Waterbird Use of Northern Atlantic Wetlands Protected Under the North American Wetlands Conservation Act

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Abstract.—The North American Wetlands Conservation Act (NAWCA) supports the conservation of significant amounts of wetland in the Northern Atlantic region. The Atlantic Coast Joint Venture, which uses Act funds to implement wetland habitat protection in the region, has expanded its goals to include conservation of all wetland birds. We conducted field surveys at all 30 completed NAWCA project sites between Virginia and Maine, as well as at comparable wetland sites on other publicly owned land, to determine the waterbird species using the sites during the spring migration and breeding season. We compared species diversity and abundance at NAWCA sites and comparable reference wetlands. In addition, we compared the species found on each NAWCA site to the list of species predicted for the site in the project application, corrected for the season of the survey. In general, NAWCA sites had comparable numbers of species and individuals relative to the reference sites, although some species occurred more frequently at NAWCA sites. Lists of species predicted to occur on the sites had very low similarity with species actually recorded, so additional approaches are needed to predict which potential future projects would make the highest contribution to waterbird diversity. However, most waterbird species identified as high priority in bird conservation plans for the region did not occur at either the NAWCA or reference sites. Inclusion of additional habitat types that were uncommon at NAWCA sites, particularly including shallow mudflat and coastal shoreline, would likely improve the success of the program in providing habitat for high-priority waterbird species.

Key words.—North American Wetlands Conservation Act, NAWCA, waterbird diversity, northern Atlantic, wetland conservation.

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The North American Wetlands Conservation Act (NAWCA) provides federal funding to acquire and restore wetlands throughout the United States, including approximately $53 million for habitat protection in the Atlantic coast region through the year 2000 ($368 million nationally). The program requires a non-federal match, and is administered by the Division of Bird Habitat Conservation of the U.S. Fish and Wildlife Service. The Atlantic Coast Joint Venture, which has implemented the goals of the North American Waterfowl Management Plan (NAWMP) through NAWCA funding in the states along the Atlantic coast, has set an ambitious goal of delivering the full spectrum of bird conservation in cooperation with all of the major bird conservation initiatives in the region. Realizing this goal will require a detailed analysis of past effectiveness at providing nongame waterbird habitat through NAWCA projects. This paper addresses this goal by assessing waterbird use of existing NAWCA project sites and selected reference wetlands in the northern part of the Joint Venture from Virginia to Maine. The project addresses four groups of nongame waterbirds, including marshbirds (e.g., rails and bitterns), wading birds (e.g., herons and egrets), marsh-dwelling passerines (e.g., sparrows and wrens), and shorebirds (e.g., plovers and sandpipers).

The northern Atlantic coast provides critical breeding and migration habitat for a wide range of nongame waterbirds. Of the 50 shorebird species that breed in or migrate through the United States, the U.S. Shorebird Conservation Plan classifies the northern Atlantic region as "extremely important" for 16 species and "important" for ten others (Brown *et al.* 2001a). Many species of wading birds, including herons and egrets, congregate in large nesting colonies, but forage widely in coastal and inland wetlands. For many of the species of conservation concern in the North American Waterbird Conservation Plan (Kushlan *et al.* 2002), the northern Atlantic region includes a large proportion of the breeding colonies identified in national surveys (Spendelow *et al.* 1988). The con-

servation status of marshbirds is currently being determined with their recent inclusion in the Waterbird plan. Several species have been designated by the U.S. Fish and Wildlife Service as species of management concern because they are thought to be declining in the region, including Black Rail (*Laterallus jamaicensis*), Least Bittern (*Ixobrychus exilis*), and American Bittern (*Botaurus lentiginosus*). These secretive birds are often difficult to survey, and therefore their conservation status is less well understood. The Partners In Flight physiographic area plans for Southern New England and the Mid-Atlantic Coastal Plain have identified wetland-dependent sparrows and marshbirds as high-priority species in saltmarsh habitats, including sharp-tailed sparrows (*Ammodramus* spp.) (Rosenberg 1998; Watts 1999; Pashley *et al.* 2000).

