Bird Use of Restoration and Reference Marshes Within the Barn Island Wildlife Management Area, Stonington, Connecticut, USA

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ABSTRACT / Tidal marshes have been actively restored in Connecticut for nearly 20 years, but evaluations of these projects are typically based solely on observations of vegetation change. A formerly impounded valley marsh at the Barn Island Wildlife Management Area is a notable exception: previous research at this site has also included assessments of primary productivity, macroinvertebrates, and use by fishes. To determine the effects of marsh restoration on higher trophic levels, we monitored bird use at five sites within the Barn Island complex, including both restoration and reference marshes. Use by summer bird populations within fixed plots was monitored over two years at all sites. Our principal focus was Impoundment One, a previously impounded valley marsh reopened to full tidal exchange in 1982. This restoration site supported a greater abundance of wetland birds than our other sites, indicating that it is at least equivalent to reference marshes within the same system for this ecological function. Moreover, the species richness of birds and their frequency of occurrence at Impoundment One was greater than at 11 other estuarine marshes in southeastern Connecticut surveyed in a related investigation. A second marsh, under restoration for approximately ten years, appears to be developing in a similar fashion. These results complement previous studies on vegetation, macroinvertebrates, and fish use in this system to show that over time, the reintroduction of tidal flooding can effectively restore important ecological functions to previously impounded tidal marshes.

Tidal marsh estuarine communities are recognized as being among the most biologically productive ecosystems in the world (De la cruz 1973; Bertness 1992). Tidal marshes generate vast quantities of vascular plant biomass that contribute to the detrital food chain, while the associated estuaries serve as spawning and feeding grounds for approximately two thirds of the commercially important finfish and shellfish harvested along the Atlantic coast (Dugan 1993). Coastal wetlands also support a rich diversity of terrestrial wildlife and provide valuable breeding and foraging habitat for numerous species of shorebirds, passerines, waterfowl, and colonial waterbirds (Howe 1987). In addition, many birds that breed in the Arctic or prairies either overwinter in coastal waters or use tidal marshes as stopover areas in which to rest and feed during annual migrations.

Despite these important environmental functions, a substantial portion of the tidal wetlands that once existed in the United States have been destroyed since European colonization (Tiner 1984). It has been estimated that 30% of Connecticut's tidal marshes have been lost over the last 90 years (Rozsa 1995). Those marsh systems that have not been severely impacted by dredging or filling have been altered to some degree by ditching for mosquito control, agriculture, or waterfowl management. A more subtle anthropogenic impact has been the restriction of normal tidal exchange in coastal marshes due to the construction of roads, bridges, causeways and impoundment dikes (Niering and Warren 1980; Roman and others 1984, Barrett and Niering 1993). Restriction of normal tidal flow typically results in reduction in soil water salinity, lowering of the water table, and replacement of typical salt marsh vegetation with tall perennial reeds and grasses such as *Phragmites australis* or *Typha angustifolia* (Roman and others 1984).

In response to the alarming rate of tidal wetland destruction in the northeastern United States, Connecticut adopted the Tidal Wetlands Act in 1969 (Connecticut General Statues 22a-28 to 22a-35), creating a regulatory program that only permits activities that result in tidal wetland preservation. In addition, the Coastal Management Act of 1980 (C.G.S. 22a-90 to 22a-112) specifically encourages the rehabilitation and restoration of degraded tidal wetlands. Permanent restrictions to tidal exchange were removed from many coastal

KEY WORDS: Estuarine; Tidal marsh, Wetland birds, Restoration

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marshes when the Connecticut Department of Environmental Protection began implementing this policy in the early 1980s (Rozsa 1995).

Although restoration work has been conducted in coastal wetlands throughout the northeastern United States for nearly 20 years, comprehensive evaluations of the success of these projects are rare (Shisler 1990, Mitch and Gosselink 1993, Peck and others 1994). The most thorough evaluation of tidal marsh restoration in Connecticut has focused on a previously impounded valley marsh at the Barn Island Wildlife Management Area in Stonington, where a series of scientific studies has documented changes in the vegetation (Sinicrope and others 1990, Barrett and Niering 1993), macroinvertebrates (Fell and others 1991, Peck and others 1994), and fish populations (Allen and others 1994) following the reestablishment of tidal flooding. To date, however, no studies have focused on the status of higher trophic levels at this restoration site.

