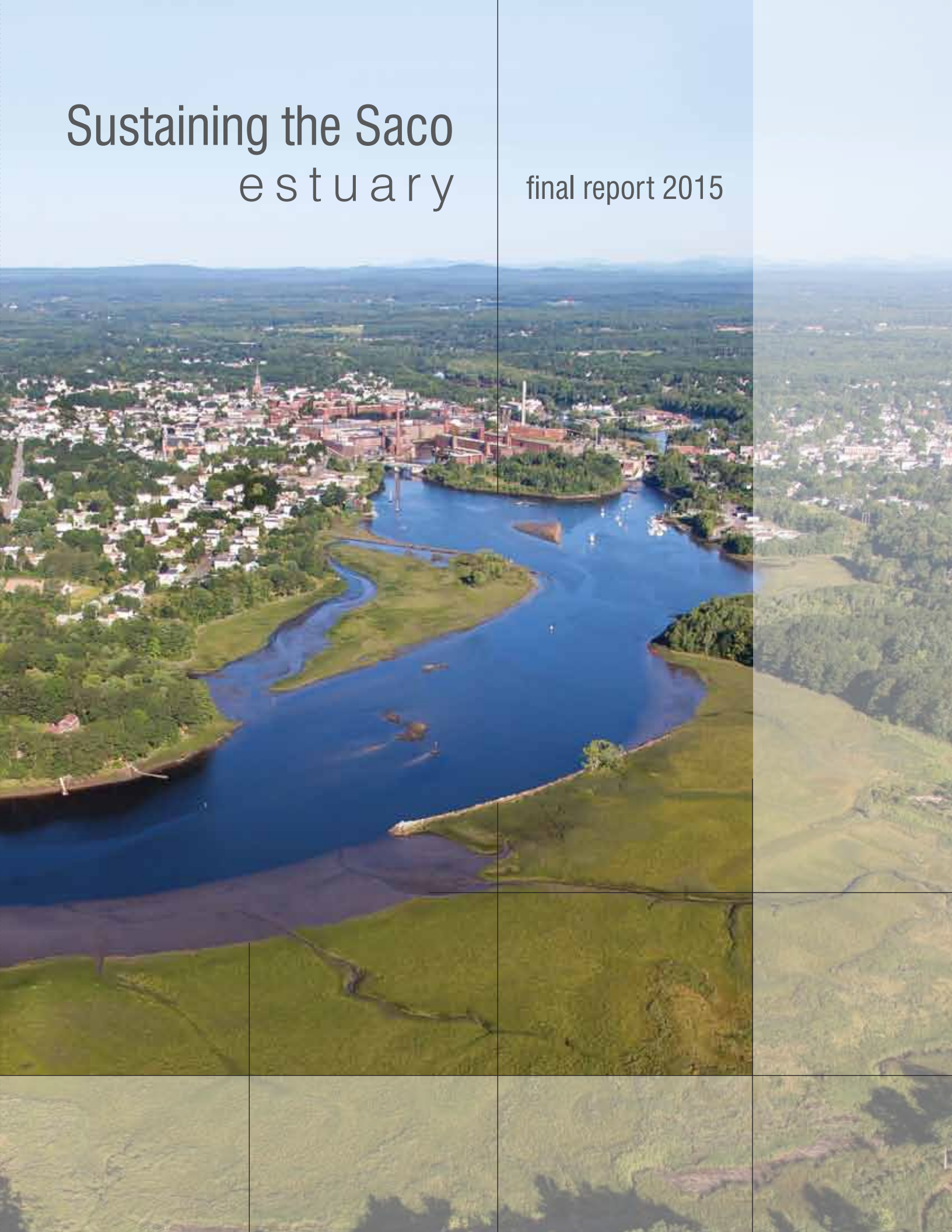
Sustaining the Saco estuary

final report 2015



Sustaining the Saco estuary

final report 2015

Project Leaders

Christine B. Feurt, Ph.D.
University of New England and
Wells National Estuarine Research Reserve
Tel: (207) 602-2834
Email: cfeurt@une.edu

Pamela A. Morgan, Ph.D.
University of New England
Tel: (207) 602-2227
Email: pmorgan@une.edu

Project Team

University of New England

Mark Adams, Ph.D.
Anna Bass, Ph.D.
Carrie Byron, Ph.D.
Michael Daley, Ph.D.
Michael Esty
Noah Perlut, Ph.D.
Michele Steen-Adams, Ph.D.
James Sulikowski, Ph.D.
Stephan I. Zeeman, Ph.D.