Habitat loss has been identified as one of the major factors limiting populations of shorebirds (Goss-Custard 1979; Harrington 1995) and other nongame waterbirds in the northern Atlantic region (Erwin 1995). While most species face additional challenges from other human impacts on their wintering grounds, protection of their critical migration and breeding habitat in the northern Atlantic is necessary to support stable populations. Most of these species depend on wetlands for major parts of their life histories, making these habitats critical to their survival. Many former heron colonies have been abandoned completely, and remaining colonies are challenged by increased human presence and loss of quality foraging habitats. The International Shorebird Surveys indicate that several shorebird species have declined significantly in the northern Atlantic region over their former numbers (Howe *et al.* 1989). In addition, human disturbance limits shorebird foraging, and may constrain their ability to meet the high energetic demands for southward migration from this region (Pfister *et al.* 1992).

The goals of this project were to characterize wetland habitat types protected at NAWCA project sites, and determine the number of species and individuals using NAWCA sites relative to other comparable public lands. In addition, we determined how closely the predicted bird communities at NAWCA sites compare with actual bird communities observed during field surveys.

METHODS

Study sites were selected from all completed NAWCA projects throughout the northern Atlantic region, which includes the Chesapeake Bay north to Maine. Of the 43 projects funded in the northern half of the Atlantic Coast Joint Venture, we included in the study all 30 projects in which land acquisition had been completed (Fig. 1). Because most projects included multiple parcels, we randomly subsampled 69 parcels from the total set of 149 parcels at all completed projects. Reference sites were selected for each NAWCA project site from nearby comparable wetland habitats in public ownership. Data were collected from a total of 48 reference wetlands on nearby publicly owned land with similar habitat types and wetland size. At some NAWCA project sites with multiple parcels, appropriate reference wetlands were limited, and in these cases comparisons were made between each parcel and one or more available reference sites. We surveyed only marshes and associated habitats at study sites, and did not attempt to characterize the waterbird species using forested wetlands at project sites or forested upland buffers.

All study sites were surveyed twice during the breeding season between April and June, 2000. Four survey types were used, including: (1) a 5 minute point count of a half-circle area with radius of 100 m facing the marsh; (2) an area survey to record all species using an area of approximately 1 ha visible from the point count location; (3) a site search conducted by walking the accessible perimeter of the site to record additional species using the project parcel; and (4) a playback survey for secretive waterbirds (Gibbs and Melvin 1993). We recorded all birds using each site, and the type of survey during which they were observed. To determine the contribution of NAWCA sites to regional waterbird diversity, we compared the frequency of species occurrences between NAWCA sites and reference sites recorded in any survey type. For these comparisons, we assumed that samples at each type of site were independent.

To determine the similarity of species lists between NAWCA site bird communities and both reference sites and predicted bird communities, we used the Jaccard Similarity index (Ludwig and Reynolds 1988) using site pairs, with entire NAWCA projects and reference sites as sampling units (N = 30). The value of this index is 1.0 for identical communities, and 0 for communities that do not share any species. The lists of species expected to occur at each project are submitted by the project applicant as part of the grant proposal for each project, and are based on whatever information is available to the applicant about the site. Because projects score higher with more extensive species lists, there is an incentive for the applicant to list all species that could occur on the habitat type of the proposed project. To compare the predicted species lists with our field data, we modified the species lists from project applications and only included those species expected to occur at the habitat type of the sample parcels and during the spring migration and breeding season. We used separate variance t-tests (SPSS, Inc. 1999) to compare mean numbers of bird species and individuals between NAWCA and reference sites, and to