Shortly after its acquisition by the State of Connecticut in 1946–1947, impoundment dikes were constructed across four of five valley marshes at Barn Island to restore waterfowl habitat lost when the system was ditched for mosquito control in the 1930s. The restriction of tidal exchange in the impounded marshes resulted in the replacement of the existing *Spartina*-dominated vegetation by nearly monotypic stands of *T. angustifolia* and *P. australis* (Sinicrope and others 1990, Barrett and Niering 1993). In 1978 the Connecticut Department of Environmental Protection installed a 1.5-m-diameter culvert at the westernmost impoundment (Impoundment One) in an attempt to raise salinity levels and control the spread of *P. australis*. In 1982, a second, larger (2.1-m) culvert was installed to fully restore tidal exchange.

Previous research indicates that plant, invertebrate, and fish communities characteristic of tidal salt marshes are becoming reestablished at this restoration site. The objective of this study was to determine whether Imponndment One is functionally equivalent to other marshes within the Barn Island wetland complex in terms of bird use.

Study Site

Situated on the north shore of Little Narragansett Bay in Stonington, Connecticut, USA, the Barn Island Wildlife Management Area is bordered to the east by the Pawcatuck River and to the west by Wequetequock Cove (Figure 1). Barn Island consists of undeveloped forested uplands and an ≈1.5-km^2 complex of wetlands known historically as the Wequetequock–Pawcatuck tidal marshes (Miller and Egler 1950). The mean tidal range in Little Narragansett Bay is 0.82 m and summer salinity ranges between 28‰ and 32‰ (Sinicrope and others 1990).

Five distinct areas within the Barn Island tidal wetland complex were sampled during this study. Weqnetequock Cove (WC), a 1.2-ha bayfront marsh separated from the rest of the system by an asphalt parking area/boat launch, is the only nnditched marsh at Barn Island. This small fringe of high marsh still exhibits the bayfront-to-upland vegetation pattern described by Miller and Egler (1950). Headquarters (HQ) is an 8-ha bayfront marsh that is dominated by short *S. alterniflora* and forbs (Warren and Niering 1993). Impoundment One (IP1) is a 21-ha, previously impounded valley marsh restored to full tidal exchange in 1982. Short *S. alterniflora* is the most abundant species recolonizing this marsh (Sinicrope and others 1990). Impoundment Three (IP3) is a 12-ha, previously impounded valley marsh tbat has been under restoration for approximately 10 years. Davis marsh (DS), a 19-ha valley marsh that has never been impounded, is in private ownership, and has been mowed for salt marsh hay with varying degrees of iutensity for over 300 years (Mitchell 1992). Substantial vegetation change over the last four decades at both HQ and DS has been primarily attributed to an imbalance between the rate of relative sea-level rise and vertical marsh accretion (Warren and Niering 1993).

Methods

In each marsh, one 25-m × 100-m plot was situated perpendicular to the shoreline and extending approximately 5-m beyond the limit of low marsh vegetation into the associated creek or bayfront. Bird censuses were conducted eight times in each plot (three to five times per year) between July and August 1993 and May and July 1994. The location and behavior of all birds seen or heard within the plot were recorded during 30-min surveys. Birds feeding in the air above the plot were also recorded, but transient individuals passing over the plot were not. To flush hirds that were not readily visible, the observer(s) walked diagonally across the plot during the census. Study sites were sampled between 0:600 and 19:00 h at least once during each of the following four tidal stages; low (slack low tide: ±1.5 h); flood (low tide: +1.5–4 h); high (slack high tide: ±1.5 h); and ebb (slack high tide: +1.5–4 h).