Wells National Estuarine Research Reserve

Jacob Aman
Michele Dionne, Ph.D.
Jeremy Miller
Kristin Wilson, Ph.D.

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.

Report Editing and Design: Waterview Consulting

CONTENTS

CHAPTER 1 INTRODUCTION: Why Is the Saco Estuary an Ideal Living Laboratory for Sustainability Science? 1
by Christine B. Feurt and Pamela A. Morgan

CHAPTER 2 RECOGNIZING AND ENGAGING THE STEWARDSHIP NETWORK: Actively Working to Sustain the Saco Estuary 7
by Christine B. Feurt

CHAPTER 3 PLANTS OF THE SACO ESTUARY: Tidal Marshes 17
by Pam Morgan

CHAPTER 4 BENTHIC MACROINVERTEBRATES OF THE SACO ESTUARY: Tidal Flats and Low Marsh Habitats 29
by Anna L. Bass

CHAPTER 5 FISH OF THE SACO ESTUARY: River Channel and Tidal Marshes 39
by Kayla Smith, Kristin Wilson, James Sulikowski, and Jacob Aman

CHAPTER 6 BIRD COMMUNITY OF THE SACO ESTUARY: Tidal Marshes 57
by Noah Perlut

CHAPTER 7 FOOD WEB OF THE SACO ESTUARY'S TIDAL MARSHES 69
by Carrie Byron

CHAPTER 8 LAND USE AND LAND COVER ALONG THE SACO ESTUARY'S SHORELINE 81
by Mark Adams

CHAPTER 9 SEA LEVEL RISE AND THE SACO ESTUARY: Tidal Marshes 105
by Michael Esty

CHAPTER 10 WATER QUALITY IN THE SACO RIVER 113
by Stephan I. Zeeman and Tyler Spillane

CHAPTER 6

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

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 *Phragmites australis*: 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.

diversity, 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 likelihood) $-$ 2(the number of estimated parameters). We then calculated Δ for each model, which measures the difference in AIC_c between model *I* and the best-fitting model and the AIC_c weight (w_i), 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 ag riculture. 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 mar 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
Accipiter cooperii	Cooper's Hawk	
Accipiter striatus	Sharp-shinned Hawk	
Actitis macularius	Spotted Sandpiper	
Agelaius phoeniceus	Red-winged Blackbird	
Aix sponsa	Wood Duck	
Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow	Species of Special Concern
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	Species of Special Concern
Anas clypeata	Northern Shoveler	
Anas platyrhynchos	Mallard	
Anas rubripes	American Black Duck	
Anser anser domesticus	Domestic Goose	
Anthus rubescens	American Pipit	Endangered
Archilochus colubris	Ruby-throated Hummingbird	
Ardea alba	Great Egret	
Ardea herodias	Great Blue Heron	Species of Special Concern
Baeolophus bicolor	Eastern Tufted Titmouse	
Bombycilla cedrorum	Cedar Waxwing	
Branta canadensis	Canada Goose	
Buteo jamaicensis	Red-tailed Hawk	
Buteo platypterus	Broad-winged Hawk	
Butorides virescens	Green Heron	
Calidris fuscicollis	White-rumped Sandpiper	
Calidris maritima	Purple Sandpiper	
Calidris minutilla	Least Sandpiper	
Calidris pusilla	Semipalmated Sandpiper	Species of Special Concern
Cardellina pusilla	Wilson's Warbler	
Cardinalis cardinalis	Northern Cardinal	
Cathartes aura	Turkey Vulture	
Catharus ustulatus	Swainson's Thrush	
Chaetura pelagica	Chimney Swift	Species of Special Concern
Charadrius semipalmatus	Semipalmated Plover	
Charadrius vociferus	Killdeer	
Chroicocephalus philadelphia	Bonaparte's Gull	Species of Special Concern
Circus cyaneus	Northern Harrier	Species of Special Concern
Cistothorus palustris	Marsh Wren	
Colaptes auratus	Northern Flicker	
Columba livia	Rock Pigeon	
Corvus brachyrhynchos	American Crow	