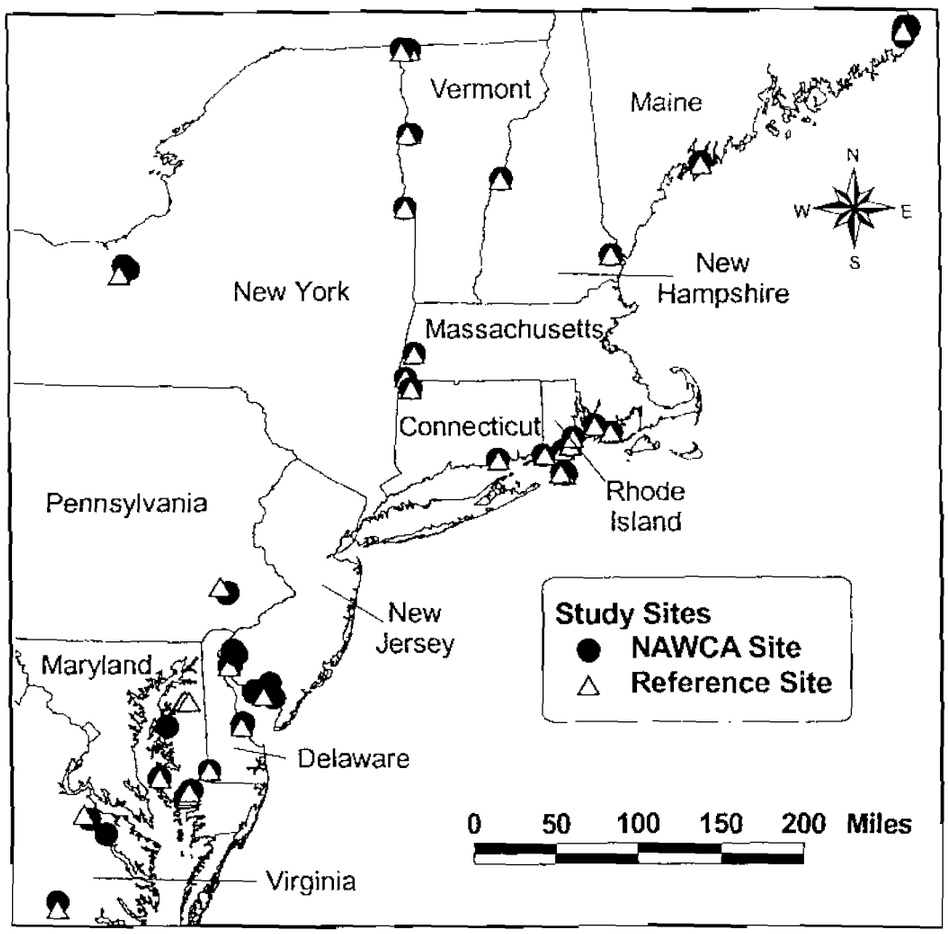

Figure 1. Location of NAWCA project sites and reference sites in the northern Atlantic region.

compare mean numbers of species within broad taxonomic groups between types of sites. Comparisons of species presence included data from all four survey types, while comparisons of individual number included point counts, area surveys, and playback surveys.

Habitat characteristics surrounding study sites were analyzed using National Wetland Inventory maps (*http://www.nwi.fws.gov/*). Survey sites selected in the field were geographically referenced with a global positioning system. National Wetland Inventory maps were available for most study sites except in Rhode Island and Massachusetts, where wetland information was obtained from state Geographic Information System webservers (RIGIS, http://www.edc.uri.edu/rigis/, and MassGIS http://www.state.ma.us/mgis/massgis.htm). Wetlands in Rhode Island were delineated from 1988 aerial photography under the classification scheme developed by Cowardin *et al.* (1979). In Massachusetts, wetlands were delineated from color-infrared photography (1:12000 scale) at the University of Massachusetts—Amherst, and verified by the Massachusetts Department of Environmental Protection Wetlands Conservancy Program.

All National Wetland Inventory quads or other wetland data layers in the vicinity of each NAWCA study site were merged into one Geographic Information System file. ArcView scripts were used to generate 0.5 km buffer strips around each site, and the areas of each National Wetland Inventory wetland class that fell within the buffer area were calculated. This process was repeated for all 99 of the total 117 NAWCA project and reference sites for which landscape scale information was available. The sites with no Geographic Information System coverage available were not used in the spatial analyses. We used the landscape scale information to derive estimates of the percentage of each wetland system and subsystem surrounding each NAWCA and reference site. We used linear regression to compare relationships between habitat characteristics and the number of bird species present. All statistical analyses were performed using SYSTAT (SPSS, Inc. 1999).

RESULTS

The majority of the survey sites at NAWCA parcels were in palustrine (36%) and estuarine (14%) wetlands (Fig. 2). In addition to these types, there was also a small number of lacustrine, non-tidal riverine, and tidal riverine wetlands surveyed. The most common type of land surrounding NAWCA and reference sites was upland (Fig. 3). Estuarine intertidal was the next most common surrounding wetland type, followed by estuarine subtidal. There were no significant differences in the wetland type at the site or in the proportion of the surrounding area in any type of wetland between the NAWCA and reference sites, indicating that the reference sites had comparable wetland types and landscape settings to the NAWCA sites ($P > 0.05$ for all tests; Fig. 3).

