanderling sites) explore creative approaches and new opportunities for involving and engaging the public in learning about and caring for shorebirds and their habitats. Launch several new annual shorebird/waterbird festivals (or other combined events related to wildlife including shorebirds) in each flyway.

By 2011

- Implement an improved monitoring scheme in the United States (along Pacific, Atlantic, and Gulf coasts, as well as in the interior) for migration and winter;
- Launch specific studies or surveys that shed light on important “unknowns” identified in this plan – including research in South America;
- Designation by WHSRN and Ramsar of more sites in North and South America that are important to the Sanderling, with special emphasis on coastal sites or any others that face significant and immediate threats.
- Continue building public support for shorebirds (at/near important shorebird/Sanderling sites), through educational materials, citizen science, and other activities that involve and engage the public in learning about and caring for shorebirds and their habitats.

By 2012

- Conduct specific threat-abating activities/education with landowners at important sites;
- Explore the feasibility of, and support the development of, increased monitoring for shorebirds in South America, during migration and winter (e.g., by revising and expanding ISS monitoring scheme);

- Obtain commitments/agreements from key decision-makers at important sites to change practices (e.g,. human disturbance management, pollution control) to benefit shorebirds.

By 2013

- Put strategies in place for purchasing or otherwise permanently protecting specific North or South American sites identified as being important (but currently unprotected).

EVALUATION

Although much remains unknown about Sanderling ecology and population dynamics, we must act to protect this species before all questions are answered; otherwise, conservation may become unattainable. However, actions taken with insufficient knowledge may result in an inefficient investment of resources for the amount of conservation gained. Therefore, it is essential that conservation and management actions have well-defined, measureable objectives and are implemented in a hypothesis-driven, adaptive framework to allow for iterative evaluation and adjustment (Schulte and Brown 2006). As specific research questions are addressed, their results will help steer resource and land managers towards the most effective strategies for conservation.

Across the Sanderling's range, the organizations and agencies responsible for managing Sanderling habitat should set objectives to increase or maintain the number of Sanderlings using their managed lands. Specific goals will vary by location. Hypotheses should be generated to test specific management actions (such as habitat restoration, beach closures, etc.), and management actions should be implemented in a way that enables testing of additional hypotheses. Such an approach is an iterative process, in which management and conservation actions are continually re-evaluated and adapted, so that explicit objectives may be met most efficiently (Schulte and Brown 2006). This process should be applied to quantify the effects of beach closures, habitat restoration, habitat alteration, and other actions. Although in many cases this approach remains an ideal rather than standard practice, it is nevertheless a crucial investment tool for understanding how to manage efficiently and effectively. Meanwhile, the continued commitment to multiple case studies can provide some insights into the apparent responses of wildlife to certain management actions.

Evaluation of individual conservation projects is similarly important, with respect to their more limited and short-term goals. For example, when a project aims to reduce human disturbance (e.g., by controlling human access to a site), habitat use by Sanderlings must be monitored both before and after treatments are applied. Similarly, if habitat restoration/creation is the goal, the numbers of Sanderlings present as well as some metric related to their fitness, must both be monitored, and compared to reference habitats. Individual projects should also be evaluated in the larger context of adaptive management, as described above.

LITERATURE CITED

Acosta-Cruz, M. and L. Mugica-Valdes 2006. Final Report: Waterbirds in Cuba. Waterbirds International.

Adams, S.G., F.M. Conly, C.L. Gratto-Trevor, K.J. Cash, and T. Bollinger. 2003. Shorebird Use and Mortality at a Large Canadian Prairie Lake Impacted by Botulism. Waterbirds 26(1):13–25.

Alexander, S.A. and C.L. Gratto-Trevor. 1997. Shorebird migration and staging at a large prairie lake and wetland complex: the Quill Lakes, Saskatchewan. Canadian Wildlife Service Occasional Paper No. 97. Ottawa, Ontario.

Andersson, M., J. Wallander and D. Isaksson. 2009. Predator perches: a visual search perspective. Functional Ecology: 23(2): 373–379.

Andres, B.A. and R.E. Gill, Jr. (eds) and Alaska Shorebird Working Group. 2000. A Conservation Plan for Alaska Shorebirds. 47 pp. Available on the Internet: http://www.fws.gov/shorebirdplan/

Andrews, R. and R. Righter.1992. Colorado birds: a reference to their distribution and habitat. Denver Mus. Nat. Hist., Denver, CO.

Angehr, G. 2005. Waterbirds In Panama. Final Report: Waterbird Conservation for the Americas. On the Internet: http://www.birdlife.org/action/science/species/waterbirds/waterbirds_pdf/waterbirds_report_panama_2006.pdf

Armstrong, R.H. 1995. Guide to the birds of Alaska. 4th ed. Alaska Northwest Books, Seattle, WA.

Audubon Watch List. 2007. (On the Internet: http://web1.audubon.org/science/species/watchlist/)

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

Bertochi, L.E., G. Castro and J.P. Myers.1984. Notes on the predators, especially the peregrine, of Sanderlings on the Peruvian coast. Wader Study Group Bull. 42: 31–32.

Beyersbergen, G.W., and D. Duncan. 1995. Shorebird abundance and migration at Chaplin/Old Wives/Reed Lakes, Saskatchewan. Internal Canadian Wildlife Service Report, Prairie and Northern Region, Edmonton, Alta.

Beyersbergen, G.W., and D. C. Duncan. 2007. Shorebird abundance and migration chronology at Chaplin Lake, Old Wives Lake and Reed Lake, Saskatchewan: 1993 – 1994. Canadian Wildlife Service Technical Report Series No. 484. Prairie and Northern Region. Edmonton, Alberta. 47 pp.

Beyersbergen, G.W. (In prep). Shorebird migration surveys of Alberta – Saskatchewan border lakes and the north-central lakes of Saskatchewan: 1995 – 1998. Environment Canada, Canadian Wildlife Service unpublished report. Edmonton, Alberta, Canada.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. Ibis 136:412–425.

BirdLife International. 2008. IUCN Red List. On the Internet: http://www.birdlife.org/action/science/species/global_species_programme/red_list.html

BirdLife International. 2009. Important Bird Areas, World Bird Data Base. On the Internet: http://www.birdlife.org

Blanco, D. E., P. Yorio , P. F. Petracci and G. Pugnali. 2006. Distribution and abundance of non-breeding shorebirds along the coasts of the Buenos Aires province, Argentina. Waterbirds 29(3): 381–390.

Boates, J.S., and R. McNeil. 1984. Longevity record for the Sanderling. J. Field Ornithol. 55: 485.

Boertmann, D. 1994. An annotated checklist to the birds of Greenland. Meddr. Grønland, Biosci. 38: 29.

Bourget, A. 1993. Quebec shorebird surveys. Bird Trends 3: 6–7.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Brown, W.M., and R.C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision and mortality. Wildlife Society Bulletin 23:217–227.

Buchanan, J.B. 1988. The abundance and migration of shorebirds at two Puget Sound estuaries. Western Birds 19:69–78.

Buchanan, J.B. 1992. Winter abundance of shorebirds at coastal beaches of Washington. Washington Birds 2:12–19.

Buchanan, J.B. 1996. A comparison of behavior and success rates of Merlins and Peregrine Falcons when hunting Dunlins in two coastal habitats. Journal of Raptor Research 30(2): 93–98.

Buchanan, J.B. 2000. Shorebirds: Plovers, Oystercatchers, Avocets and Stilts, Sandpipers, Snipes, and Phalaropes. *In* Larson, E. and N. Nordstrom (editors). Management recommendations for priority bird species. Washington Department of Fish and Wildlife, Olympia. Volume IV: 20–48.

Buchanan, J.B., and J.R. Evenson. 1997. Abundance of shorebirds at Willapa Bay, Washington. Western Birds 28:158–168.

Burger, J., M.A. Howe, D.C. Hahn, and J. Chase. 1977. Effects of tide cycles on habitat selection and habitat partitioning by migrating shorebirds. Auk 94: 743–758.

Burger, J. 1997. Effects of oiling on feeding behavior of Sanderlings and Semipalmated Plovers in New Jersey. Condor 99: 290–298.

Burger, J., and M. Gochfeld. 1991. Human activity influence and diurnal and nocturnal foraging of Sanderlings (*Calidris alba*). Condor 93:259–265.

Burger, J., C. Jeitner, K. Clark, and L. Niles. 2004. The effect of human activities on migrant shorebirds: successful adaptive management. Environmental Conservation 31(4):283–288.

Butler, R. W., R. I. G. Morrison, F. S. Delgado, R. K. Ross and G. E. J. Smith. 1997. Habitat associations of coastal birds in Panama. Colonial Waterbirds 20(3): 518–524.

Butler, R.W., R.C. Ydenberg, and D.B. Lank. 2003. Wader migration on the changing predator landscape. Wader migration on the changing predator landscape. Wader Study Group Bull. 100: 130–133.

Butler, R.W., R.C. Ydenberg, G.D. Donaldson, and S. Brown. 2004. Hypothesis to explain census declines in North American shorebirds. Shorebird Research Group of the Americas. Report 1. (On the internet: http://www.shorebirdresearch.org/).

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The Birds of British Columbia - Volume 1 - Introduction and Loons through Waterfowl and Vol 2 - Diurnal Birds of Prey through Woodpeckers. Royal British Columbia Museum.

