Salt Marsh Bird Conservation Plan

Partners working to conserve salt marshes and the birds that depend on them.

ATLANTIC COAST JOINT VENTURE

EXECUTIVE SUMMARY

Since 2014, conservation partners have been collaborating on a conservation plan for salt marsh-dependent birds to address the growing number of species experiencing steep population declines and/or range contractions. This plan is the outcome of that collaboration, which included partners from every state (and state wildlife agency) from Maine to Florida, academic experts on salt marsh birds, and several organizations focused on bird habitat conservation. This plan prioritizes bird species and habitat conditions that are most in need of conservation attention, and presents a set of eight different strategies considered most important to halting population declines of salt marsh birds, improving their habitat conditions, and providing for future habitat in the face of sea level rise.

- Salt marshes provide valuable public benefits such as protection from flooding and storm damage, nursery habitat for fish and shellfish that support a multi-billion dollar industry, and vital habitat for many birds and other wildlife that depend on them for part or all of their life cycle.
- Many salt marsh dependent bird species are in steep decline from habitat loss and degradation due to historic and present human impacts and sea-level rise.
- Species of greatest conservation concern on the Atlantic Coast include the Eastern Black Rail, Saltmarsh Sparrow, and Coastal Plain Swamp Sparrow. Most or all of their global populations are found within Atlantic (and Florida's Gulf) Coast salt marshes, and all have experienced large losses and/or range restrictions within recent decades.
- Higher elevation portions of salt marsh, which are typically flooded only a few times per month, provide nesting habitat for the species of greatest conservation concern, and are most threatened by sea-level rise; therefore, high marsh is a major focus for collective conservation attention by partners.
- Sea level rise coupled with historic alternations, is degrading the integrity and resilience of high marsh habitat; in many places high marsh areas are transitioning to low marsh or unvegetated areas (e.g., open water).
- Conserving salt marsh bird populations and sustaining high marsh habitat in the face of sea-level rise requires that the quality and resilience of high marsh habitat be increased through restoration, enhancement, and management efforts.
- This plan identifies a series of highest priority actions and strategies to conserve salt marsh birds, including habitat protection, restoration, enhancement, and engagement and coordination with key agencies and organizations at the local, state, regional, and federal level, including the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Department of Agriculture, Natural Resources Conservation Service, Environmental Protection Agency, National Oceanic and Atmospheric Administration, and federal, state, and local Departments of Transportation.
- Although there is a considerable body of research and implementation focused on restoring and improving tidal marshes, it is premature to deduce benefits to focal species of salt marsh birds. This plan calls for the immediate development and implementation of a new menu of management actions and approaches focused on high marsh habitat, across multiple states, to halt declines of focal species.
- The menu of conservation actions recommended in this plan, including many relatively new approaches, needs to be rigorously tested and evaluated. It is critical to develop and employ an adaptive management framework so partners can understand and improve the effectiveness and efficiency of conservation efforts as rapidly as possible to conserve salt marsh birds across the Atlantic Flyway.
- There is a clear need for more regular and systematic monitoring throughout the Atlantic Flyway, from the local to the flyway scale, to understand population trends, determine whether conservation efforts are successful, and identify areas of particular importance to salt marsh birds during migration and winter.
- Living shorelines are an important strategy for protecting beaches, communities, and tidal marsh ecosystems; however, to date they have not been implemented on a large enough scale to improve high marsh habitat for salt marsh birds. Therefore, living shorelines are not highlighted as a key implementation action in this plan, though that strategy may become important in some areas if implemented on a scale that benefits entire tidal marsh complexes (including high marsh).
- The ability of tidal marshes to migrate inland is considered the single most important way that we can offset or prevent the net loss of wetlands as sea levels rise. Lands adjacent to and inland of salt marshes should be protected to serve as buffer zones and allow for marsh migration, to reduce and offset marsh habitat losses due to future sea-level rise. The integrity of existing marshes and future availability of important habitats are seriously threatened by ongoing development.
- There are major differences between salt marshes in the Northeast (i.e., Maine to Virginia) and Southeast U.S. (i.e., North Carolina to Florida) in terms of their distribution, degree of alteration, and conservation needs. Less extensive areas and more extensive alterations characterize the Northeast, so conservation needs include a host of strategies related to restoration, enhancement, protection, and marsh migration. More extensive areas and less extensive alterations in the Southeast equate to lower threat levels in that region, although most of the conservation strategies in this plan are still needed in particular areas. Proactive protection of inland buffers and marsh migration space are necessary to sustain the extensive and high quality habitat areas that currently exist in the Southeast.

Saltmarsh Sparrow. Peter Paton

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Section 1:
INTRODUCTION

A CRITICAL ECOSYSTEM

Salt marshes are one of the most biologically productive ecosystems (Lieth 1975) in the world, matched only by tropical rainforests in their ability to support life (McLeod et al. 2011). The U.S. supports one third of this globally rare habitat, which only covers an area about twice the size of New Jersey, worldwide (Greenberg et al. 2006). U.S. salt marshes support the highest degree of diversity and endemism (Greenberg & Moldanado 2006) of salt marsh vertebrates in the world (Greenberg & Moldanado 2006), hosting most of the world's species or subspecies that are restricted to salt marsh habitats.

Beyond their value to biodiversity, salt marshes are, arguably, one of the most economically valuable coastal habitats. A crucial component in estuarine ecosystems, salt marshes provide essential 'nursery habitat' that helps support most commercially and recreationally important fish and shellfish species (Barbier et al. 2011) in the U.S.(Lellis-Dibble et al. 2008). This multi-billion dollar industry ($37.8 billion in annual sales on the Atlantic coast) provides more than 1.6 million jobs in the U.S.. Salt marshes also protect human communities (Narayan et al. 2017) by absorbing the energy and flood waters from coastal storms (Spalding et al. 2013), stabilizing shorelines and removing sediments and pollution from coastal rivers and bays where nearly 40% of the U.S. population lives. In 2012, "Superstorm Sandy" hit the East coast and caused nearly $50 billion in flood damages, mostly from storm surge. However, where coastal wetlands were present, they prevented more than $625 million in property damage (Narayan et al. 2017) by reducing and absorbing wave energy and flood waters. Coastal wetlands continue to provide annual flood-related cost-savings to communities that have retained marshes. As the frequency and intensity of hurricanes and coastal storms increases (Mousavi et al. 2010) with a warming climate, the value of healthy and resilient salt marsh systems will only continue to grow.

CONSERVATION NEED

Centuries of human impacts have resulted in the loss of more than half (Kennish 2001) of the original salt marsh habitat in the U.S. (Gedan et al. 2009). Much of what remains has been highly degraded through filling, ditching, diking, or draining for development and agriculture. This is especially true in the northeastern U.S.; from Maine to Virginia, fully 90% of salt marshes were ditched (Tonjas 2013) before World War II. In the Southeastern U.S., although a higher proportion of salt marshes remain in an unaltered state, nearly all salt marshes have experienced some degree of wetland loss and degradation throughout the Atlantic Coast.

