ARCTIC SHOREBIRDS *in* NORTH AMERICA

A Decade of Monitoring

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FOREWORD

Contribution of Arctic PRISM to Monitoring Western Hemispheric Shorebirds

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WHY MONITOR SHOREBIRDS?

Long-term monitoring of populations is of paramount importance to understanding responses of organisms to global environmental change and to evaluating whether conservation practices are yielding intended results through time (Wiens 2009). The population status of many shorebird species, the focus of this volume, remain poorly known. Long-distance migrant shorebirds have proven particularly difficult to monitor, in part because of their highly migratory nature and ranges that extend into highly inaccessible regions. As migrant shorebirds travel the length of the hemisphere, they congregate and disperse in ways that vary among species, locations, and years, presenting serious challenges to designing and implementing monitoring programs.

Rigorous field and quantitative methods that estimate population size and monitor trends are vitally needed to direct and evaluate effective conservation measures. Many management efforts depend on unbiased population size estimates; for example, the shorebird conservation plans for both Canada and the United States seek to restore populations to levels calculated for the 1970s based on the best information available from existing surveys. Further, federal wildlife agencies within the United States and Canada have mandates to understand the state of their nations' resources under various conventions for the protection of migratory birds. Accurate estimates of population size are vital statistics for a variety of conservation activities, such as prioritizing species for conservation action and setting management targets. Areas of essential habitat, such as those designated under the Western Hemisphere Shorebird Reserve Network, the Important Bird Areas program of BirdLife International and the National Audubon Society, or Canada's National Wildlife Areas program, are all evaluated on the basis of proportions of species' populations which they contain. The size, and trends in size, of a species' population are considered key information for assessing its vulnerability and subsequent listing under the U.S. *Endangered Species Act* and the Canadian *Species at Risk Act*.

To meet the need for information on population size and trends, shorebird biologists from Canada and the United States proposed a shared blueprint for shorebird monitoring across the Western Hemisphere in the late 1990s; this effort was undertaken in concert with the development of the Canadian and U.S. Shorebird Conservation Plans (Donaldson et al. 2000, Brown et al. 2001). Soon thereafter, partners in the monitoring effort adopted the name "Program for Regional and International Shorebird Monitoring" (PRISM). Among the primary objectives of PRISM were to estimate the population sizes and trends of breeding North American shorebirds and describe their distributions (Bart et al. 2002). PRISM members evaluated ongoing and potential monitoring approaches to address 74 taxa (including subspecies) and proposed a combination of arctic and

boreal breeding surveys, temperate breeding and non-breeding surveys, and neotropical surveys.

CHALLENGES WITH MONITORING SHOREBIRDS

Despite their importance for conservation and management of shorebirds, accurate estimates of population size have proven difficult to obtain for many species; some species disperse widely during migration, vary in their lengths of stay at stop-over sites, and differ in their ratios of imperfect detection. Estimates provided in Morrison et al. (2006) represent the best information currently available, and although the authors have devoted substantial effort to refining the estimates, 47 of 75 (63%) of the taxa described have population estimates that are considered only within one or more orders of magnitude. Trend data, too, are in many cases not sufficiently robust to support management action. Despite the apparent widespread declines in shorebird populations, imprecision and potential bias in the trend estimates mean that some species in need of conservation attention do not have the basic level of information necessary to support unequivocally sound management actions, such as listing for protection under the Canadian *Species at Risk Act*.

BENEFITS OF ARCTIC MONITORING

Arctic PRISM was designed to monitor the status of shorebird populations by estimating population size across the entire North American arctic at regular intervals using data collected at a regional scale. This multiscale geographic focus offers a number of advantages from a management perspective. Local and regional density information can be applied directly in an impact assessment context (as was the case for the proposed Mackenzie Valley Oil and Gas project; see Rausch and Johnston, Chapter 5, this volume) or could be applied indirectly to estimate flyway populations for management efforts elsewhere. Partitioning population sizes among smaller-scale geographies allows local managers to set management targets for their area of interest. The range-wide nature of the population information provided by PRISM also will allow managers to better understand national and international responsibilities for a species' protection.