Castro, G. and J.P. Myers. 1987. Ecología y conservación del playero blanco (*Calidris alba*) en el Perú. Bol. de Lima 52: 47–61.

Castro, G. and J.P. Myers. 1990. Validity of predictive equations for total body fat in Sanderlings from different nonbreeding areas. Condor 92: 205–209.

Castro, G. and J.P. Myers. 1993. Shorebird predation on eggs of horseshoe crabs during spring stopover on Delaware Bay. Auk 110: 927–930.

Castro, G., J.P. Myers and L.E. Bertochi. 1988. Predatores del "playero blanco" en el Perú. Bol. de Lima 58: 57–59.

Castro, G., J. P. Myers and A. R. Place. 1989. Assimilation efficiency of Sanderlings (*Calidris alba*) feeding on horseshoe crab (*Limulus polyphemus*) eggs. Physiol. Zool. 62: 716–731.

Castro, G., J.P. Myers and R.E. Ricklefs. 1992. Ecology and energetics of Sanderlings migrating to four latitudes. Ecology 73: 833–844.

China-Australia Migratory Bird Agreement (CAMBA). 1986. (On the Internet: http://www.environment.gov.au/biodiversity/migratory/waterbirds/index.html).

Clark, K. and L. Niles. 2000. Northern Atlantic Regional Shorebird Plan. U.S. Shorebird Conservation Plan. Version 1.0. 17 pp.

Clark, K.E., L.J. Niles, and J. Burger. 1993. Abundance and distribution of migrant shorebirds in Delaware Bay. Condor 95: 694–705.

Climate Impacts Group. 2009. University of Washington. On the Internet: http://cses.washington.edu/cig/

Colwell, M.A. 1994. Shorebirds of Humboldt Bay, California: abundance estimates and conservation implications. Western Birds 25: 137–145.

Colwell, M.A., and K.D. Sundeen. 2000. Shorebird distributions on ocean beaches of northern California. Journal of Field Ornithology 71(1): 1–16.

Committee on the Status of Endangered Wildlife in Canada list (COSEWIC). On the internet. http://www.cosewic.gc.ca/

Connors, P.G., J.P. Myers, C.S.W. Connors, and F.A. Pitelka. 1981. Interhabitat movements by Sanderlings in relation to foraging profitability and the tidal cycle. Auk 98: 49–64.

Contreras, A.R. 2003. Sanderling (*Calidris alba*). Pages 233–234 in The Birds of Oregon: a general reference. Marshall, D.B., M.G. Hunter, A. Contreras (editors). Oregon Breeding Bird Atlas Project. Oregon State University Press, Corvallis, OR. (752 pp).

Cramp, S., and K.E.L. Simmons. 1983. The birds of the Western Palearctic. Vol. 3: waders to gulls. Oxford Univ. Press, Oxford, U.K.

Cresswell, W., J.A. Clark, and R. Macleod. 2009. How climate change might influence the starvation-predation risk trade-off response. Proceedings of the Royal Society B-Biological Sciences 276 (1672): 3553–3560.

Cyr, A., and J. Larivée.1995. L'atlas saisonnier des oiseaux du Québec. Presses de l'Université de Sherbrooke et Société de Loisir ornithologique de l'Estrie, Sherbrooke, QC.

Danufsky, T., and M.A. Colwell. 2003. Winter shorebird communities and tidal flat characteristics at Humboldt Bay, California. Condor 105(1): 117–129.

Davidson, N.C., and P.R. Evans. 1987. Habitat restoration and creation: its role and potential in the conservation of waders. Wader Study Group Bulletin 49 (Supplemental): 139–145.

Dekker, D., and R. Ydenberg. 2004. Raptor predation on wintering Dunlins in relation to the tidal cycle. Condor 106(2): 415–419.

De Luca, A., P. Develey, and F. Olmos. 2006. Waterbirds in Brazil: A Conservation Assessment. Waterbird Conservation for the Americas. On the Internet: http://www.birdlife.org/action/science/species/waterbirds/waterbirds_pdf/waterbirds_report_brazil_2006.pdf

De Repentigny, L.G. 1999. Fichier insulaire du Fleuve Saint-Laurent. Service canadien de la faune, Environnement Canada, région du Québec.

de Szalay, F., D. Helmers, D. Humburg, S.J. Lewis, B. Pardo, and M. Shieldcastle. 2000. Upper Mississippi Valley / Great Lakes Regional Shorebird Conservation Plan. Version 1.0. 33 pp. Available on the Internet: http://www.fws.gov/shorebirdplan/

Dickson, H.L., and D. Duncan. 1993. Conservation of shorebirds on the prairies. Bird Trends 3: 8–9.

Dinsmore, S.J., J.A. Collazo and J.R. Walters. 1998. Seasonal numbers and distribution of shorebirds on North Carolina's Outer Banks. Wilson Bull. 110: 171–181

Donaldson, G.M., C. Hyslop, R.I.G. Morrison, H.L. Dickson, and I. Davidson. 2000. Canadian Shorebird Conservation Plan. Canadian Wildlife Service (Special Publication).

Dunne, P., D. Sibley, C. Sutton and W. Wander. 1982. 1982 aerial shorebird survey of Delaware Bay. Rec. New Jersey Birds 8: 68–75.

Drut, M.S., and J.B. Buchanan. 2000. Northern Pacific Coast Regional Shorebird Management Plan. U. S. Shorebird Conservation Plan. 32 pp.

Dzialak, M.R., K.M. Carter, and M.J. Lacki. 2007. Perch site selection by reintroduced Peregrine falcons *Falco peregrines*. Wildlife Biology: 13(3): 225–230.

Elliott, L. (ed) *et al*. 2000. Lower Mississippi /Western Gulf Regional Shorebird Conservation Plan. 64 pp. Available on the Internet: http://www.fws.gov/shorebirdplan/

Engilis, Jr., A,. and M. Naughton. 2004. U.S. Pacific Islands Regional Shorebird Conservation Plan. U.S. Shorebird Conservation Plan. U.S. Department of the Interior, Fish and Wildlife Service. Portland, Oregon. Available on the Internet: http://www.fws.gov/shorebirdplan/

Evans, P.R., and M.W. Pienkowski. 1984. Population dynamics of shorebirds. Pp. 83–123 *in* Behavior of marine animals. Vol. 5 (J. Burger and B. L. Olla, eds.). Plenum Press, New York.

Evenson, J.R., and J.B. Buchanan. 1997. Seasonal abundance of shorebirds at Puget Sound estuaries. Washington Birds 6:34–62.

Fellows, S., K. Stone, S. Jones, N. Damude and S. Brown. Central Plains / Playa Lakes Regional Shorebird Conservation Plan. Version 1.0. 25 pp. Available on the Internet: http://www.fws.gov/shorebirdplan/

Fernandez, G., and D.B. Lank. 2008. Effects of habitat loss on shorebirds during the non-breeding season: Current knowledge and suggestions for action. *Ornitologia Neotropical* 19: 633–640.

Ferns, P.N. 1980. The spring migration of Sanderlings *Calidris alba* through Britain in 1979. Wader Study Group Bull. 30: 22–25.

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

Gill, R.E., Jr., R.W. Butler, P.S. Tomkovich, T. Mundkur, and C.M. Handell. 1994. Conservation of North Pacific Shorebirds. Trans. 59th No. Am. Wildl. & Natur. Resour. Conf. 63–78.

Gill, R.E., C.M. Handel, and G.W. Page. 1995. Western North American shorebirds. Pp. 60–65 *in* Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems (E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac, eds.). U.S. Dep. Int., Nat. Biol. Surv., Washington, D.C.

Godfrey, W.E. 1986. The birds of Canada. Rev. ed. Natl. Mus. Nat. Sci., Ottawa, ON.

González, P.M. 1996. Habitat partitioning and the distribution and seasonal abundances of migratory plovers and sandpipers in Los Alamos, Rio Negro, Argentina. Int. Wader Stud. 8: 93–102.

Granfors, D.A. and N.D. Niemuth. 2005. Prairie Pothole Joint Venture 2005 Implementation plan: Section III – Shorebird Plan. 22 pp.

Gratto-Trevor, C.L., G. Beyersbergen, H.L. Dickson, P. Erickson, R. MacFarlane, M. Raillard and T. Sadler. 2001. Prairie Canada shorebird conservation plan. Prairie Habitat Joint Venture, Canadian Wildlife Service, Edmonton, Alberta.

Haramis, G.M., W.A. Link, P.C. Osenton, D.B. Carter, R.G. Weber, N.A. Clark, M.A. Teece, and D.S. Mizrahi, 2007. Stable isotope and pen feeding trial studies confirm the value of horseshoe crab Limulus polyphemus eggs to spring migrant shorebirds in Delaware Bay. Journal of Avian Biology 38(3): 367–376.

Hayman, P., J. Marchant, and T. Prater. 1986. Shorebirds: an identification guide. Houghton Mifflin, Boston, MA.

Helmers, D.L. 1993. Enhancing the management of wetlands and migrating shorebirds. Trans. North America Wildlife & Natural Resource Conference. 58:335–344.

Hickey, C., W.D. Shuford, G.W. Page, and S. Warnock. 2003. Version 1.1. The Southern Pacific Shorebird Conservation Plan: A strategy for supporting California's Central Valley and coastal shorebird populations. PRBO Conservation Science, Stinson Beach, CA.

Hicklin, P.W. 1987. The migration of shorebirds in the Bay of Fundy. Wilson Bulletin 99: 540–570.