(continued)

TABLE 2 *(Continued)*

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

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

(continued)

TABLE 2 *(Continued)*

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

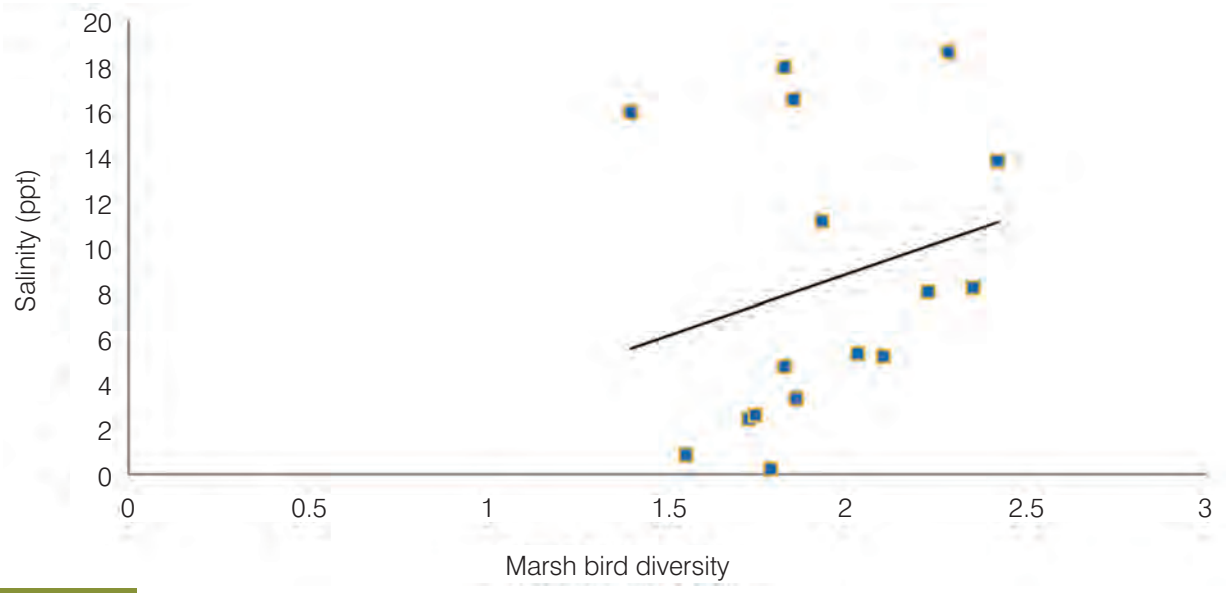


FIGURE 3 Marsh bird diversity was positively associated with increasing salinity in the Saco River.

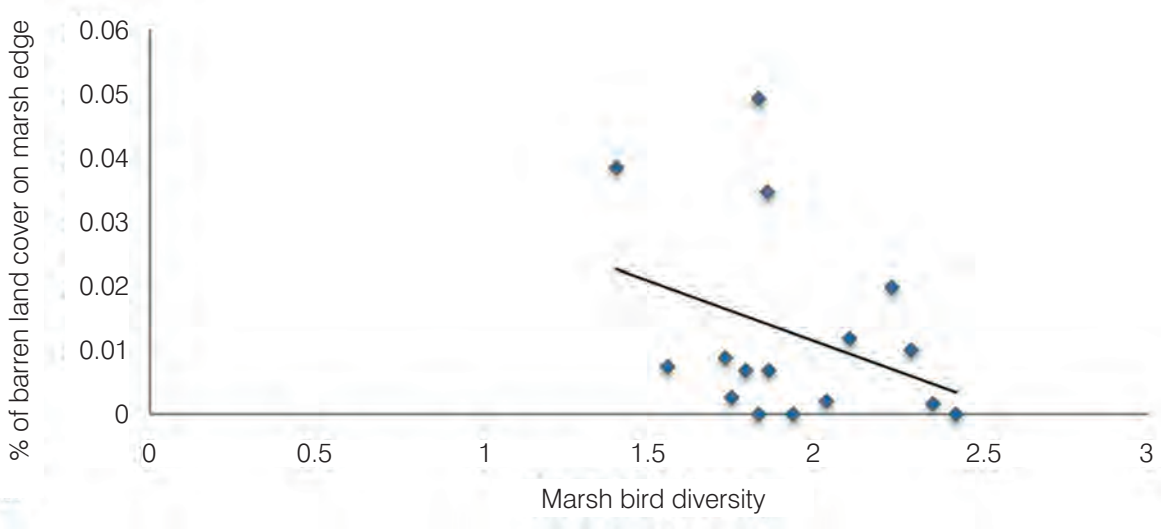


FIGURE 4 Marsh bird diversity was negatively associated with the percent of barren land on the surrounding edges. Barren land is defined as 15% vegetative coverage, primarily shrubs and no mature tree species.

