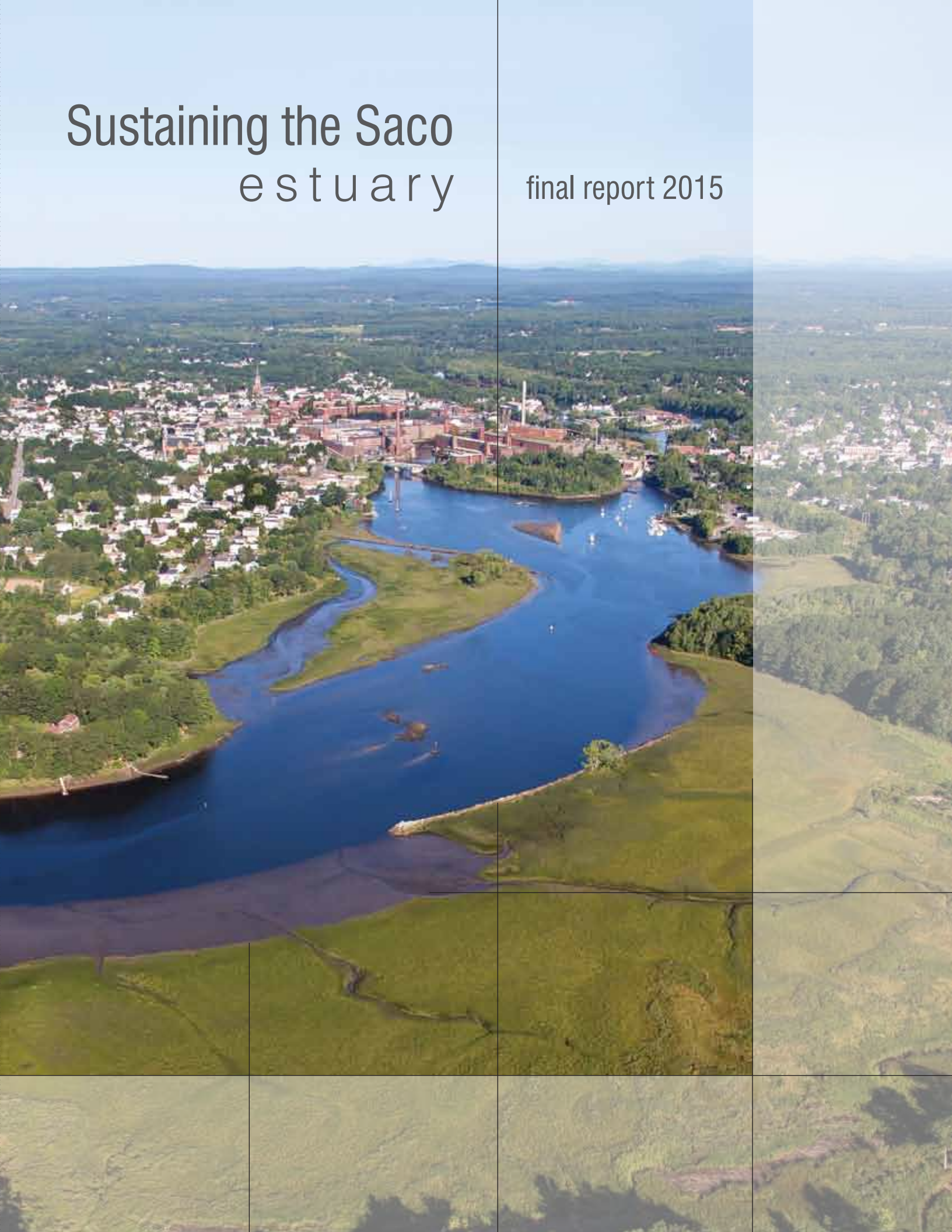


Sustaining the Saco e s t u a r y

final report 2015



Sustaining the Saco estuary

final report 2015



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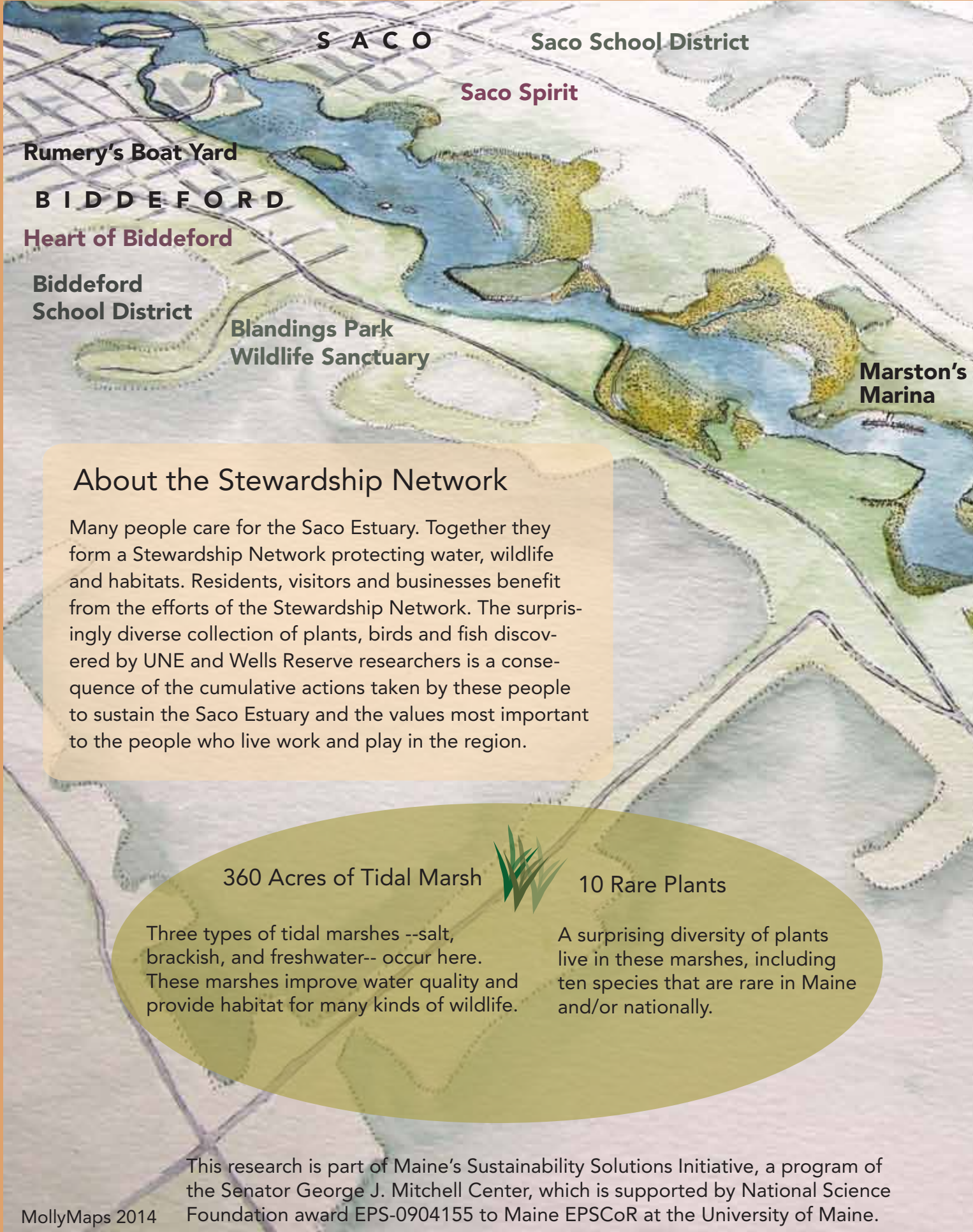
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S A C O

Saco School District

Saco Spirit

Rumery's Boat Yard

B I D D E F O R D

Heart of Biddeford

Biddeford School District

Blandings Park Wildlife Sanctuary

Marston's Marina

About the Stewardship Network

Many people care for the Saco Estuary. Together they form a Stewardship Network protecting water, wildlife and habitats. Residents, visitors and businesses benefit from the efforts of the Stewardship Network. The surprisingly diverse collection of plants, birds and fish discovered by UNE and Wells Reserve researchers is a consequence of the cumulative actions taken by these people to sustain the Saco Estuary and the values most important to the people who live work and play in the region.