Sun setting on a saltmarsh. Beau Considine

More recently, the rate of global sea-level rise has been increasing, with significant consequences to salt marsh health. Seas rose by an average of 1.2 mm/yr between 1901 and 1990 (Hay et al. 2015) but that rate accelerated to more than 3.2 mm/yr between 1993 and 2010 (IPCC 2018). The Atlantic Coast of North America, between North Carolina and New England, experienced rates of sea level rise three to four times greater than the global average (Sallenger Jr. et al. 2012). Rapid sea level rise has exacerbated salt marsh degradation and currently poses the greatest threat to the integrity and long-term persistence of salt marshes and salt marsh birds Raposa et al. 2017. More frequent flooding of salt marsh habitat during the avian nesting season is causing ponding and overall saturation of the marsh platform (Hill & Anisfeld 2015). As marshes get wetter, plants either die off or convert to vegetation more tolerant of inundation, leading to a net loss of salt marsh habitat and a transition to more flooded habitats that do not support the highest priority bird species (Field et al. 2016).

Several salt marsh-dependent bird species have declined dramatically in the last 10 to 20 years. Populations of Saltmarsh Sparrow (*Ammospiza caudacuta*), a habitat specialist that is restricted to salt marshes, are declining at 9% annually (Correll et al. 2016), with its highest rates of decline in New England (12.2%). In 2011 and 2012, the Saltmarsh Sparrow population was estimated at 60,000 individuals (Weist et al. 2019), but could drop below 5,000 individuals by 2040. The U.S. Fish and Wildlife Service (USFWS; the Service) recently proposed the Eastern Black Rail (Laterallus jamaicensis jamaicensis) for listing as threatened under the Endangered Species Act (ESA). The Service is planning to complete a Species Status Assessment by 2023 for Saltmarsh Sparrow to evaluate whether its listing is warranted. Both Black Rail and Saltmarsh Sparrow are designated as Species of Greatest Conservation Need (SGCN) in State Wildlife Action Plans throughout the Atlantic Flyway and Regional Species of Greatest Conservation Need in both the North and the South Atlantic, are listed as threatened or endangered in most states in which they breed, and are a major focus of bird conservation organizations such as Audubon and American Bird Conservancy. Other populations or subspecies of birds strongly associated with salt marsh habitat along the Atlantic Coast have also shown alarming declines (Watts 2014) or disappearances in recent decades, including Henslow's Sparrow (Norment 2002, Reinking 2002) and Coastal Plain Swamp Sparrow (Blankenship 1999). Given the projected sea-level rise that is expected along the Atlantic Coast during this century, scientific models predict large losses (Crosby et al 2016; Watson et al 2016) of habitat for many salt marsh species, and increased nest failure due to flooding (Bayard & Elphick 2011). Immediate and concerted conservation action throughout the Atlantic Coast is necessary to halt and reverse the declines in these species —before it is too late.

PURPOSE

This plan, which was developed by ACJV partners and salt marsh bird experts, outlines key actions needed to maintain or restore self-sustaining populations of a suite of salt marsh bird species. It represents the collective view of the salt marsh bird conservation community on the major threats facing these birds and their habitats, the priority strategies needed to address them, and the collaborative actions necessary for long-term success. The plan includes eight conservation strategies with measurable and time-bound objectives that partners can use to evaluate success over time. It also highlights the most promising management actions needed to restore and create high quality habitat and to restore healthy populations of salt marsh birds and the many ecosystem functions they represent.

SCOPE OF THE PLAN

Habitat

Tidal marshes exist along a broad salinity gradient from salt water to brackish to freshwater. This plan is focused on estuarine or brackish tidal marshes, also known as salt marsh, which regularly get salt water from the ocean. Freshwater tidal marshes, which occur higher up in coastal rivers or bays where freshwater inputs reduce or eliminate salinity, are not within the scope of this plan. Salinity levels vary by season (and locally, by wind/rain events), so large areas of Delaware Bay and Chesapeake Bay are brackish for only part of the year, but are within the scope of this plan if occupied by focal salt marsh bird species. This plan focuses particular attention on the higher-elevation portion of tidal marshes that is above the mean high water mark and is flooded infrequently (i.e., two periods per month) by only the highest observed tides. These so-called "high marsh" areas are densely vegetated by perennial salt-tolerant grasses, rushes and other vegetation that varies by geography. Microhabitat features within this zone include creeks, bayous, channels, pools, and unvegetated pannes. Tidal mudflats, tidal freshwater, and mangrove habitats are generally not the focus of this plan.

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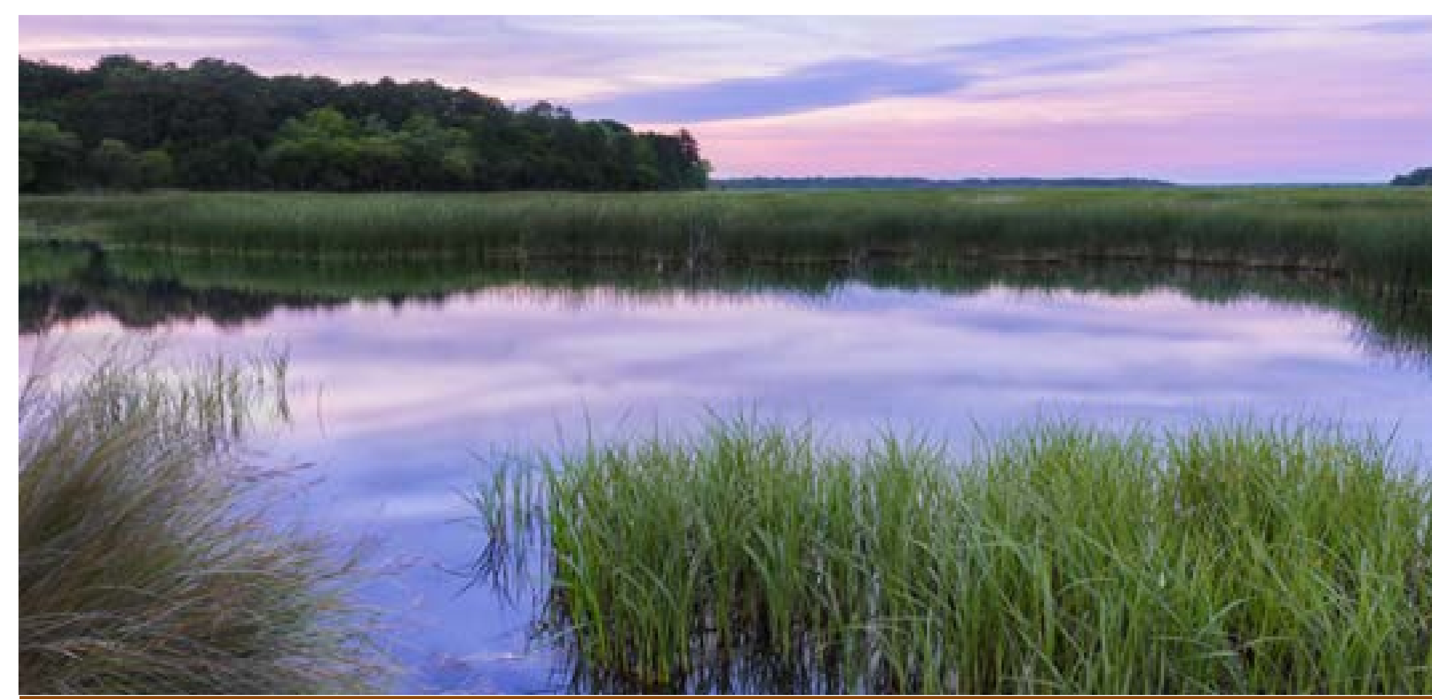
Geography