Birds recorded during the surveys were divided into four groups: marsh specialists, long-legged waders, shorebirds, and marsh generalists. Marsh specialists (willet, marsh wren, saltmarsh sharp-tailed sparrow, and seaside sparrow) are species that breed in tidal wetlands and inhahit these marshes exclusively during the breeding

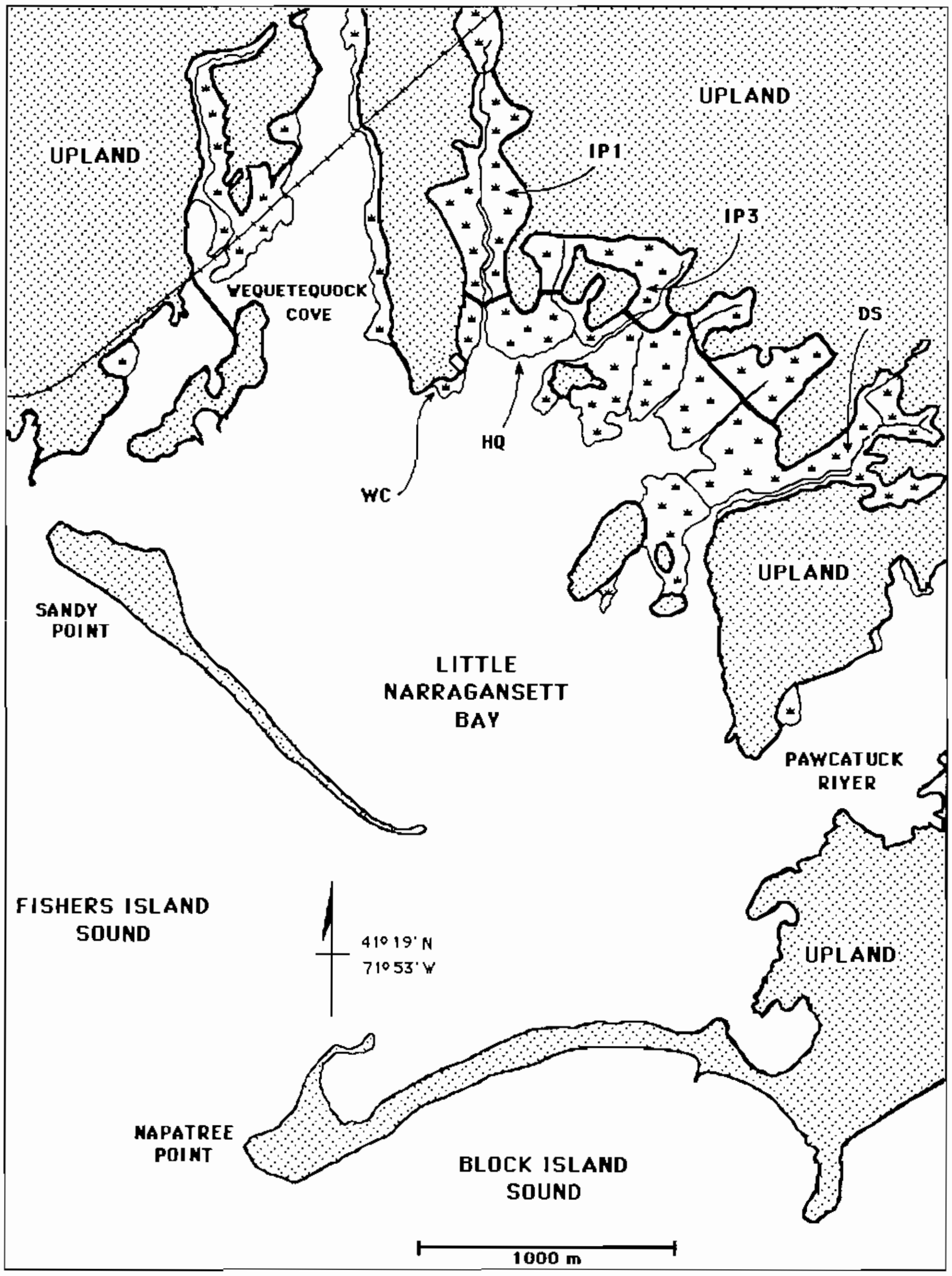

Figure 1. Location of five study sites at the Barn Island Wildlife Management Area in Stonington, Connecticut. Abbreviations for study sites are: DS, Davis; HQ, Headquarters; IP1, Impoundment One; IP3, Impoundment Three; and WC, Wequetequock Cove.