360 Acres of Tidal Marsh



10 Rare Plants

Three types of tidal marshes --salt, brackish, and freshwater-- occur here. These marshes improve water quality and provide habitat for many kinds of wildlife.

A surprising diversity of plants live in these marshes, including ten species that are rare in Maine and/or nationally.

This research is part of Maine's Sustainability Solutions Initiative, a program of the Senator George J. Mitchell Center, which is supported by National Science Foundation award EPS-0904155 to Maine EPSCoR at the University of Maine.

MollyMaps 2014

A Stewardship Network Sustains the Saco Estuary

60 Fish Species



The Saco River estuary has the highest number of fish species --including adult and larval fish caught in the river and bay -- recorded in any Maine estuary.

133 Bird Species



Nearly half of all bird species in Maine have been observed using the Saco River estuary. Many of the species are not commonly associated with estuaries.

Saco Bay Tackle

Camp Ellis

University of New England

BIRD COMMUNITY OF
THE SACO ESTUARY

TIDAL MARSHES

BY NOAH PERLUT

INTRODUCTION

The Saco estuary separates the towns of Saco and Biddeford, Maine, and includes both tidal salt and tidal fresh marshes. Landscape factors affecting the tidal portion of the river have changed dramatically over the last century, including the closure of large industrial mills in the early 1970s, construction of numerous in-river jetties, and a land-use shift from agriculture to suburban development. To assess the impact of these changes on birds, we established a long-term study of bird diversity and abundance, as well as the ecological processes affecting these factors, in the tidal marshes on the Saco River. The status and composition of the bird diversity for this estuary had never been assessed prior to this study. Therefore, the drivers that affect ecological processes are unknown. The most recent comprehensive avian diversity study was done as a literature review and not field study by the U.S. Department of Agriculture in 1983. The USDA researchers identified 165 species of birds as occurring in the entire 385-square-mile Saco River watershed.

Tidal marsh bird diversity is affected by factors such as marsh size, proportion of invasive plant species, plant diversity, and salinity (Craig and Beal 1992; Shriver 2004; Xiaojing 2009). Here we hypothesize that marsh size and extent of invasion by non-native *Phragmites australis* would explain variation in marsh bird diversity. We studied the 16 small intertidal marshes ranging from tidal fresh to tidal salt (Figure 1). We classified the land cover—open fresh water, mud flat, forest, barren, developed, developed open, agriculture, and vegetated but not forest—within a 100 m buffer around each marsh (see Chapter 8), assessed the plant species diversity (see Chapter 3), and measured salinity (also described in Chapter 10), marsh area, and marsh proximity to the mouth of the river.

STUDY OBJECTIVES—BIRDS

Our objectives for the bird study were to answer these questions related to the tidal marshes of the Saco Estuary:

1. Which species of birds use the tidal marshes of the Saco Estuary?
2. Which bird species of concern use the estuary?
3. What are the landscape factors that influence bird diversity in the estuary?

RESEARCH DESIGN AND METHODS

We conducted 10-minute point counts in May through September 2010–2013 between sunrise and 9:45 a.m. at 16 sites. The 16 sampling sites were located on both the Biddeford and Saco sides of the river and ranged from 562 m (Camp Ellis) to 7,000 m (near Cataract Dam in Biddeford) from the mouth of the river (Figure 1). The average marsh size was 5.58 ha and the average marsh width was 81.2 m (Table 1).

Each bird was classified as less than 50 m, 50–100 m, or more than 100 m from the count site. We counted birds up to 10 m beyond the marsh edge, regardless of surrounding habitat type (Figure 2). The analysis includes only species that explicitly use marshes for some aspect of their life histories, and that were counted within 50 m of the point. The total species count includes all birds counted across all the distance classes.

We first calculated marsh bird diversity at each of the 16 marshes using the Shannon-Wiener Index. We then used these marsh-specific diversity values with an information theoretic approach (Burnham and Anderson 2002) to understand variation in marsh bird diversity. We used this approach to test the effects of plant diversity,



FIGURE 1 Locations of the 16 tidal marsh sites sampled along the Saco River. The center of the circles indicate the point count locations.