The number of wetland-dependent bird species detected was weakly but significantly correlated with the area surrounding the site that was classified as estuarine subtidal emergent wetlands ($r^2 = 0.19$, $F_{1,97} = 22.8$, $P < 0.001$) and with the area classified as estuarine subtidal open water ($r^2 = 0.05$, $F_{1,97} = 5.53$, $P < 0.05$). The number of individual birds of wetland-dependent species was also weakly correlated with the area surrounding the site that was classified as estuarine subtidal emergent wetlands ($r^2 = 0.07$, $F_{1,97} = 7.27$, $P < 0.01$). There were also weak negative correlations between the number of wetland-dependent bird species and both the percent of surrounding area in deciduous forested wetland ($r^2 = 0.07$, $F_{1,97} = 7.20$, $P < 0.01$) and upland ($r^2 = 0.13$, $F_{1,97} = 13.8$, $P < 0.001$).

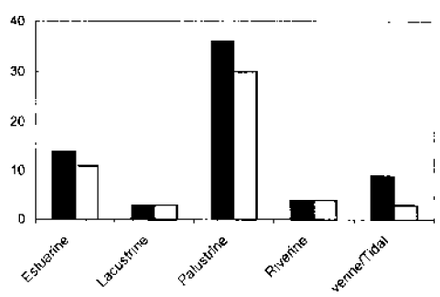

Figure 2. Proportions of NAWCA and reference sites categorized in each National Wetlands Inventory wetland type. NAWCA sites are shown with black bars, reference sites with white bars.

Most taxonomic groups of birds were represented at NAWCA sites and reference sites by comparable numbers of birds and of species. The average number of individual birds did not differ between NAWCA and reference sites for any species group ($P>0.05$ for all tests; Fig. 4). When bird species were compared, the average number per site was not significantly different for any species group (Fig. 5). Each species was categorized as being either wetland-dependent, wetland-associated, or upland-associated (Brown *et al.* 2001b). There were no significant differences between numbers of wetland-associated species, wetland-dependent species, or total bird species (Fig. 6a) or for comparisons between average numbers of individuals in the same groups (Fig. 6b).

When the total numbers of birds was corrected for the relative number of NAWCA and reference sites, some species of birds occurred more frequently than would be expected by chance at NAWCA sites relative to reference sites (Table 1). These species were recorded more frequently than expected according to the relative proportion of NAWCA (59%) and reference sites (41%). Several other waterbird species were recorded more frequently than expected at reference sites, including several colonial waterbird and waterfowl species (Table 1).

Several shorebird species that were frequently predicted by project applications to occur on project parcels were never recorded at any project sites (Table 2). These species were listed in a minimum of five project applications, but were not recorded at any project parcels. Although there were more shorebird species and individuals recorded at NAWCA sites, the mean number of both individuals and species recorded did not differ significantly between the types of sites. The mean of 18.1 (±63.4 SD, N = 30) individual shorebirds at NAWCA sites did not differ from the mean of 4.5 at reference sites (±13.0 SD; $t_{29} = 1.45$, n.s.). Similarly, the mean number of shorebird species at NAWCA sites (1.1 ± 1.8 SD, N = 30) did not differ from the reference sites (0.6 ± 1.1 SD; $t_{29} = 1.79$, n.s.).