This plan is for the U.S. portion of the Atlantic Flyway, from Maine to Florida, which corresponds to the geographic area of the Atlantic Coast Joint Venture (ACJV), (see Box). Although this plan includes the Gulf Coast of Florida, it does not extend to the rest of the Gulf of Mexico (i.e., Alabama to Mexico). Because many salt marsh bird species found along the Atlantic Coast spend part of their annual life cycle along the Gulf of Mexico, successful conservation will ultimately rely on joint implementation efforts and coordination by Atlantic and Gulf Coast partners.

> ***THE ATLANTIC COAST JOINT VENTURE***
>
> The ACJV is a regional partnership that collaborates to restore and sustain native bird populations and habitats throughout the ACJV region. The ACJV is comprised of 16 state wildlife agencies from Maine to Florida and the territory of Puerto Rico; federal and regional habitat conservation agencies; and other organizations that share our vision. The ACJV is currently focused on one of the most imperiled habitats in the ACJV region–coastal marshes and the suite of vulnerable birds that depend on them.



South Carolina Lowcountry marsh. Ace Basin

Species

This plan focuses on bird species expected to experience measurable population declines due to changes in salt marsh habitat over the next 50 years. Some of the priority bird species discussed in this plan (e.g., Black Rail) also occur in inland, freshwater habitats and also may benefit from work in those habitats. However, this plan is strictly focused on strategies and actions to benefit salt marsh habitat and the birds that rely upon it as their primary habitat. Although many additional bird species use and benefit from salt marsh habitat during part of their annual life cycle, these species are not directly mentioned in this plan if they are primarily associated with other habitat types.

A PHASED APPROACH

The conservation effort described in this plan is envisioned as a phased approach that adapts, expands, and improves over time as collective knowledge, tools, and partnerships advance. This plan includes the strategies selected by experts as the most important for sustaining and restoring healthy populations of salt marsh birds and the habitat they depend on. The plan's proposed actions will benefit the entire suite of salt marsh bird species, as well as many other wildlife species that use salt marshes. We expect priorities to evolve over time as the conservation status of priority species shifts with changing threats or effectiveness of implemented strategies. As such, we expect to evaluate and revise the plan periodically (every five years).

Partners intend to address the major needs of a suite of priority bird species through the actions in this plan, which will benefit many other species of greatest conservation need (see Table 1). ACJV partners are also developing species-specific conservation plans for two of the highest priority species highlighted in this plan, Black Rail and Saltmarsh Sparrow, for which population declines are so serious that there is a risk of population collapse in the next 50 years (Correll et al 2016) without immediate conservation action. For these species, along with another ACJV "flagship" species (American Black Duck), we have developed regional and state-specific population and habitat objectives, and identified specific strategies and actions that we believe are critical to those individual species. These species conservation plans will complement the strategies and actions laid out in this salt marsh plan and, together with this plan, will comprehensively cover the full universe of conservation strategies needed to meet the needs of these three species, including some aspects that fall outside of salt marshes.

Black Rail. ©Sergio Bitran

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A PARTNERSHIP EFFORT

This Salt Marsh Bird Conservation Plan began in 2014 as an effort to develop, prioritize, and coordinate conservation activities aimed at securing populations of focal bird species in eastern North America that are likely to be affected by future changes to salt marshes. Plan development drew on the expertise and research of groups like the Saltmarsh Habitat & Avian Research Program (SHARP), ACJV, and dozens of agency, academic, and NGO partners during two in-person workshops in 2014 and 2016 and a series of web conferences. This effort was informed by conservation business plans such as the Atlantic Flyway Shorebird Initiative, and population-level conservation plans, such as the Partners in Flight Landbird Conservation Plan and Waterbird Conservation for the Americas.

An initial scoping document for the plan was developed following the 2014 workshop and planning efforts continued at a second workshop in 2016. The ACJV convened partners from Maine to Texas to identify an initial set of priority strategies using the Open Standards for the Practice of Conservation process. A core team of workshop participants continued to refine and review the strategies and develop specific species and habitat objectives. In 2017, partners mutually decided to restrict the scope of the plan to the U.S. Atlantic Coast from Maine to Florida (including the Gulf coast of Florida) to conform to the Atlantic Coast Joint Venture geography. Partners in the Gulf of Mexico will continue to plan for and implement salt marsh conservation efforts in that region, considering the strategies and objectives of this plan as appropriate.

ACKNOWLEDGMENTS

This Salt Marsh Bird Conservation Plan is the result of a great deal of work by many individuals from across the eastern U.S. ACJV partners from every state wildlife agency and federal conservation-related agency along the Atlantic Flyway were engaged in this effort. The plan's Steering Committee provided invaluable, long-term input and guidance: Aimee Weldon, Amy Schwarzer, Brian Olsen, Caleb Spiegel, Chris Elphick, Craig Watson, Dave Curson, Greg Shriver, Gwen Brewer, Mark Woodrey, Mitch Hartley, Troy Wilson, Whitney Wiest, and Woody Woodrow. Caroline Stem and Adrienne Marvin of Foundations of Success provided guidance and facilitation on many aspects of the plan. Dozens of other partners attended workshops, webinars, retreats, or conference calls to develop this plan. Special thanks to all those who provided us with extra help, including: Bri Benvenuti, Erin King, Kate O'Brien, Ray Danner, and Suzanne Paton.