TABLE 1 Biotic and abiotic factors used to explain variation in marsh bird diversity in the Saco estuary.

Explanatory factors (range and mean)	
Plant species diversity (species richness):	11 – 35 (mean = 20)
Salinity (ppt):	0.18 – 18.6 (mean = 8.4)
Marsh area (ha):	0.2 – 19.1 (mean = 5.6)
Marsh width (m):	9 – 200 (mean = 81.2)
Distance to the mouth of the river (m):	478 - 7000 (mean = 3410.9)
Total area of marsh occupied by <i>Phragmites australis</i> :	0 - 28.7% (mean = 2.6%)
Percent of surrounding landscape	open, fresh water (0 – 1.2%)
	mudflat (0.3 – 19.5%)
	forest (0 – 67.8%)
	barren (0 – 5%)
	developed open (0 – 28.5%)
	developed (12 – 56.3%)
	agriculture (0 – 24.7%)
vegetated, not forest (0 – 5.3%)	



FIGURE 2 Tidal marshes on the Saco River are small and surrounded by diverse habitat types, increasing the overall diversity of bird species that use the marsh and its edges. We stood at the yellow marker during the point count at this site. Distance values are included to give context to the marsh size and proximity to other land cover types.

salinity, marsh size, marsh width, distance to the mouth of the river, and surrounding landscape characteristics on bird diversity by running a series of single factor, two- and three-way additive, and two-way interactive generalized linear models (Table 1). Competing models were ranked by their corrected (for small sample size) Akaike Information Criterion (AIC_c) values. AIC_c is a second-order correction for AIC computed as $-2(\log \text{likelihood}) - 2(\text{the number of estimated parameters})$. We then calculated Δ for each model, which measures the difference in AIC_c between model l and the best-fitting model and the AIC_c weight (w_l), interpreted as the probability of being the best model in the model set. This allowed us to identify the characteristics that are most likely to affect variation in tidal marsh bird diversity.

RESULTS AND DISCUSSION

We identified 53 marsh bird species and 133 total bird species, representing 40.2% of all bird species known to occur in Maine (Table 2). We identified three state-listed endangered species, one listed threatened species, and 20 listed species of special concern.

The average number of plant species per marsh was 20, although this varied across marshes (Table 1). The land cover surrounding the marshes also varied notably among marshes. The land cover types that varied the most among the marshes included mudflat, forest, developed, developed open, and agriculture. The cover types barren, open fresh water, and vegetated but not forest all showed less variability among sites (Table 1). The non-native plant *Phragmites australis* occupied 0-28.7% (mean = 2.6%) of the marsh plant cover and occurred in six of the 16 marsh study sites.

Variation in marsh bird diversity was best explained by salinity (Table 3; Figure 3) and percent cover of barren land around the marsh (Figure 4). Salinity was in the top three ranking models, which together explained 47% of the variation in marsh bird diversity. Barren was defined as 15% or less vegetative coverage, primarily shrubs and no mature tree species. Barren land cover was in two of the three top ranking models, which together explained 26% of the variation in bird diversity. Marsh size, plant species diversity, extent of invasion by *Phragmites*, marsh width, distance from the mouth of the river, and the proportion of other types of land cover did not explain variation in marsh bird diversity.

Factors Affecting Avian Diversity

Salinity was the most important factor influencing variation in marsh bird diversity in the tidal marshes of the Saco River. This result is particularly interesting in that the river's salinity is likely lower than it was pre-1900, as the numerous rock jetties in the river influence how salt water moves in the tidal portion of the river. Our results contradict other studies that showed marshes should be viewed by managers with caution because the amount of barren land around these study marshes was very low (0-5% of the surrounding landscape). Therefore, it is possible this was a spurious result or that it masked the effects of some other unmeasured variable.

TABLE 2 Bird species identified in the tidal marshes or within 10 m of the marsh edge of the Saco River.