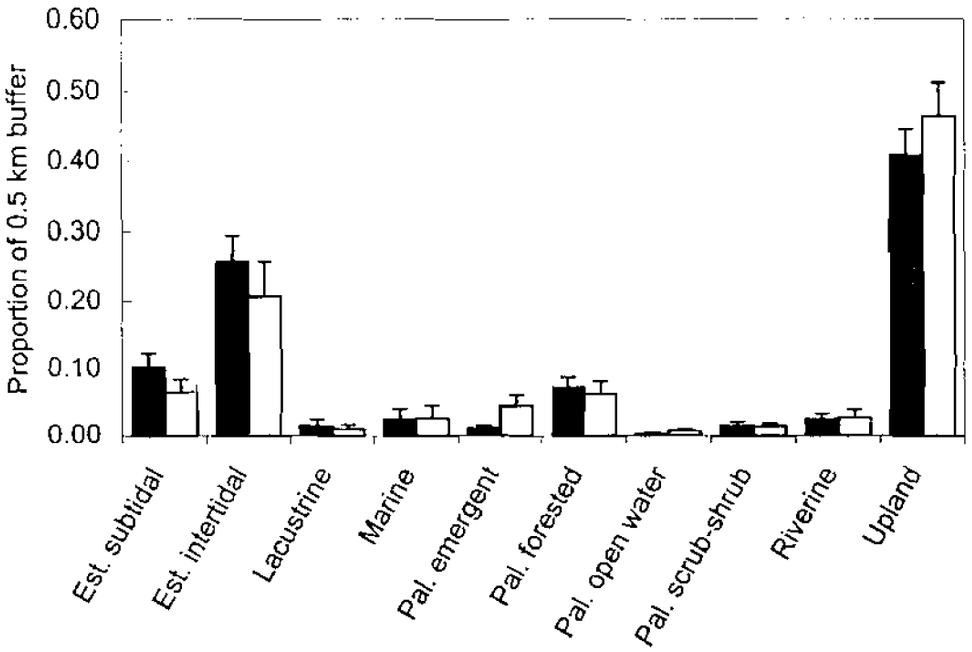

Figure 3. Proportion of the area within 0.5 km surrounding each NAWCA and reference site that was classified in the GIS analysis in each major wetland type, with standard errors. Est. = Estuarine, Pal. = Palustrine. NAWCA sites are shown with black bars, reference sites with white bars.

We identified the waterbirds that are likely to occur in wetlands of the northern Atlantic region and that have been listed by the relevant bird conservation plans as priority species for conservation attention (Appendix 1). Of these priority species, several species were recorded at NAWCA sites, but the majority of priority species were never recorded (Appendix 1). Among species classified as depending primarily on vegetated wetlands, seven of the twelve priority species were recorded at NAWCA sites. In contrast, among the species classified as depending primarily on coastal shoreline habitats or shallow mudflats, none of the nine priority species was recorded.

The comparisons between NAWCA and reference site bird communities indicated substantial differences resulting in low similarity values between the species lists at the two types of sites (average similarity = 0.32 ± 0.17 SD). However, there were even larger differences between the predicted bird communities listed in project applications and the actual bird communities observed at NAWCA parcels (average similarity = 0.06 ± 0.06 SD). The average reference site shared approximately 32% of the species found at the paired NAWCA site, while the average application list corrected for the appropriate season and hab-

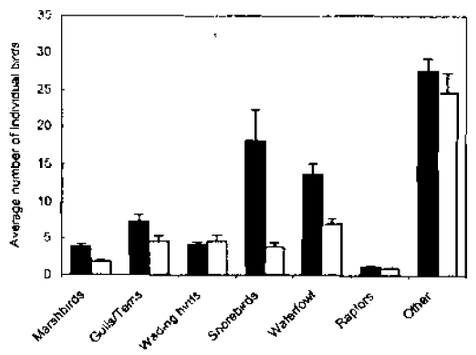

Figure 4. Average number of individual birds of each group recorded in all surveys at each site compared between NAWCA and reference sites, with standard errors. NAWCA sites are shown with black bars, reference sites with white bars.

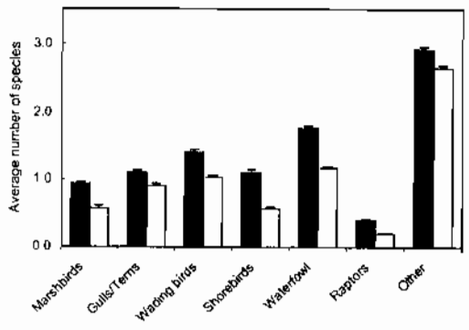

Figure 5. Average number of wetland bird species in each group recorded at each site compared between NAWCA and reference sites, with standard errors. NAWCA sites are shown with black bars, reference sites with white bars.

itat type shared only about 6% of the species actually observed at the NAWCA parcels. The difference between the two was significant (t_{29} = -8.3, $P < 0.001$), with the reference sites a significantly better predictor of species occurrence at NAWCA sites than the predicted species lists from project applications.

DISCUSSION

This study showed that the wetland sites protected under the NAWCA program provide important habitat for a diverse array of waterbird species. In addition, some waterbird species were more common at NAWCA sites than at other public lands. However, other species were more common at other protected public lands than at NAWCA sites.