Design by Debra Reynolds

Cover photo: Coastal mist. Keith Carver

SUGGESTED CITATION

Salt Marsh Bird Conservation Plan for the Atlantic Coast. 2019. Atlantic Coast Joint Venture. www.acjv.org

Section 2:

PRIORITY SPECIES & HABITAT

SPECIES

When salt marsh bird conservation planning began in 2014, considerable attention was given to which species would be the focus of concerted efforts. Partners considered a long list of species, subspecies, and distinct population segments (hereafter referred to as "species", as defined by the ESA). Details about all species considered and the rationale for all decisions made during the initial prioritization process are in Appendix 1. The priority species in this plan were determined by the following criteria:

- Degree of dependence upon salt marsh; i.e., likelihood that a species would experience noticeable declines due to decreases in the amount, quality, or types of salt marsh habitat.
- International Union for the Conservation of Nature (IUCN) conservation status.
- Regional responsibility, defined as the proportion of the species' global population that is within the ACJV area.

If changes in salt marsh habitat would have a trivial impact on a species' population, it was excluded from this plan, even if it was a species of high conservation concern, with the rationale that salt marsh conservation is not the best way to address those species' needs. Conservation status was defined based on IUCN status. Highest-priority species were those in the following IUCN categories:

- Endangered (facing a very high risk of extinction in the wild)
- Vulnerable (facing a high risk of extinction in the wild)
- Near Threatened (close to qualifying for or is likely to qualify for a threatened category in the near future)

For distinct populations or subspecies that have not been assessed by the IUCN, partners estimated their status based on IUCN criteria.

The above criteria were used to classify species in this plan into priority tiers.

Tier A represents the highest priority species defined as those:
- With Near Threatened or greater IUCN status, and
- With a large proportion of their global population within the ACJV area

Tier B species were either:
- Near Threatened or lesser IUCN status with most of their global population outside of the ACJV area, or
- Not in one of the IUCN classes above, but with a large proportion of their global population within the ACJV area

All Tier B species are experiencing serious population declines, and are considered to be on a trajectory to become Tier A species within a decade or less if their population status does not improve. All other species were placed in Tier C if there was not clear evidence that they belonged in Tier A or B, or in Tier D if there were insufficient data to classify them in Tiers A, B, or C.

Of the 25 salt marsh bird species placed in these tiers, five are in Tier A, seven are in Tier B, 11 are in Tier C, and two are in Tier D (Table 1). Given the more imminent risk, strategies recommended in this plan should be implemented in places and ways that ensure the greatest and most immediate benefits to Tier A species, first and foremost, and Tier B species secondarily. If our concerted conservation efforts provide strong benefits for

Table 1. Bird species and Priority Tiers considered in the Salt Marsh Bird Conservation Plan. Species highlighted in gray rows were determined to be outside the scope of this plan (see Appendix 1 for details about species prioritization).

Common Name	Priority Tier	Scientific Name
Black Rail	A	*Laterallus jamaicensis* (E. tidal marsh population)
Saltmarsh Sparrow	A	*Ammospiza caudacuta*
"Coastal Plain" Swamp Sparrow	A	*Melospiza georgiana nigrescens*
"Eastern" Henslow's Sparrow	A	*Centronyx henslowii susurrans*
Whooping Crane	A	*Grus americana*
"Acadian" Nelson's Sparrow	B	*Ammospiza nelsoni subvirgatus*
Clapper Rail	B	*Rallus crepitans*
King Rail	B	*Rallus elegans*
American Oystercatcher	B	*Haematopus palliatus*
Lesser Yellowlegs	B	*Tringa flavipes*
Mottled Duck	B	*Anas fulvigula fulvigula (FL, GA, SC) and Anas f. maculosa (GA, SC)*
Whimbrel	B	*Numenius phaeopus* (*hudsonicus* & *rufiventris*)
American Black Duck	C	*Anas rubripes*
Boat-tailed Grackle	C	*Quiscalus major*
"Eastern" Willet	C	*Tringa semipalmata semipalmata*
Forster's Tern	C	*Sterna forsteri* (Eastern coastal population)
Glossy Ibis	C	*Plegadis falcinellus*
Greater Yellowlegs	C	*Tringa melanoleuca*
Laughing Gull	C	*Leucophaeus atricilla*
Seaside Sparrow	C	*Ammospiza maritima*
Tricolored Heron	C	*Egretta tricolor*
Wood Stork	C	*Mycteria americana* (US breeding population)
Marsh Wren	C	*Cistothorus palustris* (*griseus* & *marianae*)
Nelson's Sparrow	D	*Ammospiza nelsoni* (*alterus* & *nelsoni*)
Yellow Rail	D	*Coturnicops noveboracensis*

Tier A and/or Tier B species, those actions likely would be valuable—and may be adequate—for improving populations of other salt marsh bird species as well.

Predicted changes in habitat availability due to sea-level rise are expected to increase the amount and/or quality of some types of tidal habitat (e.g., lower-elevation marsh); therefore, habitat conditions for some species (e.g., Clapper Rail, Seaside Sparrow) are predicted to improve in future decades, which could prevent the need for concerted action for these species.

In the future, our planning efforts may expand to include additional strategies and actions, which may specifically integrate Tier B and C species, especially if their status and/or threats are considered to be elevated. Species in Tier C are not the immediate focus of conservation implementation under this plan. However, priority rankings for species may be revisited in the future, given that conditions in tidal marshes are projected to change in coming decades. For Tier D species, the only conservation action recommended is to obtain sufficient data to allow an assessment of the species' status.

The scope of this plan was further narrowed to exclude Tier A and B species that are already the subject of other major conservation planning efforts or are distributed primarily along the Gulf Coast. Conservation planning for these species is considered to be adequate for the time being due to the existing plans in place: Whooping Crane (ESA recovery planning team); Mottled Duck (Gulf Coast Joint Venture's Mottled Duck Conservation Plan); and American Oystercatcher, Lesser Yellowlegs, and Whimbrel (Atlantic Flyway Shorebird Initiative). Actions also were deferred for Eastern Henslow's Sparrow (susurrans subspecies) as it is considered to be extirpated from tidal marshes, and its status as a distinct subspecies is uncertain. Although these species will not be the basis for action planning at this time, they were included in the plan to indicate to partners implementing their respective conservation plan(s) that we have also identified them for possible conservation attention. Additional species were also considered, but ultimately not included in this plan for various reasons (see Appendix 1 for details), including Snowy Egret, White Ibis, Northern Harrier, Virginia Rail, Purple Gallinule, Marbled Godwit, Least Sandpiper, Least Tern, Short-eared Owl, Peregrine Falcon (Delmarva population), and Sedge Wren.

All three Tier A species that are the focus of this plan, Black Rail, Saltmarsh Sparrow, and Coastal Plain Swamp Sparrow, are associated with "high marsh" habitat, which is facing the greatest threat from sea-level rise as well as encroaching development, disturbance, and nest-predation risk. Therefore, conservation of high marsh is the focus of this plan.