season (see Table 1 below for scientific names). Long-legged waders (great blue heron, great and snowy egrets, and glossy ibis) forage extensively in open-water marsh habitats (e.g., tidal pools, pans, mud flats, and mosquito ditches) but breed colonially on coastal islands and, less commonly, in uplands. Shorebirds include killdeer, greater and lesser yellowlegs, and least, semipalmated, spotted and Baird's sandpipers. Most of these species breed in the arctic but forage in New England marshes during migration in spring and late summer. Marsh generalists are widely distributed species that breed in grasslands, thickets, and forest-edge communities as well as the upper border of tidal wetlands. This group consists of song sparrows and red-winged blackbirds. In addition, some of the species recorded do not belong to any of these four groups. Except for tree and barn swallows, which form large post-breeding flocks and can be extremely abundant in coastal marshes in late summer, these additional species were included in comparisons of the total number of individuals recorded per site.

The dominant vegetation in each plot was estimated quantitatively using three parallel 100-m transects; two ran lengthwise along the outer edges of the plot and one through the center. The percentage cover of the dominant angiosperms was estimated visually (to the nearest 10%) for each species within a 0.4-m-diameter circle at 5-m intervals along each of the transects. The mean of the cover estimates for each species was used as a measure of dominance. The frequency of occurrence, or percentage of sample points in which a species occurred, was also determined for each of the dominant plant species. Points on the transects located in the intertidal waters below the zone of tall *S. alterniflora* were not included in these averages. Persistent open water, salt pans, and mosquito ditches on the high marsh, however, were included in the total cover estimates. Vegetation sampling was conducted in July and August 1994.

One-way analysis of variance was used to compare the abundance of birds in each group at the five sites. Student-Newman-Keuls tests were performed to determine whether pairs of sites were significantly different. To assess differences in the diversity of marsh specialists at the five sites, we calculated the Shannon-Wiener diversity index:

$$H' = -\sum_{i=1}^{k} p_i \log p_i$$

where p_i is the proportion of individual birds that belong to species i, and k is the number of species (Zar 1996). Analysis of variance was used to determine whether the diversity indices differed among sites.

Results

Bird Use

A total of 456 individuals and 28 bird species were detected during this study. Of the 28 species, 4 were marsh specialists, 4 were long-legged waders, 7 were shorebirds, 2 were marsh generalists, and 11 were species not included in these categories. Between 8 and 12 species were recorded at each of the five sites, witb the greatest species richness (12 species) occurring at the two restoration marshes (Tahle 1). The average number of individuals recorded per visit (excluding tree and barn swallows) ranged from 1.0 at Davis marsh to 11.6 at Impoundment One. Use of the five sites by marsh specialists, waders, shorebirds, and marsh generalists differed greatly (Figure 2).

Differences in the abundance of marsh specialists at the five sites were highly significant ($F = 6.4$; $df = 4, 35$; $P = 0.0005$), primarily due to the large number of saltmarsh sharp-tailed sparrows (hereafter referred to as sharp-tailed sparrow) recorded at Wequetequock Cove (Figure 3). Marsh specialists were significantly more abundant at Wequetequock Cove than at all other sites except Impoundment One (Student-Newman-Keuls test, $P < 0.05$). The diversity indices for marsh specialists at the five sites were also significantly different ($F = 3.97$; $df = 4, 35$; $P = 0.01$). The average diversity of marsh specialists per visit was highest at Headquarters (0.142), followed hy Impoundment One (0.141) and Wequetequock Cove (0.031). Multiple-range comparisons indicate that the diversity indices for the two most diverse sites, Headquarters and Impoundment One, did not differ significantly, but both were significantly more diverse than the other three sites (Tukey test, $P < 0.05$).

Shorehirds, particularly least and semipalmated sandpipers, were more abundant at Headquarters and Impoundment One than at the other three sites (Figure 3). Long-legged waders were most abundant at Impoundment One, but were widely distributed and moved frequently among foraging areas. Red-winged hlackbirds, which are marsh generalists, were most abundant at Impoundment Three. The differences in abundance for long-legged waders, shorebirds, and marsh generalists at the five sites were not significant, bowever.