Scientific Name	Common Name	State Listing
<i>Accipiter cooperii</i>	Cooper's Hawk	
<i>Accipiter striatus</i>	Sharp-shinned Hawk	
<i>Actitis macularius</i>	Spotted Sandpiper	
<i>Agelaius phoeniceus</i>	Red-winged Blackbird	
<i>Aix sponsa</i>	Wood Duck	
<i>Ammodramus caudacutus</i>	Saltmarsh Sharp-tailed Sparrow	Species of Special Concern
<i>Ammodramus nelsoni</i>	Nelson's Sharp-tailed Sparrow	Species of Special Concern
<i>Anas clypeata</i>	Northern Shoveler	
<i>Anas platyrhynchos</i>	Mallard	
<i>Anas rubripes</i>	American Black Duck	
<i>Anser anser domesticus</i>	Domestic Goose	
<i>Anthus rubescens</i>	American Pipit	Endangered
<i>Archilochus colubris</i>	Ruby-throated Hummingbird	
<i>Ardea alba</i>	Great Egret	
<i>Ardea herodias</i>	Great Blue Heron	Species of Special Concern
<i>Baeolophus bicolor</i>	Eastern Tufted Titmouse	
<i>Bombycilla cedrorum</i>	Cedar Waxwing	
<i>Branta canadensis</i>	Canada Goose	
<i>Buteo jamaicensis</i>	Red-tailed Hawk	
<i>Buteo platypterus</i>	Broad-winged Hawk	
<i>Butorides virescens</i>	Green Heron	
<i>Calidris fuscicollis</i>	White-rumped Sandpiper	
<i>Calidris maritima</i>	Purple Sandpiper	
<i>Calidris minutilla</i>	Least Sandpiper	
<i>Calidris pusilla</i>	Semipalmated Sandpiper	Species of Special Concern
<i>Cardellina pusilla</i>	Wilson's Warbler	
<i>Cardinalis cardinalis</i>	Northern Cardinal	
<i>Cathartes aura</i>	Turkey Vulture	
<i>Catharus ustulatus</i>	Swainson's Thrush	
<i>Chaetura pelagica</i>	Chimney Swift	Species of Special Concern
<i>Charadrius semipalmatus</i>	Semipalmated Plover	
<i>Charadrius vociferus</i>	Killdeer	
<i>Chroicocephalus philadelphia</i>	Bonaparte's Gull	Species of Special Concern
<i>Circus cyaneus</i>	Northern Harrier	Species of Special Concern
<i>Cistothorus palustris</i>	Marsh Wren	
<i>Colaptes auratus</i>	Northern Flicker	
<i>Columba livia</i>	Rock Pigeon	
<i>Corvus brachyrhynchos</i>	American Crow	

(continued)

TABLE 2 (Continued)

Scientific Name	Common Name	State Listing
<i>Corvus ossifragus</i>	Fish Crow	
<i>Cyanocitta cristata</i>	Blue Jay	
<i>Dendroica caerulescens</i>	Black-throated Blue Warbler	
<i>Dendroica pensylvanica</i>	Chestnut-sided Warbler	Species of Special Concern
<i>Dendroica striata</i>	Blackpoll Warbler	
<i>Dendroica virens</i>	Black-throated Green Warbler	
<i>Dolichonyx oryzivorus</i>	Bobolink	
<i>Dryocopus pileatus</i>	Pileated Woodpecker	
<i>Dumetella carolinensis</i>	Gray Catbird	
<i>Egretta caerulea</i>	Little Blue Heron	
<i>Egretta thula</i>	Snowy Egret	
<i>Empidonax alnorum</i>	Alder Flycatcher	
<i>Empidonax traillii</i>	Willow Flycatcher	
<i>Empidonax vireescens</i>	Acadian Flycatcher	
<i>Falco peregrinus</i>	Peregrine Falcon	Endangered
<i>Gallinago delicata</i>	Wilson's Snipe	
<i>Gavia immer</i>	Common Loon	
<i>Geothlypis trichas</i>	Common Yellowthroat	
<i>Haemorhous mexicanus</i>	House Finch	
<i>Haemorhous purpureus</i>	Purple Finch	
<i>Haliaeetus leucocephalus</i>	Bald Eagle	Species of Special Concern
<i>Hirundo rustica</i>	Barn Swallow	Species of Special Concern
<i>Hylocichla mustelina</i>	Wood Thrush	Species of Special Concern
<i>Icterus galbula</i>	Baltimore Oriole	
<i>Icterus spurius</i>	Orchard Oriole	Species of Special Concern
<i>Larus argentatus</i>	Herring Gull	
<i>Larus delawarensis</i>	Ring-billed Gull	
<i>Larus marinus</i>	Great Black-backed Gull	
<i>Limnodromus griseus</i>	Short-billed Dowitcher	
<i>Megaceryle alcyon</i>	Belted Kingfisher	
<i>Melanerpes carolinus</i>	Red-bellied Woodpecker	
<i>Melanitta fusca</i>	White-winged Scoter	
<i>Meleagris gallopavo</i>	Wild Turkey	
<i>Melospiza georgiana</i>	Swamp Sparrow	
<i>Melospiza melodia</i>	Song Sparrow	
<i>Mergus merganser</i>	Common Merganser	
<i>Mimus polyglottos</i>	Northern Mockingbird	