Tier A species are of highest or high conservation concern in all states they breed (or used to breed) in, and many states in which they overwinter (Table 2). All Tier A and B species are known to be declining—some precipitously—and have small population sizes (Table 3) relative to most other bird species. As a comparison, grassland birds are often reported to be the habitat guild of greatest continental conservation concern in North America; however, population estimates for most grassland bird species in North America are more than one million individuals. The priority species in this plan all have much lower global population sizes and are of very high conservation concern throughout the Atlantic Flyway.

The long-term success of this plan will ultimately be evaluated by our collective progress toward stemming declines and stabilizing populations of these focal species, and increasing their populations (i.e., abundance, distribution, and productivity) over time. Even if efforts to conserve Tier A species are not fully successful, they may be sufficient to stabilize or increase populations of other declining species (e.g., Tier B and C), and prevent those species from needing additional conservation attention or listing consideration in the future.

Marsh Wren. ©Matt "smooth tooth" Knoth, Creative Commons

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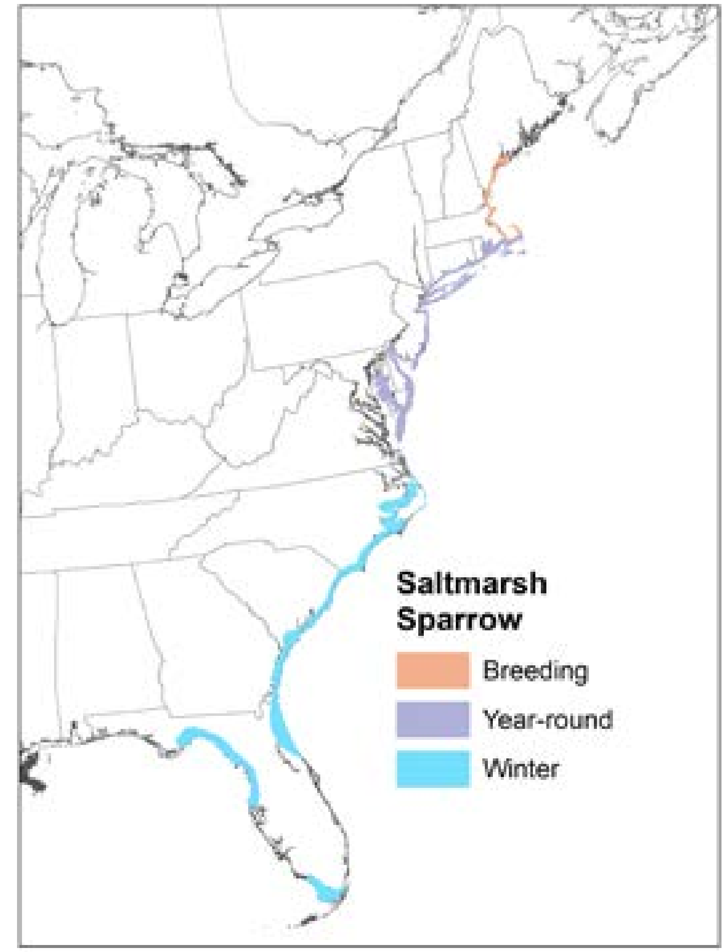


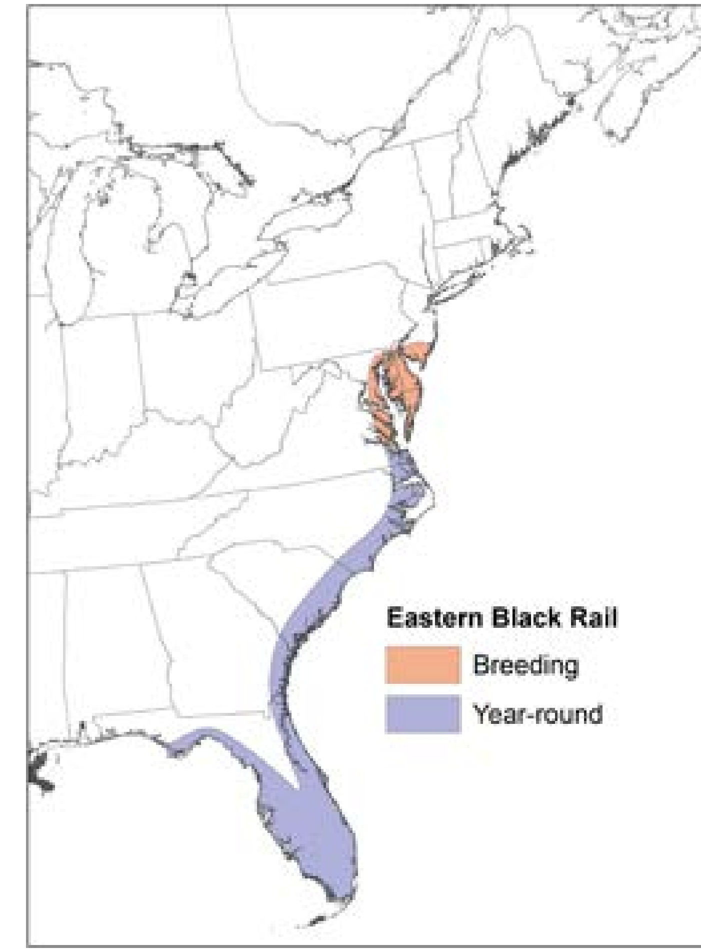
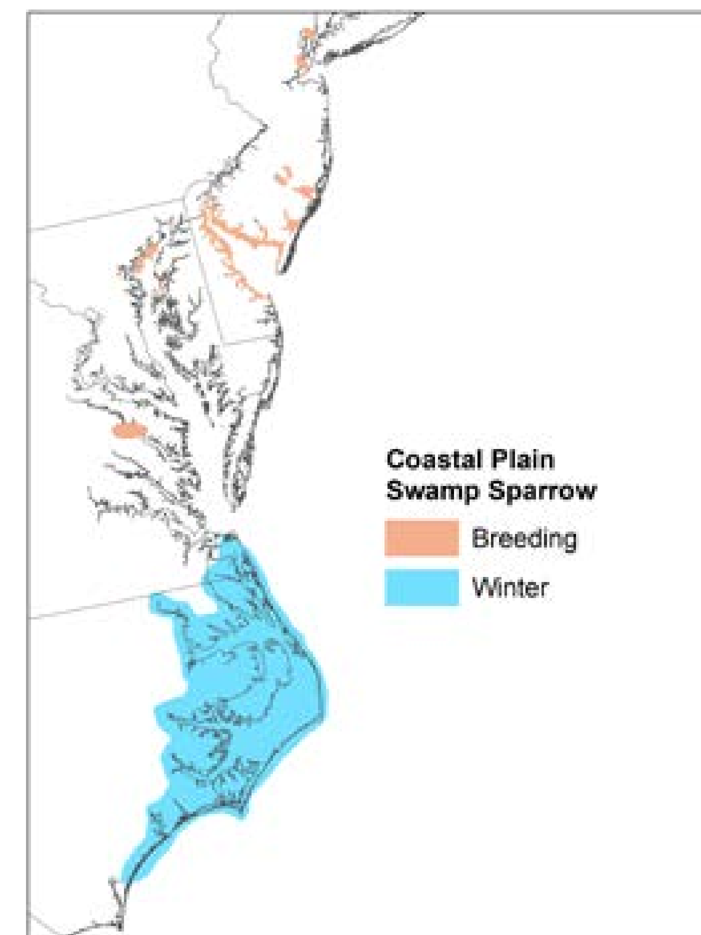