Vegetation

The five areas chosen for this investigation are *Spartina*-dominated tidal marsh characterized by typical salt marsh vegetation (Table 2). The Wequetequock Cove marsh is unditched and relatively dry. The sample plot is representative of these conditions and is dominated by the high marsh graminoids *S. patens*, *Distichlis spicata*, and *Juncus gerardii*. The only low marsh vegetation is a narrow belt of tall *S. alterniflora* along the bayfront. Small clumps of *Iva frutescens* are scattered throughout the marsh at higher elevations, and several dense clones of *P. australis* line the upper border of the marsh.

The vegetation at Headquarters and Davis marshes reflect somewhat wetter site conditions and are complex mosaics of *S. patens* and short *S. alterniflora* intermixed with *D. spicata*, *J. gerardii*, and forbs. The Headquarters site is distinctive due to the high contribution of forbs to the total plant cover. The mosquito ditches, which have not been maintained at Barn Island since

Table 1. Abundance of birds (average number of individuals per visit) in five study sites at Barn Island Wildlife Management Area, Stonington, Connecticut

Species	Site[a] DS	HQ	IP1	IP3	WC
Marsh specialists					
Willet (*Catoptrophorus semipalmatus*)[b]	—	1.4	—	—	—
Marsh wren (*Cistothorus palustris*)	—	—	—	—	0.3
Saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*)[c]	0.4	1.1	2.4	0.3	8.3
Seaside sparrow (*Ammodramus maritimus*)[c]	—	—	2.8	—	—
Long-legged waders					
Great blue heron (*Ardea herodias*)[c]	0.1	—	—	—	—
Great egret (*Ardea alba*)[b]	—	—	—	0.1	—
Snowy egret (*Egretta thula*)[b]	—	—	0.1	—	—
Glossy ibis (*Plegadis falcinellus*)[c]	—	—	0.5	—	—
Shorebirds[d]					
Killdeer (*Charadrius vociferus*)	—	—	0.1	0.1	—
Greater yellowlegs (*Tringa melanoleuca*)	—	—	0.1	—	—
Lesser yellowlegs (*Tringa flavipes*)	—	—	1.3	—	—
Spotted sandpiper (*Actitis macularia*)	—	—	—	0.1	—
Semipalmated sandpiper (*Calidris pusilla*)	—	1.1	0.1	0.1	—
Least sandpiper (*Calidris minutilla*)	—	2.9	3.3	1.8	—
Baird's sandpiper (*Calidris bairdii*)	—	—	—	0.3	—
Marsh generalists					
Song sparrow (*Melospiza melodia*)	—	—	—	0.4	0.4
Red-winged blackbird (*Agelaius phoeniceus*)	—	0.5	1.0	2.0	0.1
Other species					
Double-crested cormorant (*Phalacrocorax auritus*)	0.1	—	—	—	—
Mute swan (*Cygnus olor*)	—	0.5	—	—	—
Canada goose (*Branta canadensis*)	—	0.8	—	—	—
Red-tailed hawk (*Buteo jamaicensis*)	0.3	—	—	—	—
Common tern (*Sterna hirundo*)[c]	—	0.1	—	—	—
Least tern (*Sterna antillarum*)[b]	—	1.1	—	0.3	—
Belted kingfisher (*Ceryle alcyon*)	0.1	—	—	—	—
Eastern kingbird (*Tyrannus tyrannus*)	0.1	—	—	—	0.1
Tree swallow (*Tachycineta bicolor*)[e]	0.3	0.5	0.4	0.8	1.3
Barn swallow (*Hirundo rustica*)[e]	9.3	2.1	2.8	1.6	1.3
Common grackle (*Quiscalus quiscula*)	—	—	—	—	0.1
Average number of individuals per visit (all species except aerial insectivores)	1.0	9.5	11.6	5.4	9.1
Total number of species recorded	8	11	12	12	8

[a]Site abbreviations are given in text.