Hill, N.P. 1965. The birds of Cape Cod, Massachusetts. William Morrone and Co., New York, NY.

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.

Howell, S.N.G., and S. Webb. 1995. The birds of Mexico and northern Central America. Oxford Univ. Press, New York.

Hughes, P.A. 1979. Notes of the Charadriiformes of the south coast of Peru. Stud. Avian Biol. 2: 49–53.

Hunter, W.C. *et al*. 2000. Southeastern Coastal Plains-Caribbean Regional Shorebird Conservation Plan. (Revised 2002). 25 pp. (plus appendices). Available on the Internet: http://www.fws.gov/shorebirdplan/

Important Bird Areas of Canada. 2009. On the internet: http://www.ibacanada.com/

Isleib, M.E. 1979. Migratory shorebird populations on the Copper River Delta and eastern Prince William Sound, Alaska. Stud. Avian Biol. 2: 125–129.

Janss, G.F.E., and M. Ferrer. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. Journal of Field Ornithology 69:8–17.

Johnson, S.R. and D.R. Herter. 1986. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage, AK.

Kelly, J.P. 2001. Distribution and abundance of winter shorebirds on Tomales Bay, California: Implications for Conservation. Western Birds 32(3): 145–166.

Kitchin, E.A. 1949. Birds of the Olympic Peninsula. Olympic Stationers, Port Angeles, Washington, USA.

Klein, M.L., S.R. Humphrey, and H.F. Percival. 1995. Effects of ecotourism on distribution of waterbirds in a wildlife refuge. Conservation Biology 9:1454–1465.

Koolhaas, A., A. Dekinga, and T. Piersma. 1993. Disturbance of foraging knots by aircraft in the Dutch Wadden Sea in August-October 1 992. Wader Study Group Bulletin 68 (special issue):20–22.

Lake Ontario Lakewide Management Plan. On the Internet: www.on.ec.gc.ca/water/greatlakes/raps

Lank, D.B., R.W. Butler, J. Ireland, and R.C. Ydenberg. 2003. Effects of predation danger on migration strategies of sandpipers. Oikos 103:303–319.

Latour, P.B., C.S. Machtans, and G.W. Beyersbergen. 2005. Shorebird and passerine abundance and habitat use at a High Arctic breeding site: Creswell Bay, Nunavut. Arctic 58(1): 55–65.

Lock, A.R., R.G.B. Brown, and S.H. Gerriets. 1994. Gazetteer of Marine Birds in Atlantic Canada: an atlas of sea bird vulnerability to oil pollution. Canadian Wildlife Service Environmental Conservation Branch Environment Canada Atlantic Region.

LopezUriarte, E., A. Escofet, E. Palacios, and S. Gonzalez. 1997. Migrant shorebirds at sandy beaches located between two major wetlands on the Pacific coast of Baja California (Mexico). Natural Areas Journal 17(3): 212–218.

Manning, T. H., and A.H. Macpherson. 1961. A biological investigation of Prince of Wales Island, N.W.T. Trans. R. Can. Inst. 23: 116–239.

Manning, T.H., E.O. Höhn, and A.H. Macpherson. 1956. The birds of Banks Island. Natl. Mus. Can. Bull. 143:1–144.

MacWhirter, B., P. Austin-Smith, and D. Kroodsma. 2002. Sanderling (Calidris alba), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.offcampus.lib.washington.edu/bna/species/653.

Mayfield, H.F. 1983. Densities of breeding birds at Polar Bear Pass, Bathurst Island, Northwest Territories. Can. Field-Nat. 97: 371–376.

Meltofte, H. 1985. Populations and breeding schedules of waders, Charadrii, in high arctic Greenland. Meddr. Grønland Biosci. 16: 1–43.

Metcalfe, N.B. 1984. The effects of habitat on the vigilance of shorebirds: is visibility important? Animal Behaviour 32:981–985.

Morrison, R.I.G. 1993. Shorebird population status and trends in Canada. Bird Trends 3: 3–5.

Morrison, R.I.G. 1984. Migration systems of some New World shorebirds. Pp. 125–202 *in* Behavior of marine animals. Vol. 6 (J. Burger and B. L. Olla, eds.). Plenum Press, New York, NY.

Morrison, R.I.G., and R.K. Ross. 1989. Overview. Pp. 27–41 *in* Atlas of Nearctic shorebirds on the coast of South America (R.I.G. Morrison and R.K. Ross, eds.). Can. Wildl. Serv., Ottawa, ON.

Morrison, R.I.G., P.T.Z. Antas, and R.K. Ross. 1987. Migratory Routes in the Amazon Coast. Pages 159–199 *In* Anais do Seminario sobre desenvolviento economico e Impacto Ambiental em Areas de Tropico Unido Brasilero, A experiencia da CVRD, held in Belem, Brasil, 29 September – 4 October 1986. Companhia Vale do Rio Doce,Rio de Janeiro. 334 pp.

Morrison, R.I.G., R.K. Ross, and S. Torres M. 1992. Aerial surveys of Nearctic shorebirds wintering in Mexico: some preliminary results. Progress Notes 120. Can. Wildl. Serv., Ottawa, Ontario.

Morrison, R.I.G., C. Downes, and B. Collins. 1994. Population trends of shorebirds on fall migration in eastern Canada. Wilson Bulletin 106:431–447.

Morrison, R.I.G., R.W. Butler, G.W. Beyersbergen, H.L. Dickson, A. Bourget, P.W. Hicklin, J.P. Goossen, R.K. Ross, and C.L. Gratto-Trevor. 1995. Potential W. Hemisphere shorebird reserve network sites for shorebirds in Canada: 2nd Ed CWS Tech. Rep. 227.

Morrison, R.I.B., R.E. Gill, Jr., B.A. Harrington, S. Skagen, G.W. Page, C.L. Gratto-Trevor, and S.M. Haig. 2000. Population estimates of Nearctic shorebirds. Waterbirds 23: 337–352.

Morrison, R.I.G., R.E. Gill, Jr., B.A. Harrington, S. Skagen, G.W. Page, C.L. Gratto-Trevor, and S.M. Haig. 2001. Estimates of shorebird populations in North America. Canadian Wildlife Service Occasional Paper No. 104. Environment Canada. 64 pp.

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.

Myers, J.P. 1981. A test of three hypotheses for latitudinal segregation of the sexes in wintering birds. Can. J. Zool. 59: 1527–1534.

Myers, J.P. 1983a.Conservation of migrating shorebirds: staging areas, geographic bottlenecks, and regional movements. Am. Birds 37: 23–25.

Myers, J.P. 1983b. Space, time, and the pattern of individual associations in a group-living species: Sanderlings have no friends. Behav. Ecol. Sociobiol. 12: 129–134.

Myers, J.P. 1984. Spacing behavior of nonbreeding shorebirds. Pp. 271–321 *in* Behavior of marine animals. Vol. 6 (J. Burger and B. L. Olla, eds.). Plenum Press, New York, NY.

Myers, J.P. 1988. The Sanderling. Pp. 650–666 *in* Audubon wildlife report (W. J. Chandler, ed.). Academic Press, New York, NY.

Myers, J.P., and L.P. Myers. 1979. Shorebirds of coastal Buenos Aires province, Argentina. Ibis 121: 186–200.

Myers, J. P., P. G. Connors and F. A. Pitelka. 1979a.Territory size in wintering Sanderlings: The effects of prey abundance and intruder density. Auk 96: 551–561.

Myers, J.P., P.G. Connors, and F.A. Pitelka. 1979b.Territoriality in non-breeding shorebirds. Stud. Avian Biol. 2: 231–246.

Myers, J.P., G. Castro, B.A. Harrington, M. Howe, J. Maron, E. Ortiz, M. Sallaberry, C.T. Schick, and E. Tabilo. 1984a. The Pan American Shorebird Program: A Progress Report. Wader Study Group Bull. 43: 26–30.

Myers, J.P., C.T. Schick, and C. J. Hohenberger. 1984b.Notes on the 1983 distribution of Sanderling along the United States' Pacific Coast. Wader Study Group Bull. 40: 22–26.

Myers, J.P., J.L. Maron, and M. Sallaberry. 1985. Going to extremes: why do Sanderlings migrate to the Neotropics? Ornithol. Monogr. 36: 520–535.

Myers, J.P., R.I.G. Morrison, P.Z. Antas, B.A. Harrington, T.E. Lovejoy, M. Sallaberry, S.E. Senner, and A. Tarak. 1987a. Conservation strategy for migratory species. American Scientist 75:18–26.

Myers, J.P., P.D. McLain, R.I.G. Morrison, P.Z. Antas, P.J. Canevari, B.A. Harrington, T.E. Lovejoy, V. Pulido, M. Sallaberry, S.E. Senner. 1987b. The Western Hemisphere Shorebird Reserve Network. Wader Study Group Bulletin 49, Suppl./IWRB Spec. Publ. 7:122–124.

Myers, J.P., C.T. Schick, and G. Castro. 1988. Structure in Sanderling (*Calidris alba*) populations: the magnitude of intra- and inter-year dispersal during the nonbreeding season. Acta XIX Congr. Int. Ornithol. 19: 604–615.

Myers, J.P., M. Sallaberry, E. Ortiz, G. Castro, L.M. Gordon, J.L. Maron, C.T. Schick, E. Tabilo, P. Antas, and T. Below. 1990. Migration routes of New World Sanderlings (*Calidris alba*). Auk 107: 172–180.