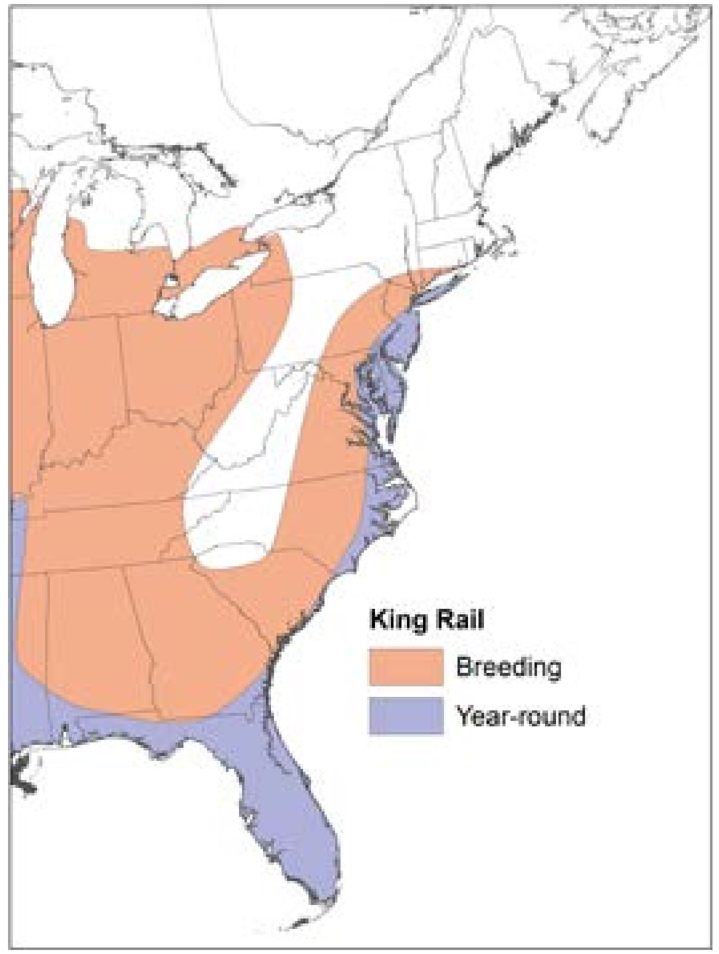
Figure 1a. Range maps for Tier A species.

Saltmarsh Sparrow - Based on Greenlaw et al. (2018), from The Birds of North America https://birdsna.org, maintained by the Cornell Lab of Ornithology.

Eastern Black Rail - Modified from BirdLife International and Handbook of the Birds of the World (2018) Bird species distribution maps of the world. Version 2018.1. Available at http://datazone.birdlife.org/species/requestdis and Schwarzer et al. (2018).

Coastal Plain Swamp Sparrow: Based on Greenberg and Droege (1990), Beadell et al. (2003), and Greenberg et al. (2007).





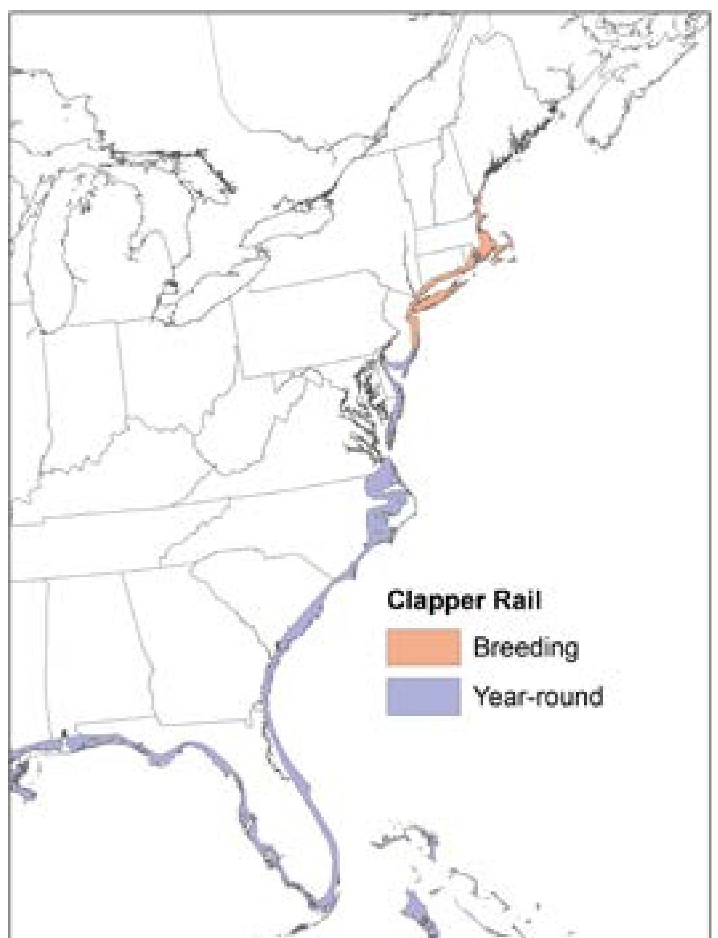


Figure 1b. Range maps for Tier B species.

Acadian Nelson's Sparrow - Based on The Birds of North America https://birdsna.org, maintained by the Cornell Lab of Ornithology, and Greenlaw, J.S. (personal communication).

King Rail - BirdLife International and Handbook of the Birds of the World (2018) Bird species distribution maps of the world. Version 2018.1. Available at http://datazone.birdlife.org/species/requestdis.

Clapper Rail - BirdLife International and Handbook of the Birds of the World (2018) Bird species distribution maps of the world. Version 2018.1. Available at http://datazone.birdlife.org/species/requestdis.