[b]Species Threatened in Connecticut.

[c]Species of Special Concern in Connecticut.

[d]All shorebirds except willet, which is classified as a marsh specialist.

[e]Aerial insectivores: not included in average number of individuals per visit.

1980, are beginning to fill in, yet constitute the dominant open-water habitat on both Headquarters and Davis marshes. The two restoration sites, Impoundment One and Impoundment Three, are the wettest sites and are dominated by short *S. alterniflora*. Shallow pools and salt pannes are more abundant at Impoundment One than in any other marshes except Impoundment Three, which floods regularly during high tides. Relic stands of *P. australis* line the upland border of both restoration sites. *Iva frutescens* is locally abundant at all five sites, occurring on dredge spoils along the edge of mosquito ditches, on natural levees along tidal creeks, and at higher elevations on the high marsh.

Discussion

Although several studies have investigated the impact of mosquito ditching and open marsh water management treatments on bird populations (Reinert and others 1981, Clarke and others 1984, Brush and others 1986, Wilson and others 1987), this is the first study to specifically address the effects of marsh restora-

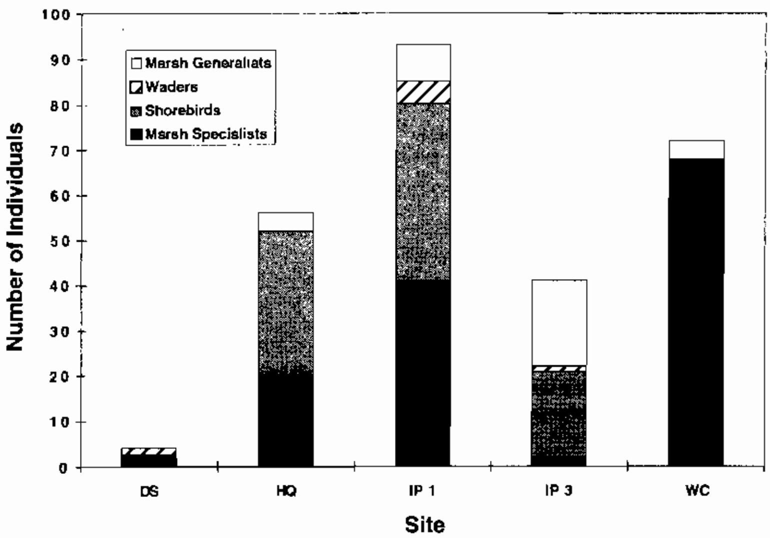

Figure 2. Total number of individuals recorded within dominant bird groups during eight visits to each site. Abbreviations for study sites as iu Figure 1.

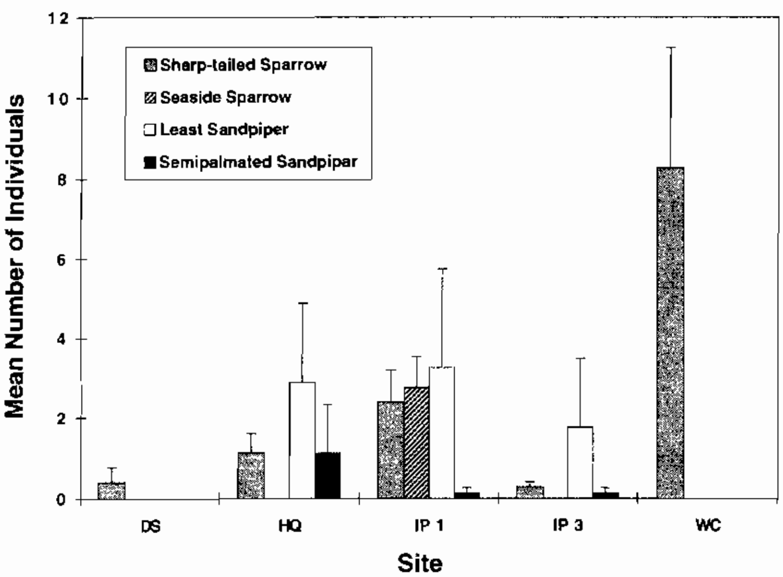

Figure 3. Mean number of dominant shorebirds and salt marsh sparrows recorded per visit at the five study sites. Error bars represent standard errors.