Scientific Name	Common Name	State Listing
<i>Mniotilta varia</i>	Black-and-white Warbler	Species of Special Concern
<i>Molothrus ater</i>	Brown-headed Cowbird	
<i>Myiarchus crinitus</i>	Great Crested Flycatcher	
<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	Threatened
<i>Oreothlypis ruficapilla</i>	Nashville Warbler	
<i>Pandion haliaetus</i>	Osprey	
<i>Parkesia noveboracensis</i>	Northern Waterthrush	
<i>Passer domesticus</i>	House Sparrow	
<i>Passerculus sandwichensis</i>	Savannah Sparrow	
<i>Phalacrocorax auritus</i>	Double-crested Cormorant	
<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak	
<i>Picoides pubescens</i>	Downy Woodpecker	
<i>Picoides villosus</i>	Hairy woodpecker	
<i>Plegadis falcinellus</i>	Glossy Ibis	
<i>Pluvialis squatarola</i>	Black-bellied Plover	
<i>Poecile atricapillus</i>	Black-capped Chickadee	
<i>Porzana carolina</i>	Sora	
<i>Quiscalus quiscula</i>	Common Grackle	
<i>Rallus limicola</i>	Virginia Rail	
<i>Rallus longirostris</i>	Clapper Rail	
<i>Regulus calendula</i>	Ruby-crowned Kinglet	
<i>Regulus satrapa</i>	Golden-crowned Kinglet	
<i>Riparia riparia</i>	Bank Swallow	
<i>Sayornis phoebe</i>	Eastern Phoebe	
<i>Seiurus aurocapilla</i>	Ovenbird	
<i>Setophaga coronata</i>	Yellow-rumped Warbler	
<i>Setophaga magnolia</i>	Magnolia Warbler	
<i>Setophaga petechia</i>	Yellow Warbler	
<i>Setophaga pinus</i>	Pine Warbler	
<i>Setophaga ruticilla</i>	American Redstart	Species of Special Concern
<i>Sialia sialis</i>	Eastern Bluebird	
<i>Sitta canadensis</i>	Red-breasted Nuthatch	
<i>Sitta carolinensis</i>	White-breasted Nuthatch	
<i>Somateria mollissima</i>	Common Eider	
<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker	
<i>Spinus tristis</i>	American Goldfinch	
<i>Spizella passerina</i>	Chipping Sparrow	

(continued)

TABLE 2 (Continued)

Scientific Name	Common Name	State Listing
<i>Stelgidopteryx serripennis</i>	Northern Rough-winged Swallow	Species of Special Concern
<i>Sterna hirundo</i>	Common Tern	Species of Special Concern
<i>Sternula antillarum</i>	Least Tern	Endangered
<i>Sturnus vulgaris</i>	European Starling	
<i>Tachycineta bicolor</i>	Tree Swallow	Species of Special Concern
<i>Thryothorus ludovicianus</i>	Carolina Wren	
<i>Toxostoma rufum</i>	Brown Thrasher	Species of Special Concern
<i>Tringa flavipes</i>	Lesser Yellowlegs	Species of Special Concern
<i>Tringa melanoleuca</i>	Greater Yellowlegs	
<i>Tringa semipalmata</i>	Willet	
<i>Tringa solitaria</i>	Solitary Sandpiper	
<i>Troglodytes aedon</i>	House Wren	
<i>Turdus migratorius</i>	American Robin	
<i>Tyrannus tyrannus</i>	Eastern Kingbird	Species of Special Concern
<i>Vireo gilvus</i>	Warbling Vireo	
<i>Vireo olivaceus</i>	Red-eyed Vireo	
<i>Vireo solitarius</i>	Blue-headed Vireo	
<i>Zenaida macroura</i>	Mourning Dove	
<i>Zonotrichia albicollis</i>	White-throated Sparrow	
<i>Zonotrichia leucophrys</i>	White-crowned Sparrow	