Table 2. Focal species (Tier A & B) conservation status. Includes status for federal listing under the ESA and its status as state-listed and/or included in a 2015 State Wildlife Action Plan (SWAP). SWAP score/coding varies by state. Special Concern = SC; Species of Greatest Conservation Need = SGCN; Regional Species of Greatest Conservation Need = RSGCN

		Tier A			Tier B		
	Program	Black Rail	Saltmarsh Sparrow	Coastal Plain Swamp Sparrow	Acadian Nelson's Sparrow	Clapper Rail	King Rail
Federal	ESA	Proposed Threatened	Under Review	---	--	---	---
Regional	RSGCN - N. Atlantic	Very High	Very High	--	--	High	Very High
	RSGCN - S. Atlantic	Very High	Very High	--	--	Moderate	High
ME	SWAP	--	1	--	2	--	--
	State List	--	SC	--	SC	--	--
NH	SWAP	--	SGCN	--	SGCN	--	--
	State List	--	SC	--	SC	--	--
MA	SWAP	--	SGCN	--	--	--	SGCN
	State List	--	--	--	--	--	Threatened
RI	SWAP	--	SGCN	--	SGCN	SGCN	SGCN
	State List	--	--	--	--	--	--
CT	SWAP	--	Most Important	--	--	Very Important	Very Important
	State List	Extirpated*	SC	--	--	--	Endangered
NY	SWAP	High Priority	High Priority	--	--	--	High Priority
	State List	E	--	--	--	--	Threatened
NJ	SWAP	Priority	Priority	--	--	Priority	Priority
	State List	E	SC	--	--	--	--
DE	SWAP	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
	State List	E	--	--	--	--	--
MD	SWAP	A	B	A	A	--	B
	State List	E	I	I	--	--	--
VA	SWAP	Tier Ia	Tier IIIa	--	Tier IIIa	Tier IVa	Tier IIB
	State List	E	--	--	--	--	--
NC	SWAP	SGCN	SGCN	--	--	SGCN	SGCN
	State List	SC	--	--	--	--	--
SC	SWAP	Highest	--	--	--	Highest	Highest
	State List	Concern	--	--	--	--	--
GA	SWAP	High	High	--	--	--	--
	State List	--	--	--	--	--	--
FL	SWAP	SCGN	SCGN	--	--	SCGN	SCGN
	State List	--	--	--	--	--	--

Formerly Endangered, then determined to be extirpated and removed from state list.

Table 3. Conservation status and population estimates (number of adult birds) for Tier A & B species, including available trend information and population objectives. TBD = To be determined

Species	Global Conservation Status (IUCN)	Population At Last Estimate (95% C.I.)	Population Trend (Per year)	Population Objective (Individuals)
Tier A				
Black Rail	Near Threatened	710 - 1,630[1]	-9%	5,000
Saltmarsh Sparrow	Endangered	60,000[2] (40k - 80k)	-9%	25,000
Coastal Plain Swamp Sparrow	Not Evaluated	56,000[3]	Decline	28,000*
Tier B				
Clapper Rail	Least Concern	575,000[4]	-4%	TBD
King Rail	Near Threatened	7,800 - 10,780[5]	Decline	11,500[6]
Acadian Nelson's Sparrow	Not Evaluated	7,000[7] (4k - 10k)	-4%	TBD

Objectives for Coastal Plain Swamp Sparrow are preliminary and not yet peer-reviewed by a broad set of partners.

[1] *From the status assessment by Watts 2016*

[2] *From Wiest et al. 2019,*

[3] *From Beadell et al. 2003*

[4] *Estimate based on southern New England south to Virginia, from Wiest et al. 2019, plus data from GA and FL (but not NC or SC), from (Hunter et al. 2017, Enloe et. al 2017)*

[5] *Estimates for the eastern North Carolina and southeast Virginia Ecoregion only; from Drew & Collazo. 2014*

[6] *Combined population objective for Bird Conservation Regions 27 & 31, from Cooper 2008 (and references therein)*

[7] *Estimate for the northeastern U.S. only (not including Canada); from Wiest et al. 2019*

HABITAT

Salt marshes often contain distinct habitat types or zones that differ in elevation, frequency of tidal flooding, and salinity, which are typically dominated by different plant communities (Figure 2). In most Atlantic Coast salt marshes, the lowest-elevation portions are flooded twice daily by high tides. This "low marsh" is the first vegetated zone between tidal mudflats (or open water) and higher-elevation portions of the marsh. Low marsh is often dominated by smooth cordgrass *(Spartina alterniflora* [syn. *Sporobulus alterniflorus*]). Low marsh is the primary breeding habitat of some bird species such as Clapper Rail and Seaside Sparrow, and the primary wintering habitat for species like American Black Duck. Higher-elevation portions of salt marsh, known as "high marsh," are not within the reach of daily tides but do flood predictably, twice each month, when the new moon and full moon cause "spring tides" with higher tidal amplitude. High marsh also gets inundated by storm surge, when wind, waves, or rain from coastal storms cause temporary flooding.

High marsh habitat is characterized by somewhat different plant species in northern versus mid-Atlantic or southeastern salt marshes, but it typically includes salt meadow cordgrass or "salt hay" (*Spartina patens [Syn. Sporobolus pumilus*]), black grass (*Juncus gerardii*; also called black rush or saltmeadow rush), needlegrass or needlerush (*Juncus roemerianus*) and bulrush or Olney's or common three-square (*Scirpus [Syn. Schoenoplectus*] *americanus* or *pungens*, respectively). The highest-elevation portions of the salt marsh usually include tidal shrublands, often dominated by groundsel tree (*Baccharis halimifolia*), or marsh elder (Iva frutescens), both of which may be referred to as high-tide bush. These areas of salt-tolerant shrubs often form a distinctive transition zone between the salt marsh and adjacent upland areas.