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

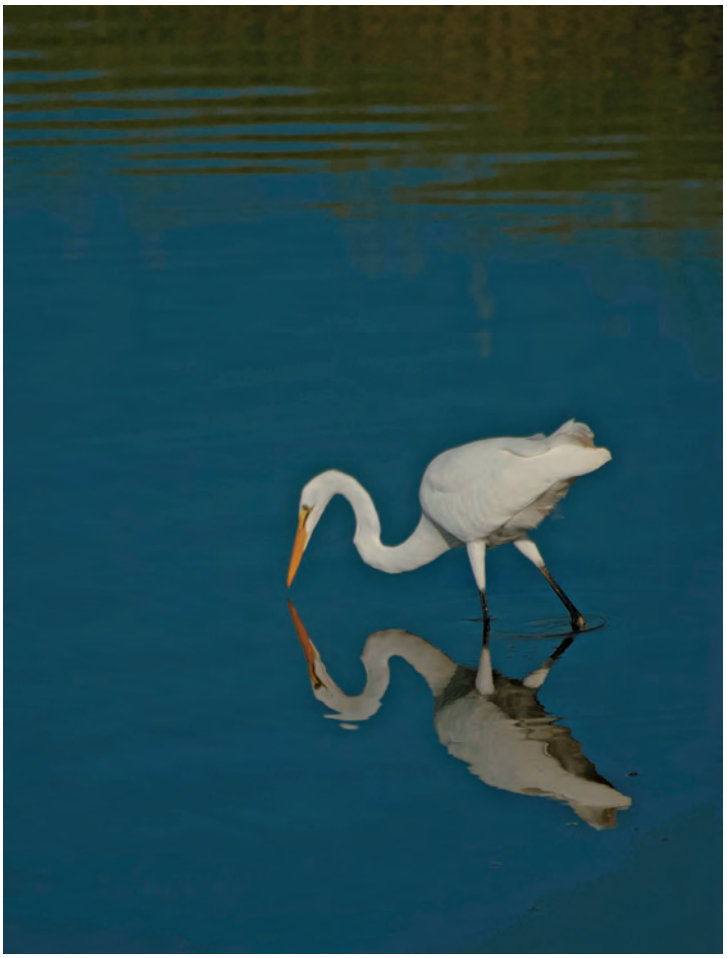


FIGURE 6 Great egret.

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.

ACKNOWLEDGEMENTS

Undergraduate students: Will Almeida, Danielle Behn, Chloe Crettien, Sarah Cowles, Chris Dracoules, Cory French, Gale Loescher, Shane Murphy. Thanks also to Biddeford and Saco landowners who allowed us access to the marshes across their property.

LITERATURE CITED

Burnham, K.P. and D.R. Anderson. 2002. Model selection and multimodel inference. Second edition. Springer, New York, New York, USA.

Craig, R. and K. Beal. 1992. The influence of habitat variables on marsh bird communities of the Connecticut River estuary. *Wilson Bulletin* 104:295-311.

Shriver, W.G., T.P. Hodgman, J. Gibbs, and P.D. Vickery. 2004. Landscape context influences salt marsh bird diversity and area requirements in New England. *Biological Conservation* 119:545-553.

Shriver, W.G., T.P. Hodgman, J.P. Gibbs, and P.D. Vickery. 2010. Home range sizes and habitat use of Nelson's and Saltmarsh sparrows. *The Wilson Journal of Ornithology* 122:340-345.

Xiaojing, G., Y. Cai, and C. Choi. 2009. Potential impacts of invasive *Spartina alterniflora* on spring bird communities at Chongming Dongtan, a Chinese wetland of international importance. *Estuarine, Coastal and Shelf Science* 83:211-218.