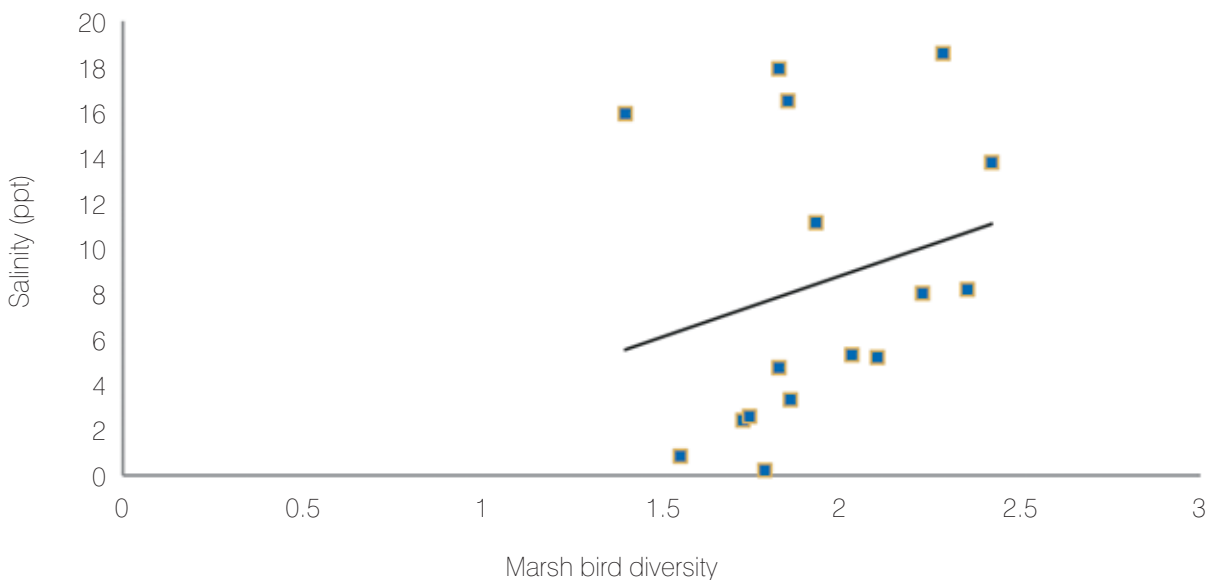


FIGURE 3 Marsh bird diversity was positively associated with increasing salinity in the Saco River.