Some high-priority waterbirds were recorded at NAWCA sites, particularly those associated with emergent vegetated wetlands. This wetland community type was the most common among the project parcels. However, the high-priority species associated with other wetland types, including coastal shoreline and shallow mudflat habitats, did not occur at NAWCA sites. Most of the high-priority species associated with these habitats were shorebirds, and while several NAWCA sites provided significant shorebird habitat, most did not. The NAWCA sites without significant shorebird use were too heavily vegetated to be attractive to foraging shorebirds. In addition, most of the shorebirds that were recorded at NAWCA sites are habitat generalists. The more specialized habitats that support many of the highest priority shorebirds, including coastal shoreline, mudflats, and associated uplands, were very rare or did not occur at most NAWCA sites. If providing shorebird habitat is a goal of future projects, attention should be given to providing the habitats used by shorebird species of high conservation priority. Most of the high-priority waterbirds did not occur at NAWCA or reference sites in sufficient numbers to allow the development of models relating their abundance to the characteristics of the landscape.

In general, the diversity of waterbirds was higher at project areas with emergent wetlands in both the point count area and the area search site. The number of wetland-dependent bird species was also related to several landscape scale variables describing the

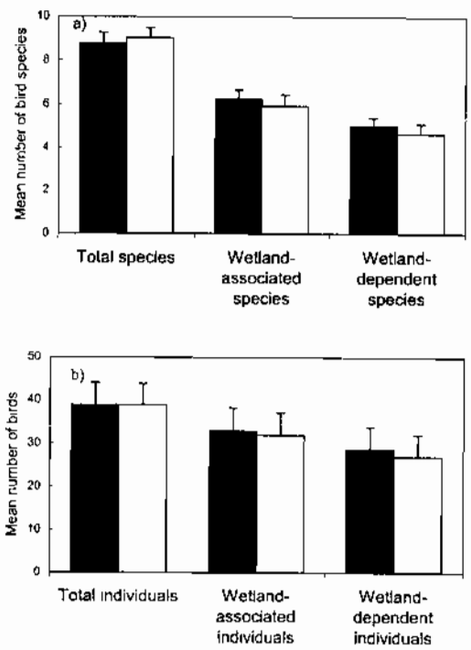

Figure 6. a) Mean number of bird species recorded at all NAWCA and reference sites, with standard errors. b) Mean number of individual birds recorded at each NAWCA and reference site, with standard errors. NAWCA sites are shown with black bars, reference sites with white bars.

Table 1. Bird species that occurred more frequently than would be expected if distributions were equal, at A) NAWCA sites or at B) reference wetlands. P values reflect cumulative probabilities of the binomial distribution.

A) Species found more frequently than expected at NAWCA sites		
Greater Yellowlegs	*Tringa melanoleuca*	$P < 0.001$
Lesser Yellowlegs	*Tringa flavipes*	$P < 0.001$
Semipalmated Plover	*Charadrius semipalmatus*	$P < 0.001$
Semipalmated Sandpiper	*Calidris pusilla*	$P < 0.001$
Spotted Sandpiper	*Actitis macularia*	$P < 0.05$
Double-crested Cormorant	*Phalacrocorax auritus*	$P < 0.05$
Ring-billed Gull	*Larus delawarensis*	$P < 0.01$
Clapper Rail	*Rallus longirostris*	$P < 0.05$
Pied-billed Grebe	*Podilymbus podiceps*	$P < 0.01$
American Black Duck	*Anas rubripes*	$P < 0.05$
B) Species found more frequently than expected at reference sites		
Snowy Egret	*Egretta thula*	$P < 0.001$
Green-winged Teal	*Anas crecca*	$P < 0.05$
Common Goldeneye	*Bucephala clangula*	$P < 0.05$
Belted Kingfisher	*Ceryle alcyon*	$P < 0.03$
Red-winged Blackbird	*Agelaius phoeniceus*	$P < 0.01$

proportion of wetland area in each type surrounding the sites. However, the relationship with most of the predictors was weak, indicating that waterbird diversity varied among the sites with respect to other variables not accounted for in the study. The wide range of habitat types and species considered probably means that larger sample sizes would be necessary to determine with confidence the general patterns affecting the diversity of all species present. Future work should include larger sample sizes from preferred habitats of the high-priority species that did not occur at NAWCA sites so that better habitat predictors can be developed and used to predict species occurrences at future sites.

The species lists provided in project applications were poor predictors of species actually recorded at NAWCA project sites. The species lists provided by applicants generally do not predict the species that will occur at project sites with sufficient accuracy to allow a characterization of the waterbird diversity that will be protected at future proposed sites. This was true even after the lists were corrected to include only breeding or migrating species expected to occur on the habitat types found at each NAWCA site during the study period. Prediction of species that will be supported by future projects is an important part of ensuring that waterbird diversity is supported by NAWCA projects. Surveying a similar wetland in the same general vicinity as the project site provides a better prediction of species that will be observed at the NAWCA site. We developed maps of for-

Table 2. Shorebird species predicted to occur at more than five NAWCA sites but that were not recorded in any field surveys at NAWCA sites.