tion on specialized wetland birds in New England. However, the effect of tidal marsh restoration on bird populations has been studied in the more extensive tidal marsh systems of New Jersey. Following the tidal restoration of a New Jersey marsh previously diked and drained for the production of salt marsh hay (*S. patens*), Slavin and Shisler (1983) observed substantial changes in both the vegetation and bird populations. More frequent tidal flooding resulted in an 88% reduction in *S. patens*, a 98% increase in *S. alterniflora*, and a 97% increase in the amount of surface water on the marsh. The number of individuals and species of waders, shorebirds, waterfowl, and gulls increased, while both the ahundance and diversity of passerines (including red-winged blackbirds; tree and barn swallows; seaside, sharp-tailed, swamp *Melospiza georgiana*, and song sparrows; and common yellowthroats) declined significantly. Total bird hiomass was far greater on the restored marsh than on a nearhy tidally restricted salt hay farm.

In their comparison of "natural," ditched, and impounded marshes in New Jersey, Burger and others (1982) found species diversity and avian biomass to be greater in impounded marshes than in either ditched or natural marshes, but noted that species restricted to East Coast salt marshes, such as clapper rail *Rallus longirostris* and seaside and sharp-tailed sparrows, only occurred in their unimpounded study sites. Although the impoundments supported a greater diversity of birds, Burger and her

Table 2. Mean percent cover and frequency of occurrence of dominant angiosperms in sample plots at the five study sites

Site[a]	Cover/frequency					
	Spartina alterniflora	*Spartina patens*	*Distichlis spicata*	*Juncus gerardii*	*Iva frutescens*	Forbs[b]
DS	35/0.86	41/0.90	6/0.22	2/0.06	<1/0.02	1/0.06
HQ	16/0.67	13/0.51	16/0.59	7/0.16	<1/0.02	25/0.69
IP1	50/0.96	10/0.26	14/0.44	0/0.00	4/0.04	9/0.39
IP3	50/0.97	5/0.10	5/0.22	0/0.00	3/0.05	1/0.17
WC	6/0.13	40/0.89	26/0.85	23/0.70	1/0.07	2/0.13

[a]Site abbreviations are given in text.

[b]Broad-leaved, herbaceous plants.

associates stress the importance of maintaining natural marshes that provide essential habitat for salt marsh-dependent species.

Numerous factors may influence the suitability of tidal wetlands for particular bird species, including natural processes and historical human impacts. For example, the progression from low marsh to high marsh during typical marsh development may reduce the availability of breeding habitat for seaside sparrows, which nest exclusively in stands of short *S. alterniflora* (Reinert and others 1981, Post and Greenlaw 1994). Conversely, an increase in the rate of relative sea-level rise may result in wetter habitat conditions and favor wetland birds that breed in *S. alterniflora* on the high marsh. In contrast, the low species diversity and absence of marsh specialists on the Davis marsh may be due to the long history of mowing for salt marsh hay.

Avian density and species richness tends to be greatest in wetlands with an adequate supply of water (Capen and Low 1980), an interspersion of open water and vegetation (Weller and Spatcher 1965), and a diversity of vegetation types (Craig and Beal 1992). In their study of avian use of ditched and unditched tidal marshes in New England, Reinert and others (1981) found a direct positive relationship between the availability of open water (particularly permanent pools) and the density and species diversity of waterfowl, shorebirds, wading birds, gulls, and terns. They also determined that short *S. alterniflora* communities, which are prevalent in unditched tidal marshes, are an essential habitat feature for breeding red-winged blackbirds and seaside and sharp-tailed sparrows. Mosqnito ditching reduces this vegetation type by draining standing water from the marsh surface.