Nadkarni. N.M. 2004. Not Preaching to the Choir: Communicating the Importance of Forest Conservation to Nontraditional Audiences. Conservation Biology 18(3): 602–606.

Neuman, K.K., L.A. Henkel, and G.W. Page. 2008. Shorebird Use of Sandy Beaches in Central California. Waterbirds 31(1): 115–121.

North American Waterfowl Management Plan. On the Internet: http://www.fws.gov/birdhabitat/NAWMP/index.shtm

Ontario Living Legacy Land Use Strategy. 2000. On the Internet.

Page, G.W., and R.E. Gill, Jr. 1994. Shorebirds in western North America: late 1800s to late 1900s. Stud. Avian Biol. 15: 147–160.

Page, G., and D.F. Whitacre. 1975. Raptor predation on wintering shore birds. Condor 77: 73–83.

Page, G.W., E. Palacios, L. Alfaro, S. Gonzalez, L.E. Stenzel, and M. Jungers. 1997. Numbers of wintering shorebirds in coastal wetlands of Baja California, Mexico. Journal of Field Ornithology 68(4): 562–574.

Page, G.W., L.E. Stenzel, and J.E. Kjelmyr. 1999. Overview of shorebird abundance and distribution in wetlands of the Pacific Coast of the contiguous United States. Condor 101(3): 461–471.

Parmelee, D. F. 1970. Breeding behavior of the Sanderling in the Canadian high Arctic. Living Bird 9: 97–146.

Parmelee, D. F. and S. D. MacDonald. 1960. The birds of west-central Ellesmere Island and adjacent areas. Nat. Mus. Can. Bull. 169: 1–303.

Paulson, D. 1993. Shorebirds of the Pacific Northwest. Univ. of Wash. Press, Seattle, WA.

Pfister, C., B.A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60:115–126.

Pienkowski, M.W., and G.H. Green. 1976. Breeding biology of Sanderlings in north-east Greenland. Br. Birds 69: 165–177.

Piersma, T., and A. Lindstrom. 2004. Migrating shorebirds as integrative sentinels of global environmental change. Ibis 146 (Suppl.1) 61–69.

Pitelka, F.A. 1974. An avifaunal review for the Barrow Region and North Slope of arctic Alaska. Arct. Alp. Res. 6: 161–184.

Pitelka, F.A., J.P. Myers, and P.G. Connors. 1980. Spatial and resource-use patterns in wintering shorebirds: the Sanderling in central coastal California. Proc. Int. Ornithol. Congr. 17: 1041–1044.

Platt, M., and R. Goggans. 1993. Observation of shorebirds between Coos and Siuslaw rivers during fall migration, 1993. Oregon Department of Fish and Wildlife report to Oregon Dunes National Recreation Area.

Pomeroy, A. 2006. Tradeoffs between food abundance and predation danger in spatial usage of a stopover site by western sandpipers, Calidris mauri. Oikos 112(3): 629 – 637.

Pomeroy, A.C., R.W. Butler, and R.C. Ydenberg. 2006. Experimental evidence that migrants adjust usage at a stopover site to trade off food and danger. Behavioral Ecology 17(6): 1041–1045.

Potter, B.A., R.J. Gates, G.J. Soulliere, R.P. Russell, D.A. Granfors, and D.N. Ewert. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Shorebird Habitat Conservation Strategy. U. S. Fish and Wildlife Service, Fort Snelling, MN. 101 pp.

PRISM, Program for Regional and International Shorebird Monitoring. On the Internet: http://www.shorebirdworld.org/fromthefield/PRISM/PRISM1.htm

Raffaele, H., J. Wiley, O. Garrido, A. Keith, and J. Raffaele. 1998. A guide to the birds of the West Indies. Princeton Univ. Press, Princeton, NJ.

Regional Shorebird Conservation Plans can be viewed and downloaded at: http://www.manomet.org/USSCP/

Roberts, G., and P.R. Evans. 1993. Responses of foraging sanderlings to human approaches. Behaviour 126:29–43.

Rodgers, J.A., and S.T. Schwikert. 2002. Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats. Conservation Biology 16(1): 216–224.

Root, T. 1988. Atlas of wintering North American birds. Univ. of Chicago Press, Chicago, IL.

Ross, K., K. Abraham, R. Clay, B. Collins, J. Iron, R. James, D. McLachlin and R. Weeber. 2003. Ontario Shorebird Conservation Plan. Environment Canada and North American Bird Conservation Initiative. 47 pp.

Sallaberry, M., E. Tabilo, C. Klesse, and J. Abarca. 1996. The Chilean Shorebird Network (RECAP). Int. Wader Stud. 8: 71–78.

Sauer, J.R., S. Schwartz, and B. Hoover. 1996. The Christmas Bird Count home page. Version 95.1. Patuxent Wildl. Res. Center, Laurel, MD. http://www.mbr.nbs.gov/bbs/cbc.html .

Schick, C.T., T.M. Johnson, C.M. Kunde, and J.P. Myers. 1984. Aerial censuses of Sanderlings and estimates for other shorebirds on the Baja California Peninsula, Mexico, 1983–1984. Wader Study Group Bull. 41: 14–15.

Schick, C.T., L.A Brennan, J.B. Buchanan, M.A. Finger, T.M. Johnson, and S.G. Herman. 1987. Organochlorine contamination in shorebirds from Washington state and the significance for their falcon predators. Environmental Monitoring and Assessment 8:1–17.

Schulte, S., S. Brown, and the American Oystercatcher Working Group. 2006. Version 1.0. American Oystercatcher Conservation Plan for the United States Atlantic and Gulf Coasts. Manomet Center for Conservation Sciences. Manomet, MA. 42 pp.

Senner, S.E., and M.A. Howe. 1984. Conservation of Nearctic shorebirds. Pp. 379–421 *in* Behavior of marine animals. Vol. 5 (J. Burger and L. Olia, eds.). Plenum Press, New York, NY.

Sherony, D.F. 1998. Sanderling. Pp. 251–252 *in* Bull's birds of New York State (E. Levine, ed.). Cornell Univ. Press, Ithaca, NY.

Shorebird Research Group of the Americas. On the Internet: http://www.shorebirdresearch.org/index.htm

Shorebird Sister Schools Program (SSSP). On the Internet: http://www.fws.gov/sssp/

Skagen, S. K., and G. Thompson. 2000. Northern plains/prairie potholes regional shorebird conservation plan, version1. http://shorebirdplan.fws.gov/regionalshorebird/regionalplans.htm

Smit, C. J., R.H.D. Lambeck, and W.J. Wolff. 1987. Threats to coastal wintering and staging areas of waders.Wader Study Group Bulletin 49 (Supplemental):105–113. Volume IV: Birds. 20–43 Washington Department of Fish and Wildlife

Smit, C.J., and G.J.M. Visser. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin 68 (special issue):6–19.

Smith, A.R. 1996. Atlas of Saskatchewan birds. Sask. Nat. Hist. Soc. Spec. Publ. no. 22, Regina, Saskatchewan.

South Atlantic Migratory Bird Initiative (SAMBI). 2009. On the internet, http://samigbird.ncusfws.org/

State Wildlife Action Plans. 2009. Association of Fish & Wildlife Agencies. On the internet, http://www.wildlifeactionplans.org/index.html

Stiles, F.G., and A.F. Skutch. 1989. A guide to the birds of Costa Rica. Cornell Univ. Press, Ithaca, NY.

Strauman, L. 1996. Whitewater Lake Report, 1996. Clean-up operations technical update.

Tabilo, E., R. Jorge, R. Riquelme, A. Mondaca, C. Labra, J. Campusano, M. Tabilo, M. Varela, A. Tapia, and M. Sallaberry. 1996. Management and conservation of the habitats used by migratory shorebirds at Coquimbo, Chile. Int. Wader Stud. 8: 79–84.

Thomas, K., R.G. Kvitek, and C. Bretz. 2003. Effects of human activity on the foraging behavior of sanderlings Calidris alba. Biological Conservation. 109(1): 67–71.

Tsipoura, N., and J. Burger. 1999. Shorebird Diet during Spring Migration Stopover on Delaware Bay. Condor 101(3): 635–644.

USFWS. 2002. Birds of Conservation Concern. U.S. Fish and Wildlife Service. Arlington, VA.

U.S. Shorebird Conservation Plan. On the Internet. http://www.fws.gov/shorebirdplan/

Veit, R.R. and W.R. Petersen. 1993. Birds of Massachusetts. Massachusetts Audubon Soc., Lincoln, MA.

Vermeer, K., and J.C. Castilla. 1991. High Cadmium residues observed during a pilot study in shorebirds and their prey downstream the El Salvador Copper Mine, Chile. Bulletin of Environmental Contamination and Toxicology 46(2): 242–248.

Walters, J.R. 1984. Winter densities of Sanderling in coastal North Carolina. Wader Study Group Bull. 40: 27–29.

Warnock, S.E., and J.Y. Takekawa. 1995. Habitat preferences of wintering shorebirds in a temporally changing environment: western sandpipers in the San Francisco Bay estuary. Auk 112: 920–930.

Wershler, C. 1987. Census and habitat evaluation for migrating shorebirds in east-central Alberta. Prepared by Sweetgrass Consultants Ltd., Calgary, for World Wildlife Fund Canada, Canadian Wildlife Service and Alberta Fish and Wildlife, Edmonton.