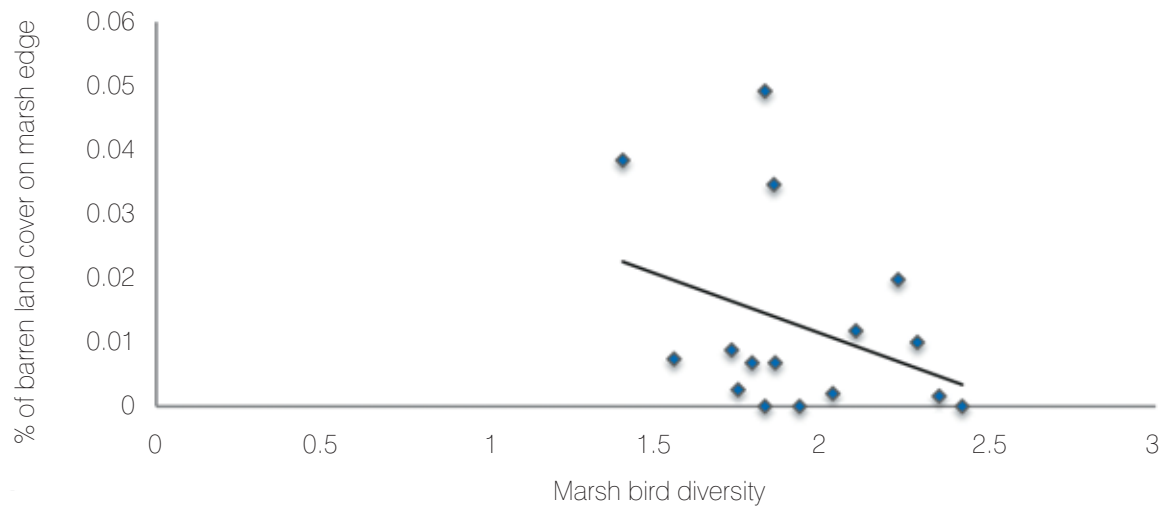


FIGURE 4 Marsh bird diversity was negatively associated with the percent of barren land on the surrounding edges. Barren land is defined as 15% vegetative coverage, primarily shrubs and no mature tree species.

TABLE 3 Models including the additive or interactive effects of salinity and barren land explained 26% of the variation (Δ) in marsh bird diversity. Models with $\Delta_1 < 2$ were considered to have substantial support in explaining variation in the data; only models with $\Delta_1 < 5$ are shown.

Model	AIC _c	Δ	Δ
Salinity + Barren	6.35	0.00	0.18
Salinity*Open Water (fresh)	7.42	1.07	0.11
Salinity*Barren	8.02	1.66	0.08
Vegetated (Not Forest)	9.02	2.67	0.05
Null (no variables)	9.13	2.77	0.04
Marsh Area + Vegetated (Not Forest)	9.76	3.41	0.03
Barren	10.08	3.72	0.03
Salinity*Vegetated (Not Forest)	10.49	4.14	0.02
Plants*Vegetated (Not Forest)	10.50	4.15	0.02
Open Water (Fresh)	10.53	4.18	0.02
Developed	10.64	4.29	0.02
Forest	10.65	4.30	0.02
Marsh Area*Open Water (Fresh)	10.81	4.46	0.02
Mudflat	10.85	4.50	0.02
Distance to Mouth	11.12	4.76	0.02
Salinity	11.24	4.88	0.02

These small marshes provided critical foraging habitat for a diverse suite of species. Many of the birds counted in the marsh during the breeding season use other types of habitats for breeding, but traveled to these marshes to forage (Table 3). Nonetheless, the marshes do provide breeding habitat for both common and species of conservation concern. For example, Nelson's sharp-tailed sparrow, a species listed as of Special Concern by the State of Maine, bred in three and was counted in four of the 16 marshes. This is notable because these marshes were all substantially smaller than the published home range size of an individual pair (Shriver et al. 2010), suggesting these marshes may be high quality, particularly for habitat-limited species. Because the foraging behavior of marsh birds varies dramatically between species—from birds that hunt insects in the air, such as the tree swallow, to those that probe for insects in the mud and shallow water, such as the Virginia rail—the factors that may make these marshes high quality are diverse. Nonetheless, the marshes likely offer a rich variety of food types, as evidenced by the diversity of birds (see Chapter 6). Finally, Shriver et al. (2004) found that species richness of salt marsh birds in the Gulf of Maine was particularly sensitive to human-developed landscapes surrounding marshes. Human development of land varied across the study sites. However, our results, although at notably smaller scale, indicate that human development of land likely does not have a major influence on marsh bird diversity in the Saco estuary.



FIGURE 5 Birding in the marsh, early morning.



FIGURE 6 Great egret.

CONCLUSIONS

We made the following conclusions from our study of the bird community in the Saco estuary's tidal marshes:

- The total number of bird species observed was 133, representing 40.2% of all species known to occur in Maine.
- A total of 20 of these birds are listed as species of special concern, 1 as threatened, and 3 as endangered in the State of Maine.
- Nelson's sharp-tailed sparrow, a species listed as of special concern by the State of Maine, uses the marshes for breeding and foraging.
- Salinity was the most important factor influencing variation in marsh bird diversity in the tidal marshes of the Saco River.
- Marsh size, extent of invasion by *Phragmites australis*, and shoreline development were not important factors influencing marsh bird diversity.

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