Efforts prior to Arctic PRISM to estimate population size based primarily on wintering and migration surveys were unable to determine the relative distribution of breeding shorebirds between Alaska versus Canada for widely dispersed species. Establishing the relative responsibility borne by Canada and the United States for a particular species' conservation was therefore difficult. Interpretation of results from surveys that varied in proportional coverage of birds along different flyways may have provided misleading perspectives for shorebirds such as the Semipalmated Sandpiper, a species currently under consideration for listing by the Committee on the Status of Endangered Wildlife in Canada. Historically, 75% of all Semipalmated Sandpipers were thought to migrate through the Bay of Fundy based on comparisons of total counts at this site during migration with counts on the wintering grounds. It was assumed that these birds bred in the eastern arctic, suggesting that Canada had the lead responsibility for conservation of both breeding and migrating Semipalmated Sandpipers.

Recent surveys in areas that previously lacked coverage are now revealing a new perspective on Semipalmated Sandpiper distribution. At sites surveyed to date, densities are much higher in the western regions than in eastern areas. Although much of the species' range remains to be surveyed, it seems that a large fraction of the population likely breeds in Alaska and may therefore use inland migration routes where they will not be exposed to environmental threats operating in the Bay of Fundy. Moreover, results to date suggest that the population size of Semipalmated Sandpipers is much larger than once believed. The Bay of Fundy may be used by a smaller fraction of the species than once thought, yet it is still of critical importance to southbound populations traveling along the Atlantic coast.

The regional information on population trends obtained through Arctic PRISM surveys will provide insights valuable to conservation efforts. This information will help to determine the geographic areas or flyways where conservation action is most urgently needed, but without some of the problems associated with counting birds at migratory stop-over locations. Arctic surveys could also complement migration surveys by helping to determine if some apparent declines are due in part to shifts in migratory stopover locations. Consider, for example, the dramatic

decline of Red-necked Phalaropes in the Bay of Fundy. Range-wide counts on the breeding grounds would provide evidence to help discriminate between explanations of population decline or geographic shift.

Arctic surveys may also help to identify changes in non-wetland arctic habitats. Shorebirds are often found at highest densities in wetland habitats, and these habitats are where monitoring efforts have traditionally been focused. In PRISM surveys to date, significant numbers of shorebirds have been found in more upland habitats such as upland heath tundra, although densities are usually significantly lower. GIS-based estimates of available habitat suggest that these habitats are nearly eight times more extensive than wetlands, and support an important fraction of shorebird populations across the arctic. Declines may occur first in marginal habitats, and would go unnoticed if monitoring targeted only a restricted number of high-density sites.

THE ROLE OF ARCTIC PRISM SURVEYS IN CONTINENTAL SHOREBIRD MONITORING

When the PRISM planning document was drafted in the early 2000s, information on population size and trends of 46 of the 74 taxa (32 of 49 species) was anticipated from arctic and boreal breeding surveys (ABBS), to be supplemented by temperate migration and winter single-species surveys (Bart et al. 2002). As pilot efforts revealed the low feasibility of implementing extensive boreal surveys (see Surveying the Boreal Fractions of Northern Species below), this list of focal species with potential for population size and trend estimates was modified to the 26 species covered by arctic breeding ground surveys (Johnston and Bart, chapter 1, this volume).

To identify the species for which arctic breeding ground surveys clearly yield the best approach for estimation of populations sizes and trends, we distinguished among the 26 focal species according to whether at least 70% of a species' range falls within the North American arctic, and the likelihood of reaching PRISM accuracy targets based on the analyses in this volume (Bart and Smith, chapter 13, this volume). The target would be met by a CV of the population estimates of 0.42 for future surveys revisiting the same plots or 0.31 for future surveys of new independently chosen plots. Based on these criteria, we classified species into four categories of concern, including: (1) species with the primary range in the arctic for which the accuracy target could easily be met; (2) species primarily breeding in the arctic for which the accuracy target could be met by adding additional elements to the survey design; (3) species with more than 30% of their range falling outside of the arctic study area but for which estimates of the arctic component would satisfy the PRISM target; and (4) species with more than 30% of their range falling outside of the arctic study area that require substantial additional design elements to adequate survey the arctic portion of their populations (Table F.1).