Wershler, C. 1989. 1988 census and habitat evaluation for migrating shorebirds in Alberta. Prepared by Sweetgrass Consultants Ltd. for World Wildlife Fund Canada, Alberta Fish and Wildlife and Canadian Wildlife Service, Edmonton.

Western Atlantic Shorebird Association (WASA). On the Internet: http://www.vex.net/~hopscotc/shorebirds

World Bird Data Base. 2009. BirdLife International. On the internet: http://www.birdlife.org/datazone/index.html

Yasue, M. 2006. Environmental factors and spatial scale influence shorebirds' response to human disturbance. Biological Conservation 128: 47–54.

Ydenberg, R.C., R.W. Butler, D.B. Lank, B.D. Smith, and J. Ireland. 2004. Western sandpipers have altered migration tactics as peregrine falcon populations have recovered. Proceedings of the Royal Society of London Series B-Biological Sciences 271(1545): 1263–1269.

APPENDIX I.

Conservation rankings for the Sanderling in North America - for the United States (U.S. Shorebird Conservation Plan[a]) and Canada (Canadian Shorebird Conservation Plan[b]).

Ranking	U.S.	Canada	Explanation
PT Population trend	5	5	*Species or population has been documented to be in decline*
RA Relative abundance	2	2	*Population size between 300,000 to <1,000,000*
TB Threats during Breeding season	2	2	*Threats assumed to be low*
TN Threats during Nonbreeding season	4	4	*Significant potential threats exist*
BD Breeding Distribution	2	2	*10–20% of North America*
ND Nonbreeding Distribution	1	1	*Very widespread = 4,000,000–7,000,000 sq. mi., or along 5,000–9,000 mi. of coast*
Conservation Category	4	4	*Species of High Concern (second highest possible priority)*
Population estimate (for North America)	300,000	300,000	*Likely to be in the correct order of magnitude, but based on broad-scale surveys (so precise estimate is not possible)*
Reliability of estimate	low	low	*Need for statistically valid monitoring scheme (to enable detection of population trends)*
Population Target	1,500,000	Not specified in Plan	*Uncertain recovery goal. Population may have recovered somewhat since period during which decline was calculated. Halt decline if ongoing and restore 1970s population.*

[a] Brown *et al*. 2001.
[b] Donaldson *et al*. 2000.

APPENDIX II.

Relative Importance of Shorebird Planning Regions to the Sanderling during migration and winter, as classified by the U.S. Shorebird Conservation Plan (Brown *et al*. 2001).

Shorebird Planning Region	Migration	Winter	Importance of region (by season)
Alaska[a]	uncommon to fairly common	uncommon to fairly common	*region within species range, but occurs in low relative abundance to other regions*
Northern Pacific	high concentrations	high concentrations	*region extremely important to the species, relative to the majority of other regions*
Southern Pacific	common or locally abundant	common or locally abundant	*region important to the species*
Intermountain West	uncommon to fairly common	(not present in winter)	*region within species range, but occurs in low relative abundance to other regions*
Northern Plains/ Prairie Potholes	uncommon to fairly common	(not present in winter)	*region within species range, but occurs in low relative abundance to other regions*
Upper Mississippi Valley/Great Lakes	common or locally abundant	(not present in winter)	*region important to the species during migration*
Lower Mississippi/ Western Gulf Coast	common or locally abundant	common or locally abundant	*region important to the species*
Northern Atlantic	high concentrations	uncommon to fairly common	*region extremely important to the species during migration; occurs in low relative abundance in winter*
Appalachians	uncommon to fairly common	(not present in winter)	*region within species range, but occurs in low relative abundance during migration*
Southern Coastal Plain/Caribbean	high concentrations	common or locally abundant	*region extremely important to the species during migration; important during winter*

[a]Sanderlings breed in the High Arctic, and therefore the breeding season is excluded from this table; however, Sanderlings are present (though uncommon) in Alaska during the breeding season.

APPENDIX III.

Regional occurrence and shorebird prioritization scores for the Sanderling in the United States (from the U.S. Shorebird Conservation Plan).

Shorebird Planning (and BCR) Regions	Occurrence[a]	Area Importance Score[b]
Alaska	m, w, b	3
Bering Sea/Aleut Isl. (BCR 1)	w, m	3
Western Alaska (BCR 2)	m	3
Arctic Plains and Mountains, AK (BCR 3)	m, b	3
Northeastern Pacific Rainforest, AK (BCR 5)	m, w	3
Northern Pacific	**M**, **W**	5
NW Pacific Rainforest – WA, OR, nw CA (BCR 5)	**M**, **W**	5
Southern Pacific	M, W	4
Coastal California (BCR 32)	M, W	4
Intermountain West	m	3
Great Basin (BCR 9)	m	3
Northern Rockies (BCR 10)	m	3
S. Rockies/Colorado Plateau (BCR 16)	m	3
Sonoran and Mojave Deserts (BCR 33)	m, w	3
Northern Plains	m	3
Prairie Potholes (BCR 11)	m	3
Badlands and Prairies (BCR 17)	m	3
Central Plains / Playa Lakes	m	3
Oaks and Prairies (BCR 21)	m	3
Upper Mississippi / Great Lakes	M	4
Boreal Hardwood Transition (BCR 12)	**M**	4
Lower Great Lakes / St. Lawrence Plain (BCR 13)	m	3
Eastern Tallgrass Prairie (BCR 22)	**M**	4
Prairie Hardwood Transition (BCR 23)	**M**	4
Lower Mississippi / Western Gulf Coast	M, W	4
West Gulf Coastal Plain/ Ouachitas (BCR 25)	m	3
Mississippi Alluvial Valley (BCR 26)	m	3
Gulf Coastal Prairie (BCR 37)	M, W	4
North Atlantic	**M**, w	5
North Atlantic / Mid-Atlantic Coast (BCR 30)	**M**, w	5

[a]Occurrence scores are as follows:
B = breeding, M = migration, W = Wintering;

b, m, w = uncommon to fairly common, region within species range but occurs in low relative abundance to other regions;
B, M, W = common or locally abundant; region important to the species;
B, M, W = high concentrations, region extremely important to the species relative to the majority of other regions.

[b]Area importance scores are defined as follows:

1 = Does not occur in the area, or only unpredictable, irregular occurrence as a vagrant. Area is outside of expected range;
2 = Rare occurrences. Area is within the expected range of the species, but it occurs at a low frequency. (In general, management for these species is not warranted within the region**;**
3 = Uncommon to fairly common;
4 = Common or locally abundant, with large numbers occurring or suspected to occur. Area of known or suspected importance relative to other regions, especially within the same flyway. The area is important to supporting hemispheric or regional populations;
5 = High concentrations known to occur. Area of high importance to the species relative to the majority of other regions. The area is critical for supporting hemispheric populations of the species.

APPENDIX IV.

Results of International Shorebird Survey (ISS) data analyses, highlighting important sites for the Sanderling during migration (Tables 1–4) and winter (Tables 5 and 6).

Table 1. U.S. sites that host >1,000 Sanderlings during **fall migration**, and were surveyed by the International Shorebird Survey (ISS) for at least **5 years** (during 1972–2005). Consistently important sites hosting 5,000 or more Sanderlings are indicated in bold.

State	Site name	Count Category[a]	Survey Period[b]	Years[c]
California	Tomales Bay, North Bay	I-II	90	7
Florida	Casey Key Beach	I-II	70, 80	6
Florida	Cape Romano	I-II	80	9
Florida	Marco River	I-II	70, 80	15
Massachusetts	Quivet Creek & Wing Island Beach	I-II	70, 80, 90*	8
Massachusetts	**Monomoy Island NWR, North End**	II-III	70, 80, 90, 00	32
Massachusetts	Orleans, New Island	I-II	70, 80	12
Massachusetts	Revere Point-O-Pines	II	70, 90, 00	6
Massachusetts	Duxbury Beach	II	70, 80, 90, 00	14
Massachusetts	Plymouth Beach	II	70, 80, 90, 00	28
Massachusetts	Lynn Harbor	I-II	80*, 90*, 00	8
Massachusetts	**South Beach Island, Chatham**	II-IV	90, 00*	14
Massachusetts	Martha's Vineyard, C. Pogue	I-II	90, 00	9
Massachusetts	Duxbury Crescent Beach	II	90, 00	10
Maine	Lubec - Lubec Flats	I-II	70*, 80, 90, 00	6
New Jersey	Great Egg Harbor (Inlet)	I-II	70*, 80	15
New York	Plumb Beach, Brooklyn	I-II	70*, 80, 90	14
South Carolina	Huntington Beach State Park	I-II	70*, 80, 00	6
Texas	Mustang Island Beach	II	70, 80	5
Virginia	**Chincoteague NWR**	II-IV	70*, 80*, 90*, 00*	24
Virginia	**Back Bay NWR (excluding False Cape)**	II-IV	90*, 00	8
Virginia	Back Bay NWR (North Mile of Beach)	I-II	90, 00	7
Virginia	**False Cape (Beaches)**	II-IV	80*, 90*, 00	7

[a]Count Category: Category indicates typical maximum count values of Sanderling during fall migration at that site (I = hundreds of Sanderlings; II = 1,000–5,000; III = 5,001–10,000; IV = 10,001–20,000; V = >20,000). When values fell within several count categories, all categories were indicated.

[b]Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Asterisks indicate the survey period (decade) during which the highest count category was reported.