Impoundment One at Barn Island has changed dramatically since the reintroduction of tidal exchange 14 years ago. *S. alterniflora* and other typical salt marsh vegetation have largely replaced the monotypic stands of *T. angustifolia* and *P. australis,* whicb dominated this area when it was in a brackisb or freshwater state (Sinicrope and others 1990; Barrett and Niering 1993). The biomass of salt marsh snails (*Melampus bidentatus*) and the density of ribbed mussels (*Guekensia demissa*) at Impoundment One are roughly comparable to reference marshes within the same system (Fell and others 1991, Peck and others 1994). In addition, Allen and others (1994) determined that common mummichogs (*Fundulus heteroclitus*) now forage in mosquito ditches both above aud below the impoundment dike.

The restored marsh at Impoundment One also provides a wide range of habitats that are used by many species of birds. Dense *I. frutescens* on the creek bank levee and relic stands of *P. australis* along the upland border provide perch sites for red-winged blackbirds, marsh wrens, and other passerines. Pools of open water are important foraging areas for waders and shorebirds (Burger and others 1982, Slavin and Shisler 1983, Reinert and Mello 1995), and snowy egrets, greater and lesser yellowlegs, glossy ibises, and least and semipalmated sandpipers were frequently recorded foraging in and around the large permanent pools at Impoundment One. Seaside and sharp-tailed sparrows, which have declined throughout portions of their range due to destruction of their breeding habitat (Greenlaw and Rising 1994, Post and Greenlaw 1994) and are listed as species of special concern in Connecticut, are common in the short *S. alterniflora* that now dominates this site. Although quantitative data on bird populations are not available for the period prior to tidal restoration, seaside and sharp-tailed sparrows were absent from Impoundment One in the 1970s even though they were present in the salt meadows below the impoundment dike (Robert Dewire, personal communication).

The overall abundance and diversity of birds at Impoundment One were comparable to or greater than at the other four Barn Island marshes. Moreover, the abundance of marsh specialists was higher at Impoundment One than at the other sites. In a related study of bird use on 16 estuarine tidal marshes in southeastern Connecticut, the abundance and diversity of wetland birds at Barn Island's Impoundment One was second only to the large, undisturbed Great Island marsh system at the mouth of the Connecticut River (Brawley 1995). Although the abundance of marsh specialists was lower at Impoundment One than at Great Island, the diversity of shorebirds, waders, and marsh generalists was greater. Furthermore, Impoundment One and the Great Island marsh were the only two study sites that supported breeding populations of seaside sparrows.

A second restoration site, Impoundment Three, appears to be developing in a similar fashion to Impoundment One. Approximately ten years after the reintroduction of tidal flooding, short *S. alterniflora* now accounts for approximately 50% of the vegetation cover, and shorebirds, waders, and marsh generalists were all relatively abundant at this site. Although Impoundment Three may still be too wet to support breeding populations of salt marsh sparrows, several sharp-tailed sparrows were recorded foraging along the large tidal creek that traverses the marsh.

This study complements the research conducted in New Jersey by Burger and others (1982) and Slavin and Shisler (1983). Although impounded marshes may support a greater diversity of birds, they represent unsuitable breeding habitat for declining populations of marsh specialists such as willets and seaside and sharp-tailed sparrows. As Slavin and Shisler noted, the restoration of tidal flow may initially increase the amount of surface water on a marsh and eliminate breeding habitat for birds that nest on the marsh surface. However, the reestablishment of *S. alterniflora* on Impoundment One demonstrates that tidal restoration can eventually create ideal conditions for these specialized species.

Recent management of the Barn Island wetland system illustrates that a number of goals can be achieved through marsh restoration, including the replacement of invasive plants with salt marsh vegetation and the creation of habitat for both highly specialized salt marsh birds and more ubiquitons marsh users such as shorebirds, waders, and marsh generalists. In tidally restricted systems, these objectives can be effectively accomplished via the reintroduction of tidal flooding. The reintroduction of tidal flow to Impoundment One has restored a suite of important ecological functions and has also created essential breeding habitat for seaside and sharp-tailed sparrows, two Connecticut species of special concern.

Acknowledgments

The authors thank Rachel Fertik for her assistance with field sampling and the Connecticut Department of Environmental Protection for providing access to the Barn Island marshes. We also thank Ron Rozsa of the Connecticut Department of Environmental Protection for reviewing this manuscript.

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