We consider the arctic breeding surveys to clearly be a viable and valuable approach to population size and trend estimation for all of the focal species in category 1, including seven species ranked as Highly Imperiled or High Concern (Bar-tailed Godwit, Ruddy Turnstone, Rock Sandpiper, Sanderling, Red Knot, Dunlin, and Buff-breasted Sandpiper), three species of moderate concern (Black-bellied Plover, Semipalmated Sandpiper, and Red Phalarope), and four species of low concern (White-rumped Sandpiper, Baird's Sandpiper, Pectoral Sandpiper, and Long-billed Dowitcher). This declaration is based on the assumption of 50 crew years and repeat surveys of plots. If the number of crew years dropped to 40, estimates of Buff-breasted Sandpipers and Long-billed Dowitchers would no longer meet the accuracy target.

The two species in category 2, Black Turnstone (High Concern) and Purple Sandpiper (Moderate Concern) breed primarily in the arctic but have a lower certainty of reaching the accuracy target, primarily because they are rare and patchily distributed. Additional coverage within their ranges is needed to approach the accuracy target. Conservation priority ranks for these species, from High Concern to Low Concern, are derived from the Canadian and United States shorebird conservation plans and subsequent updates (U.S. Shorebird Conservation Plan 2004).

For several category 3 species (those with less than 70% of their range in the arctic), the predicted accuracy of counts in the arctic is good; thus accurate trend estimates of the arctic component of their populations can feasibly come from the arctic surveys. This is true for American Golden-Plover and Whimbrel (High Concern), Pacific Golden-Plover, Wilson's Snipe, Least

TABLE F.1

Feasibility of reaching desired accuracy target (CV < 0.42) for 26 focal species with arctic breeding ground surveys, assuming repeat surveys of plots and effort of 50 crew-years in future surveys.

Breeding distribution	Focal species	
More than 70 % of breeding range in arctic	*Category 1:* Species for which accuracy target will likely be obtained (predicted CV; Table 12.2)	
	Black-bellied Plover (0.20)	White-rumped Sandpiper (0.31)
	Bar-tailed Godwit (0.36)	Baird's Sandpiper (0.24)
	Ruddy Turnstone (0.28)	Pectoral Sandpiper (0.23)
	Red Knot (0.33)	Dunlin (0.33)
	Rock Sandpiper (0.38)	Buff-breasted Sandpiper (0.29)
	Sanderling (0.26)	Long-billed Dowitcher (0.38)
	Semipalmated Sandpiper (0.21)	Red Phalarope (0.29)
	Category 2: Species for which accuracy target will likely be obtained only with additional sampling within range (predicted CV)	
	Black Turnstone (0.46)	Purple Sandpiper (1.20)
Less than 70 % of breeding range in arctic	*Category 3:* Species for which accuracy target will likely be obtained for arctic component (predicted CV; % range in arctic)	
	American Golden-Plover (0.21; 59)	Least Sandpiper (0.39; 21)
	Pacific Golden-Plover[a] (0.34; 66)	Stilt Sandpiper (0.30; 68)
	Semipalmated Plover (0.40; 39)	Wilson's Snipe (0.26; 6)
	Whimbrel (0.29; 30)	Red-necked Phalarope (0.28; 43)
	Category 4: Species that cannot be adequately surveyed in the arctic (predicted CV; % range in arctic)	
	Hudsonian Godwit (1.27; 26)	Western Sandpiper[a] (0.47; 64)

[a] Likelihood of reaching accuracy target may be improved with additional survey design elements.