[c]Years: Number of years of fall ISS surveys (between 1972–2005).

Table 2. U.S. Sites that host >1,000 Sanderlings (at least once) during **fall migration**, and were surveyed by the International Shorebird Survey (ISS) for **1–4 years** (during 1972–2005). Important sites hosting 5,000 or more Sanderlings are indicated in bold.

State	Site name	Count Category[a]	Survey Period[b]	Years[c]
California	San Francisco Bay	II	80	1
Florida	Nassau Sound	I-II	0	2
Georgia	Blackbeard Island NWR	I-II	90	3
Georgia	Little St. Simons Island (Bass Creek)	I-II	90	3
Maine	Reid State Park	I-II	70, 00	2
Maryland	Assateague Island	II	70	1
Massachusetts	West Island, Fairhaven	II	00	1
Massachusetts	Boston Harbor (TASL Project)	II	90	1
Massachusetts	Eastham (Nauset Coast Guard Beach)	I-II	70*, 00	3
Massachusetts	Ipswich, Cranes Beach (new,1993)	II	90, 00	4
Massachusetts	Lynn Beach/Long Beach	II	00	3
Massachusetts	Revere, Point of Pines	I-II	00	2
Massachusetts	South Beach/Chatham	II	00	1
New Jersey	**Brigantine Beach**	I-III	70	3
New Jersey	Sandy Hook	I-II	70, 80	2
New Jersey	Stone Harbor Point	I-II	80, 00*	2
New Jersey	**Wildwood, Two Mile Beach Pond**	III	00	1
North Carolina	Cape Hatteras Nat'l S. (Beach Bodie Isl.)	II	00	2
North Carolina	Cape Hatteras Nat'l Seashore (Ramp 26-32)	II	70	1
North Carolina	Cape Hatteras Nat'l Seashore (Ramp 44-49)	II	00	1
North Carolina	Clam Shoal (Bird Islands)	II	00	1
North Carolina	Pea Island NWR	II	70	1
Texas	**Padre Island Nat'l Seashore (64 Mile Beach)**	II-III	90	2
Virginia	Wallops Island	II	70	1
Washington	**Leadbetter Point**	III	70	1
Washington	Ocean Shores	II	90	1

[a]Count Category: Category indicates typical maximum count values of Sanderling during fall migration at that site (I = hundreds of Sanderlings; II = 1,000–5,000; III = 5,001–10,000; IV = 10,001–20,000; V = >20,000). When values fell within several count categories, all categories were indicated.

[b]Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Asterisks indicate the survey period (decade) during which the highest count category was reported.

[c]Years: Number of years of fall ISS surveys (between 1972–2005).

Table 3. U.S. sites that host >1,000 Sanderlings during **spring migration**, and were surveyed by the International Shorebird Survey (ISS) for at least **5 years** (during 1978–2005)[1]. Important sites that host at least 5,000 Sanderlings are indicated in bold.

State	Site name	Count Category[a]	Survey Period[b]	Years[c]
Florida	Cape Romano	II	80	9
Florida	Honeymoon Island	I-II	80, 90, 00	18
Florida	Marco River	I-II	80, 90	10
Massachusetts	Monomoy Island NWR, North End	I-II	70, 80, 90, 00	26
Massachusetts	South Beach Island, Chatham	I-II	00	6
New Jersey	**Delaware Bay (Aerial Survey)**	IV	80	>3
Texas	Bolivar Flats	I-II	80, 90	14
Texas	**Padre Island National Seashore (64 Mile Beach)**	III	90	1
Virginia	Back Bay NWR (beach, excluding False Cape)	I-II	90, 00	9
Virginia	**Chincoteague NWR**	II-IV	70, 80*, 90, 00	19

[1] Exception is Padre Island National Seashore, which hosts many Sanderlings but was surveyed one year. Delaware Bay is known to be critically important to the Sanderling in spring (non-ISS data confirm this).

[a] Count Category: Category indicates typical maximum count values of Sanderling during spring migration at that site (I = hundreds of Sanderlings; II = 1,000–5,000; III = 5,001–10,000; IV = 10,001–20,000; V = >20,000). When values fell within several count categories, all categories were indicated.

[b] Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Asterisks indicate the survey period (decade) during which the highest count category was reported.

[c] Years: Number of years of spring ISS surveys (between 1978–2005).

Table 4. U.S. sites with **1–4 years** of ISS data that have reported >1,000 Sanderlings (at least once) during **spring migration** between 1978–2005.

State	Site name	Count Category[a]	Survey Period[b]	Years[c]
California	Tomales Bay, North Bay	I-II	90	2
Georgia	Blackbeard Island NWR	I-II	90	3
North Carolina	Clam Shoal (Bird Islands)	II	00	1
South Carolina	Beaufort County, Harbor Island	II	00	1
Texas	Big Reef (Galveston Island)	I-II	80	3
Texas	Bolivar Shore (0-5 Miles)	II	90	1
Texas	Bolivar Shore 2 (0-10 Miles)	II	80	1
Texas	Laguna Atascosa NWR, Cayo Atascosa	I-II	90	2
Texas	Matagorda Island NWR, South Island Beach	II	90	2
Texas	Matagorda, Mid-Island Beach North	II	90	2
Texas	Matagorda, Mid-Island Beach South	II	90	2
Texas	Mustang Island Beach	II	80	3
Texas	Padre Bay, North	I-II	90	2
Texas	Padre Bay, South	II	90	2
Texas	Padre Beach (Padre Beach)	II	90	2
Texas	Upper Texas Coast	II	80	1
Virginia	False Cape (Beaches)	I-II	80, 90, 00	4
Washington	Leadbetter Point	II	70	1

[a]Count Category: Category indicates typical maximum count values of Sanderlings during spring migration at that site (I = hundreds of Sanderlings; II = 1,000–5,000; III = 5,001–10,000; IV = 10,001–20,000; V = >20,000). When values fell within several count categories, all categories were indicated.

[b]Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Asterisks indicate the survey period (decade) during which the highest count category was reported.

[c]Years: Number of years of spring ISS surveys (between 1978–2005).

Table 5. U.S. ISS sites reporting moderate (≥500) numbers [and high proportions (≥1%) of Sanderlings found at all US ISS sites] during the boreal **winter**. These sites were surveyed for **5–19 years** during the boreal **winter** (between 1974–2005).

State	Site name	Winter Count Category[a]	Survey Period[b]	Years[c]
California	**Tomales Bay**	I–III	80, 90*	8
Florida	Cape Romano	I–II	80	10
Florida	Honeymoon Island	I–II	80, 90*, 00	20
Florida	Shell Key, St. Petersburg	I–II	90, 00*	11
Florida	**Sanibel Island**	I–III	70, 80, 90*	5
Massachusetts	Quivet Creek & Wing Island Beach	I–II	80, 90*	8
Massachusetts	Monomoy Island NWR, North End	II	70, 80*, 90*, 00	19
Massachusetts	**South Beach/Chatham**	II–III	00	6
Texas	Mustang Island Beach	I–II	70, 80*	5
Virginia	**Chincoteague NWR**	I–III	80*, 90*, 00	11
Virginia	Back Bay NWR	I–II	90*, 00*	3

[a]Winter Count Category: Category indicates typical maximum count values of Sanderlings during winter at that site (I = 100–500 Sanderlings; II = 501–1,000; III = 1,001 – 5,000; IV = 5,001–10,000; V = >10,000). When values fell within several count categories, all categories were indicated.

[b]Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Astrices indicate the survey period/s (decade/s) during which the highest count category was reported.

[c]Years: Number of years of winter ISS surveys (between 1974–2005).

Table 6. U.S. sites reporting moderate (>500) counts [and high proportions (≥1%) of total Sanderlings found at all U.S. sites] during the boreal **winter**. These sites were surveyed by the International Shorebird Survey (ISS) for **1–4 years** during the boreal winters of 1972–2005.

State	Site name	Count Category[a]	Survey Period[b]	Years[c]
California	Tomales Bay, North	II	90	3
Florida	Passage Key NWR	II	90	2
Florida	Island North of Bunces Pass	I–II	90	2
North Carolina	**Pea Island NWR**	III	70	1
North Carolina	**Clam Shoal (Bird Islands)**	II–III	00	2
New Jersey	Brigantine Beach	I–II	70	3
New Jersey	Wildwood, Two Mile Beach	II	00	1
Virginia	**False Cape Beaches**	II–IV	80*, 90*, 00	4
Washington	Leadbetter Point	II	70	2
Washington	**Ocean Shores**	I–III	90	2

[a]Winter Count Category: Category indicates typical maximum count values of Sanderlings during winter at that site (I = 100–500 Sanderlings; II = 500–1,000; III = 1,001 – 5,000; IV = 5,001–10,000; V = >10,000). When values fell within several count categories, all categories were indicated.

[b]Survey Period: Decade during which ISS counts were made (70 = 1970s, 80 = 1980s; 90 = 1990s; 00 = 2000s). Astrices indicate the survey period/s (decade/s) during which the highest count category was reported.

[c]Years: Number of years of winter ISS surveys (between 1972–2005).

APPENDIX V.

Important sites and areas for Sanderling (The majority of these sites are known to host 1,000 individuals during migration and/or at least 500 during winter, representing ≥1% of the estimated flyway or wintering population. The remaining sites are lacking quantitative data but are known to be important and were therefore included. *See text for further explanation and criteria*).