Habitat type	Species	
Coastal Shoreline	American Oystercatcher	*Haematopus palliatus*
	Piping Plover	*Charadrius melodus*
	Red Knot	*Calidris canutus*
	Ruddy Turnstone	*Arenaria interpres*
	Sanderling	*Calidris alba*
Mudflat	Whimbrel	*Numenius phaeopus*
	White-rumped Sandpiper	*Calidris fuscicollis*
	Short-billed Dowitcher	*Limnodromus griseus*
Shallow water	American Avocet	*Recurvirostra americana*
Upland	Upland Sandpiper	*Bartramia longicauda*

aging distances for high-priority colonial waterbird species to help determine if proposed sites are likely to be used by these species (Brown *et al.* 2001b). Other approaches should be developed to help determine probable habitat value of proposed sites for shorebirds and marshbirds.

With the increasing emphasis on integrated bird conservation in the United States, the importance of developing new approaches to determining the habitat value of potential project sites will continue to increase. Regional planning tools that identify overlap among areas important for various groups of migratory birds would substantially improve the ability of land acquisition programs to determine which potential projects would make the greatest contribution to preserving waterbird diversity. Development of maps showing high-priority habitat for various groups of waterbirds, and locating potential projects on those maps to help determine their potential habitat value, would also provide a more objective method for reviewing project applications within programs like the North American Wetlands Conservation Act.

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Appendix 1. Priority waterbird species in wetlands of the northern Atlantic region as identified by bird conservation plans, including major habitat type, species status, and the initiative by which each species was identified as being of conservation concern (USSCP = United States Shorebird Conservation Plan, NAWCP = North American Waterbird Conservation Plan, PIF = Partners In Flight. [1]Occurred at NAWCA sites, [2]occurred at reference sites)

Habitat type	Species	Scientific name	Status	Initiative
Shallow mudflat	Whimbrel	*Numenius phaeopus*	High concern	USSCP
	Black-bellied Plover	*Pluvialis squatarola*	Moderate concern	USSCP
	Hudsonian Godwit	*Limosa haemastica*	High concern	USSCP
Vegetated wetlands	Greater Yellowlegs[1,2]	*Tringa melanoleuca*	High concern	USSCP
	Black Tern[1]	*Childonias niger*	Moderate concern	NAWCP
	Salt-marsh Sharp-tailed Sparrows[1,2]	*Ammodramus* spp.	High global priority	PIF
	Little Blue Heron[2]	*Egretta caerulea*	High concern	NAWCP
	American Bittern[1,2]	*Botaurus lentiginosus*	High regional priority	PIF
	Least Bittern[1]	*Ixobrychus exilix*	High regional priority	PIF
	Black Rail	*Laterallus jamaicensis*	High regional priority	PIF
	Seaside Sparrow[1,2]	*Ammodramus maritimus*	High global priority	PIF
	Snowy Egret[1,2]	*Egretta thula*	High concern	NAWCP
	Black-crowned Night Heron	*Nycticorax nycticorax*	Moderate concern	NAWCP
	Yellow-crowned Night Heron	*Nyctanassa violacea*	Moderate concern	NAWCP
Coastal shoreline	Piping Plover	*Charadrius melodus*	Highly Imperiled	USSCP
	Roseate Tern	*Sterna dougallii*	High concern	NAWCP
	Sanderling	*Calidris alba*	High concern	USSCP
	Red Knot	*Calidris canutus*	High concern	USSCP
	American Oystercatcher[1]	*Haematopus palliatus*	High concern	USSCP
	Wilson's Plover	*Charadrius wilsonia*	High concern	USSCP
	Black Skimmer	*Rynchops niger*	High concern	NAWCP
	Least Tern	*Sterna antillarum*	High concern	NAWCP
	Common Tern	*Sterna hirundo*	Moderate concern	NAWCP
Associated uplands	American Golden-Plover	*Pluvialis dominicus*	High concern	USSCP
	Upland Sandpiper	*Bartramia longicauda*	High concern	USSCP
	Buff-breasted Sandpiper	*Tryngites subruficollis*	High concern	USSCP