Sandpiper, Stilt Sandpiper, Red-necked Phalarope (all of Moderate Concern), and Semipalmated Plover (Low Concern). For these eight species, additional breeding surveys in other biomes or during migration or winter will be necessary to capture trends of the populations that breed outside the arctic. The remaining two focal species with less than 70% of their range in the arctic, Hudsonian Godwit and Western Sandpiper (High Concern), are in category 4 and will require both targeted design elements within the arctic and additional survey efforts outside the arctic to adequately assess trends.

Generally, the species that have proven most difficult to survey in the arctic are relatively rare and/or have a restricted distribution. While rarity can make a species difficult to survey throughout the annual cycle, a restricted distribution may in some cases be an asset for targeted, single-species surveys. High fidelity of Pacific Golden-Plovers to their Pacific island wintering sites suggests that information on changes in their population size could be obtained there (Johnson et al. 2006). Virtually all of the Hudsonian Godwits wintering along the Pacific Coast do so in the vicinity of Chiloé Island, Chile (Andres et al. 2009), and systematic ground counts could provide information on population size and trends. Recent analyses of Christmas Bird Count data (Butcher and Niven 2007) may prove useful for tracking changes in a select group of shorebirds that winter in North America, such as the Purple Sandpiper. In the Pacific Flyway, design is under way for a program to estimate trends of shorebirds during winter. A thorough review of alternative methods for species not surveyed well by Arctic PRISM should be undertaken.

SURVEYING THE BOREAL FRACTIONS OF NORTHERN SPECIES

Of the 26 taxa breeding in boreal and arctic regions, ten species have more than 30% of their range in the boreal ecozones (see Table F.1), and shorebird surveys in boreal habitats could therefore play an important role in a continental monitoring program for shorebirds. Initially, it was hoped that a ground-based survey similar to Arctic PRISM, with double sampling and stratified random plot selection, would also be effective in boreal habitats. Pilot efforts revealed that foot travel across boreal wetlands was difficult and unsafe, and methods were reconsidered. Sinclair et al. (2004) reviewed the potential for a variety of air- and ground-based survey methods, and research to evaluate some of these methods is ongoing (Elliott et al. 2010). Still, a strategy for monitoring shorebirds within challenging boreal habitats remains elusive. Surveys for boreal species may be best addressed by well-designed migration or winter surveys.

MONITORING AND CLIMATE CHANGE

Predicted changes in precipitation patterns and increases in temperature will be intensified in the arctic and will have dramatic effects on the distribution, abundance, and viability of many arctic bird species. Changes will be manifested through alterations in surface hydrology, increases in vegetation height, and shifts in lifecycle phenology of bird food resources (ACIA 2005). Continued monitoring of arctic bird populations to determine their response to changing environmental factors influenced by climate change will aid scientists, policymakers, and society in developing cost-effective mitigation actions that will maintain arctic avifaunal diversity. Anticipated changes in arctic marine and terrestrial systems will likely include increased industrial mining, oil and gas development, and international shipping, all of which can contribute additive stresses to arctic birds and their habitats. Understanding differences in shorebird abundance across the arctic will allow for development of effective land protection strategies to maintain populations of shorebirds and other tundra birds. Identification and protection of sedge–grass tundra refugia may become increasingly important in maintaining arctic shorebird diversity if current tundra habitats are altered by climate change.

CONCLUSION

The arctic plays a key role in the life cycle of many Western Hemisphere shorebird species, yet at present neither the Canadian nor the United States government has committed to a long-term program to monitor populations there. The suspected population declines occurring already, coupled with the impending threat of dramatic changes to climate and habitats, increase the need for such a program. Moreover, results to date demonstrate that the Arctic PRISM surveys, if carried out with the recommended sampling intensity, will achieve their objective of delivering reliable information on distributions, population sizes, and population trends. Continued implementation of Arctic PRISM will meet the monitoring needs for most arctic-breeding shorebirds; measuring population trends of shorebirds on their arctic breeding grounds is a critical step toward evaluating ongoing conservation efforts for this group of birds.

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