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Peninsula Valdes	Argentina	Chubut		42°17'48.36"S	63°36'1.97"W					~1,300	Morrison and Ross 1989	
Goiabal / Piratuba	Brazil	Amazonas		1°48'S	50°24'W					3,000	World Bird Data Base 2009	
Ilha Comprida, Iguape-Cananeia Estuary	Brazil	Sao Paulo		24°54'S	47°47'W		important stopover (migration period not specified)	important stopover (migration period not specified)			DeLuca et al. 2006	Further counts needed
Lagoa do Peixe	Brazil	Rio Grande do Sul	WHSRN; Ramsar; National Park	31°13'04"S	50°56'03"W		>6,600				Morrison and Ross 1989	
Lagoa dos Patos	Brazil	Rio Grande do Sul		31°41'17.09"S	51°35'11.76"W				one of the main wintering areas for Sander-ling		DeLuca et al. 2006	Further counts needed
Rio De Janeiro Coastal Lagoons	Brazil	Rio De Janeiro		22°57'57.56"S	42°41'12.73"W	22°50'S, 42°W to 23°S, 43°25'W			large numbers		DeLuca et al. 2006	Further counts needed
Rio Grande do Sul Coastline	Brazil	Rio Grande do Sul		31°22'38.62"S	51°2'17.19"W	30°54'20.32"S, 50°37'0.51"W to 31°46'43.01"S, 51°33'3.42"W					Morrison and Ross 1989	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Rios Sergipe and Vaza-Barris	Brazil	Sergipe and Bahia		11°20'15.44"S	37°16'36.27"W	10°45'S, 37°00'W to 11°55'S, 37°38'W	thousands (migration period not specified)	thousands (migration period not specified)			DeLuca et al. 2006	Further counts needed
Sao Luis Beaches and outer coast	Brazil	Maranhao		2°27'7.32"S	44°12'30.77"				3,000		Morrison and Ross 1989	
Canadian Arctic Archipel-ago (inclusive)	Canada	Northwest Territories and Nunavut		70°N	85°W	64°N to 85°N, 65°W to 125°W						
Canadian Arctic Archipel-ago: Banks Island	Canada	Northwest Territories		73°4'32.95"N	120°43'23.86" W					65,000	Manning et al. 1956	
Canadian Arctic Archipel-ago: Prince of Wales Island	Canada	Nunavut		72°40'35.82" N	99°28'9.24"W					70,000	Manning and MacPhers on 1961	
Barre de Portneuf	Canada	Quebec		48°37'1.2"N	69°4'58.8"W			"several thousand"			Important Bird Areas of Canada 2009	
Batture aux Alouettes and mouth of Saguenay River	Canada	Quebec		48°4'58.8"N	69°42'0"W			>2,800 (in 1989)			DeRepenti gny 1999; Important Bird Areas of Canada 2009	
Blaine Lakes	Canada	Saskatch-ewan		52°49'48"N	106°57'0"W		10,000 (in 1989)				Morrison et al. 1995	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Chaplin Lake	Canada	Saskatch-ewan	WHSRN	50°26'24"N	106°39'36"W		>51,000 (in 1987 and 1993); ~53,000 (in 1994)				Beyersbergen & Duncan 1995; Morrison et al. 1995	
Chappice Lake	Canada	Alberta		50°24'36"N	110°21'36"W		4,500 (in 1988)				Morrison et al. 1995	
Gooseberry Lake	Canada	Alberta		52°7'12"N	110°44'24"W		3,000 (in 1989)				Wershler 1989	
Landis Lake	Canada	Saskatch-ewan		52°10'48"N	108°30'0"W		1,670 (in 1995)				Morrison et al. 1995	
McIntyre Beach and Rose Spit	Canada	British Columbia		54°12'0"N	131°34'48"W		1,300 (in 1985)	2,000 (in 1977)			Campbell et al. 1990	
Metiskow and Sunken Lakes	Canada	Alberta		52°23'60"N	110°39'0"W		2,000 (in 1988)				Important Bird Areas of Canada 2009	
Miquelon Lake	Canada	Alberta		53°15'0"N	112°55'48"W		3,000 (in 1971)				Important Bird Areas of Canada 2009	
Old Wives-Frederick Lakes	Canada	Saskatch-ewan	WHSRN	50°6'36"N	106°0'0"W		>51,000 (in 1987); ~2,500 (in 1994)				Beyersbergen & Duncan 1995	
Quaco Bay, Bay of Fundy	Canada	New Brunswick	WHSRN	45°19'48"N	65°31'48"W			>500 (in 1979)			Hicklin 1987	
Reflex Lake (Manito Lakes Area)	Canada	Alberta		52°47'60"N	109°42'36"W		5,100 (in 1996); 6,000 (in 1995); 20,000 (in 1985)				Morrison et al. 1995	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Shepody Bay West: Bay of Fundy	Canada	New Brunswick	WHSRN	45°43'12"N	64°34'48"W			>750 (in 2000)			Lock et al. 1994; Important Bird Areas Canada 2009	
Sounding Lake	Canada	Alberta		52°9'36"N	110°28'12"W		3,000 (in 1985)				Wershler 1987	
Quill Lakes	Canada	Saskatch-ewan	WHSRN	51°55'00"N	104°20'00"W		60,000-100,000				Alexander and Gratto-Trevor 1997, Dickson and Duncan 1993, Smith 1996	
Arica Coastline	Chile	XV Region (de Arica y Parinacota)		18°24'52.29"S	70°20'10.94"W	18°21'7.57"S, 70°22'45.87"W to 18°28'15.82"S, 70°19'27.51"W			660		Morrison and Ross 1989	
Chiloe Coastline (inclusive survey sector)	Chile	X Region		42°31'5.26"S	74°11'8.04"W				>10,000		Morrison and Ross 1989	
Chiloe Coastline: Maullin to Bahia Pargua	Chile	X Region		41°44'47.74"S	73°44'10.77"W	41°36'55.67"S, 73°36'1.23"W to 41°47'12.67"S, 73°26'43.55"W			2000		Morrison and Ross 1989	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Concepcion Coastline (inclusive survey sector) 881km	Chile	VIII-IX Region		38°17'20.88"S	73°30'46.57"W				4,500		Morrison and Ross 1989	total 4,500 seen in entire Concepcion Coastline
Concepcion Coastline: Arauco Peninsula to Queule	Chile	VIII-IX Region		38°17'20.88"S	73°30'46.57"W	37°20'19.06"S, 73°40'5.02"W to 39°23'15.74"S, 73°14'27.76"W			3,400		Morrison and Ross 1989	total 4,500 seen in entire Concepcion Coastline
La Serena Coastline (inclusive survey sector)	Chile	IV Region		30°0'14.85"S	71°24'50.37"W				4,400		Morrison and Ross 1989	
La Serena Coastline: La Serena to Punta Guana-quero	Chile	IV Region		30°0'14.85"S	71°24'50.37"W	29°52'24.90"S, 71°16'28.91"W to 30°10'6.14"S, 71°26'56.82"W			3,100		Morrison and Ross 1989	
Mejillones Coastline	Chile	II Region (de Antofagasta)		22°58'58.35"S	70°19'24.68"W	22°48'9.83"S, 70°18'50.49"W to 23° 1'0.74"S, 70°30'49.21"W			important wintering area		Morrison and Ross 1989	
Rio Maipo Rivermouth	Chile	V Region		33°36'47.11"S	71°37'49.28"W				2,500 to 10,000		World Bird Data Base 2009	
Valparaiso Coastline (inclusive survey sector) 545km	Chile	V - VIII Region		35°23'24.39"S	72°29'35.14"W				8,400		Morrison and Ross 1989	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Valparaiso Coastline: Valparaiso to Arauco Peninsula	Chile	V - VIII Region		35°23'24.39"S	72°29'35.14"W	33°23'48.99"S, 71°42'47.12"W to 37°11'53.37"S, 73°32'57.72"W			8,200		Morrison and Ross 1989	total 8,200 seen in entire Valparaiso Coastline
Cahuita, Gandoca-Manzanillo and Migratory Bird Corridor	Costa Rica	Limon		9°45'N	82°52'W		2,000 - 5,000 (migration period not specified)	2,000 - 5,000 (migration period not specified)			Birdlife Internatio nal 2009; World Bird Database 2009	
Nicoya Gulf mangroves and coastal areas	Costa Rica	Guanacaste		10°4'N	85°9'W				3,000		World Bird Data Base 2009	
Pacuare, coastal wetlands and Migratory Bird Corridor	Costa Rica	Limon		10°9'N	83°14'W		5,000 (migration period not specified)	5,000 (migration period not specified)			World Bird Data Base 2009	
Guerrero Negro/Ojo de Liebre	Mexico	Baja California Sur	WHSRN	27°42'30"N	113°56'30"W		low hundreds (in 2007-08)	low hundreds (in 2006)	hundreds to thousands		R. Carmona, unpubl. data	
Laguna San Ignacio	Mexico	Baja California Sur	WHSRN	26°42'30"N	113°14'28"W		low hundreds (in 2007-08)	low hundreds (in 2006)			R. Carmona, unpubl. data; Page et al. 1997	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Chiclayo Coastline (inclusive survey sector): 872 km	Peru	Piura, and Lambayeque		6°51'49.94"S	79°56'0.07"W				31,600		Morrison and Ross 1989	
Chiclayo Coastine: Trujillo to Chiclayo	Peru	La Libertad, Lambayeque and Piura		6°51'49.94"S	79°56'0.07"W	6° 4'19.40"S, 81° 6'5.16"W to 8°13'53.21"S, 78°59'1.61"W			29,250		Morrison and Ross 1989	
Chiclayo Coastline: Sechura	Peru	Piura		5°26'3.34"S	80°56'46.10"W	5°18'53.02"S, 81° 6'23.24"W to 5°35'5.82"S, 80°51'32.44"W			very high densities		Morrison and Ross 1989	
Chimbote Coastline (inclusive survery sector) 425km	Peru	Lima, and Ancash		10°48'30.81"S	77°45'4.44"W				2,160			
Chimbote coastline: Paramonga Beaches	Peru	Lima, and Ancash		10°48'30.81"S	77°45'4.44"W	10°34'12.42"S, 77°54'19.89"W to 11° 0'48.55"S, 77°39'41.22"W			1,360		Morrison and Ross 1989	
Lima Coastline (inclusive survey sector) 792 km	Peru	Lima		12°4'30.88"S	77°9'48.04"W				18,800		Morrison and Ross 1989	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Lima Coastline: Huaura to Lima Beaches	Peru	Lima		11°24'39.28"S	77°28'19.83"W	11° 0'48.55"S, 77°39'41.22"W to 11°46'15.03"S, 77°11'18.31"W			3,500		Morrison and Ross 1989	
Lima Coastline: Lima Beaches to Paracas Peninsula	Peru	Lima and Ica	WHSRN (Paracas)	13°1'23.48"S	76°28'41.30"W	12°13'40.92"S, 76°58'54.57"W to 13°49'37.66"S, 76°22'7.82"W			12,700		Morrison and Ross 1989	
Mollendo Coastline (inclusive survey sector) 684 km	Peru	Arequipa, Moquegua, and Tacna		17°1'59.42"S	72°0'56.67"W				14,200		Morrison and Ross 1989	
Mollendo Coastline: Camana Coast	Peru	Arequipa		16°39'8.86"S	72°43'16.16"W	16°31'7.52"S, 72°55'32.36"W to 16°42'27.46"S, 72°26'37.31"W			1,100		Morrison and Ross 1989	
Mollendo Coastline: Mollendo-Mejia Coast	Peru	Arequipa		17°10'14.47"S	71°50'50.34"W	17° 2'38.20"S, 71°59'19.43"W to 17°15'28.08"S, 71°34'45.68"W			2,150		Morrison and Ross 1989	
Mollendo Coastline: Peru-Chile border to Punta Cales	Peru	Tacna		18°17'29.20"S	70°27'45.56"W	18°14'14.63"S, 70°32'24.56"W to 18°21'3.03"S, 70°22'47.77"W			6,200		Morrison and Ross 1989	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Mollendo Coastline: Punta Cales to Rio Lacumba Coast	Peru	Moquegua and Tacna		17°46'11.03"S	71°12'43.03"W	17°42'26.87"S, 71°22'50.19"W to 17°52'57.00"S, 71° 2'1.78"W			1,700		Morrison and Ross 1989	
Pacasmayo	Peru	Lambayaque		7°24'50.28"S	79°35'18.80"W				11,000		Morrison and Ross 1989	
Rio Pisco mouth (7 km)	Peru	Huancav-elica		13°40'56.18"S	76°13'19.73"W				highest densities in South America; 7,700		Morrison and Ross 1989	
Back Bay NWR	USA	Maryland/ Virginia		36°39'24N	075°56'03W			Peak >10,000 (in 1980s, 1990s)			ISS data	
Brigantine Beach	USA	New Jersey		39°24'07N	074°22'01W			high counts >5,000			ISS data (1970s); Burger et al. 1977	
Chinco-teague NWR	USA	Maryland/ Virginia	WHSRN	37°56'29N	075°18'57W		Peak >10,000 (in 1980s)	Peak >10,000 (in 1980s)	>1,000 (1980s, 1990s)		ISS data (1980s, 1990s, 2000s)	
Clam Shoal (Bird Islands)	USA	North Carolina		35°17'56"N	75°38'56"W				>1000 (2000s)		ISS data	
Clatsop Beach	USA	Oregon		46°05'56"N	123°56'34"W		12,000 (1983)	80,000 (in 1983)			Myers et al. 1984b; Contreras 2003	
Columbia River mouth	USA	Washington	WHSRN	46°14'40"N	124°03'28"W		"185 birds/km"				MacWhirt er et al. 2002	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Coos Bay	USA	Oregon		43°25'45"N	124°13'47"W				hundreds to thousands ; peak 5,200 (1985)		Paulson 1993	
Copalis/ Ocean Shores	USA	Washington		46°58'20"N	124°10'24"W		>1,000 (1970s, 1990s)		>1,000 (1990s)		ISS data; Myers et al. 1984b; Buchanan 1992	
Delaware Bay	USA	New Jersey / Delaware	WHSRN	39°10'N	75°20'W		~35,000				Myers et al. 1990, Clark et al. 1993	
False Cape Beaches	USA	Maryland/ Virginia		36°36'10N	075°53'03W			Peak >10,000 (in 1980s, 1990s)	Peak >5,000 (1980s, 1990s)		ISS data	
Florence	USA	Oregon		43°59'04"N	124°08'21"W				3,200 (in 1984)		Paulson 1993	
Grayland Beach	USA	Washington		46°47'19"N	124°05'35"W		2,400 (in 1983)		several thousand		Myers et al. 1984b; Buchanan 1992	
Grays Harbor	USA	Washington	WHSRN	46°57'02"N	124°03'04"W				typically 1,400-2,800; peaks counts >3,500		Paulson 1993	
Great Egg Harbor	USA	New Jersey		39°17'59N	074°32'44W			hundreds to thousands			ISS data; Burger et al. 1977	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Humboldt Bay	USA	California	WHSRN	40°45'25"N	124°13'46"W				hundreds to thousands		Colwell 1994, Colwell and Sundeen 2000, Danufsky and Colwell 2003	
Leadbetter Point	USA	Washington		46°38'38"N	124°02'52"W		>1,000 (ISS data)	peak >4,000 (in 1978); >5,000 (1970s)	>500		ISS data; CBC data; Paulson 1993	
Longbeach	USA	Washington		46°29'59"N	124°02'05"W		>3,800 (in 1983)	7,900 (in 1993)	several thousand		Myers et al. 1984b; Buchanan and Evenson 1997	
Monomoy NWR	USA	Massachu-setts	WHSRN	41°36'15"N	69°59'12"W			Peak >5,000			ISS data (1970's - 2000's)	
Monterey Bay	USA	California		36°48'00N	121°54'04W				thousands (peak 6,800 in 2002-2003)		Neuman et al. 2008	
Olympic-North Beach	USA	Washington		47°18'12"N	124°15'45"W		>7,100 (in 1983)		>2,000		Myers et al. 1984b; Buchanan 1992	
Orca Inlet, Prince William Sound	USA	Alaska		60°31′25″N	145°52′46″W		"flocks of 10,000" (1970s)				Isleib 1979	Further counts needed

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Oregon Dunes National Recreation Area	USA	Oregon		43°41'59"N	124°12'04"W		>5,000 (1983)	>18,000 (in 1993)			Myers et al. 1984b; Platt and Goggans 1993	
Outer Banks	USA	North Carolina		35°34'01N	075°28'07W		~35,000-40,000 annually; 9,700 in 1992-93	~35,000-40,000 annually; 28,500 in 1992-93			Myers 1988; Dinsmore et al. 1998	
Padre Island National Seashore	USA	Texas	WHSRN	26°06'13"N	97°09'53"W		Peak numbers >5,000	Peak numbers >5,000			ISS data (1990s)	
Pea Island NWR	USA	North Carolina		35°41'02"N	75°28'58"W				>1,000 (1970s)		ISS data	
Plymouth Beach	USA	Massachu-setts		41°57'45N	070°38'18W			Peak >2,500			ISS data	
Sanibel Island	USA	Florida		26°26'25N	082°06'49W				several thousand (1990s)		ISS data (1970's-1990s)	
South Beach Island, Chatham	USA	Massachu-setts		41°37'13"N	69°57'40"W			>10,000	>1,000 (2000s)		ISS data (1990's - 2000's)	
South jetty of Columbia River	USA	Oregon		46°14'11"N	124°00'19"W		30,000 (1978)		>5,800 (in 1983)		Paulson 1993	
Sunset Beach	USA	Oregon		45°58'29"N	123°56'49"W		20,000 (1977)				Paulson 1993	
Tillamook Bay	USA	Oregon		45°30'19"N	123°54'59"W				~1,000 (1974-1988)		Paulson 1993	
Tomales Bay	USA	California		38°10'11"N	122°54'36"W				>1,000 (1990s)		ISS data 1980s, & 90s; Kelly 2001	

Site Name	Country	State/ Province	Site Designation	Latitude	Longitude	Full Coordinates	North Migration	South Migration	Winter	Breeding	Source	Comments
Wildwood, Two Mile Beach	USA	New Jersey		38°56'54N	074°51'27W			>5,000			ISS data (2000s); Burger et al. 1977	
Yaquina Bay	USA	Oregon		44°37'13"N	124°02'17"W				~500 (1974-1988)		Paulson 1993	
Barra del Chuy - La Coronilla	Uruguay	Rocha		33°54'S	53°31'W		3,000 (in 2004)				Aldabe *et al*. 2006; Birdlife Internatio nal 2009	