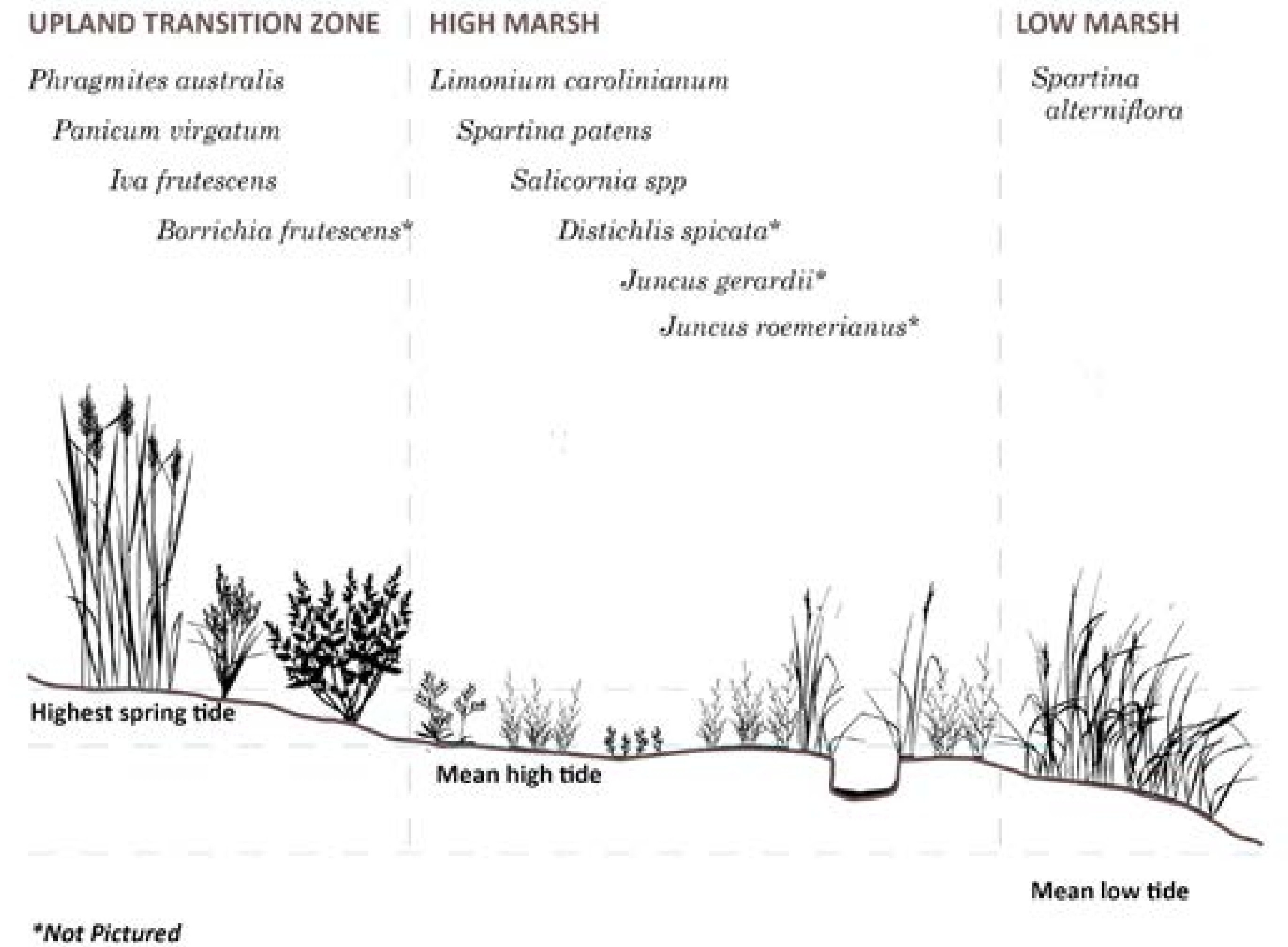


Figure 2. Diagram of classic Atlantic Coast salt marsh vegetation zones. Plant species composition varies by latitude, but most of the species listed are found along broad portions of the Atlantic Coast. Based on a figure originally designed by, and used with permission of Save the Bay.

Sea-level rise in recent decades has degraded many salt marshes, increasing flooding and the degree and period of inundation on all salt marsh zones, changing plant growth and species composition. In some areas, classic high and low marsh (Figure 2) elevation zones are becoming less distinctive. "Short form" *Spartina alterniflora* is becoming increasingly common in some salt hay meadows that characterize higher-elevation portions of the marsh, while "tall form" alterniflora is found along creek banks and pools. In some parts of New England low marshes are being lost, resulting in a vertical face of high marsh at the inter-tidal edge of the marsh.

The salt marsh bird species of greatest concern all breed primarily in higher-elevation portions of the marsh. That "high marsh" habitat is considered to be most threatened by sea-level rise and is predicted to decrease sharply in the future, whereas low marsh habitat, which is tolerant of frequent tidal flooding, is predicted to increase. Therefore, a major recommendation of this plan is to focus conservation efforts on protecting and improving the quality, integrity, and resilience of high marsh habitat and the marsh-upland transition zone to facilitate upslope migration of high marsh plant species (Watson et al. 2015).

GEOGRAPHIC PRIORITIES

The implementation strategies in this plan frequently refer to key marshes or high priority areas. Because of this plan's broad geographic scope, it does not delineate those areas specifically. Rather, this plan lays out the key implementation needs for a suite of salt marsh bird species with conservation efforts on the ground to be coordinated by groups of partners operating at the regional, subregional (i.e., multi-state), state, and local scales. Those partners will determine geographic priorities for the most important species in their area, which will be the focus of their collective efforts to achieve specific population and habitat goals (see Conservation Approach).

Saltmarsh Sparrow. Brian Henderson

Section 3:

THREATS

Evaluating threats is a central part of conservation planning and forms the basis for prioritizing the main strategies selected. Threat rating is used in the Open Standards process to help teams make decisions about where to focus efforts when resources are limited. Threats were identified and rated for bird species of concern by a broad group of partners and experts in 2014 and 2016. To quantify threats, the following criteria were considered for each threat category, using a four-point qualitative scale (for more details, see this guide):

Scope – Commonly defined as the proportion of the target of interest (i.e., focal species) that can reasonably be expected to be affected by the threat within 10 years if current circumstances and trends continue. For a species, this is typically measured as the proportion of the target species' population.

Severity – Within the scope, the level of damage to the target of interest from the threat that can reasonably be expected if current circumstances and trends continue. For a species, this is usually measured as the degree of reduction of its population within the geographic scope.

Irreversibility – The degree to which the effects of a threat can be reversed and the target of interest affected by the threat can be restored, if the threat no longer existed.

We assessed the importance of each IUCN threat category to salt marsh birds along the Atlantic and Florida Gulf Coasts in terms of:

- Individual focal species
- Subregions within the Atlantic Flyway

See Appendix 2 for the raw and summary scores by species and region. Threats across the six focal species were used to determine the overall threat rating for salt marsh birds (Table 4), based on Open Standards guidelines, with the following exception: the threat from "Problematic native species/diseases (mesocarnivores)" had an overall threat rating of "high" based only on one species (Coastal Plain Swamp Sparrow). Because that species has the smallest geographic range of all our focal species (Figure 1C), we determined that this threat was a relatively local issue, and would be most appropriately dealt with by a subset of partners working in the areas where Coastal Plain Swamp Sparrow breed.

We focused on the major threats that are prevalent throughout all or most of the Atlantic Flyway, which are listed in priority order in Table 4 and described below. We developed an initial set of conservation strategies that need to be implemented throughout the flyway to address the most important threats to salt marsh birds.

THREATS NOT ADDRESSED IN THIS PLAN

Some threats were considered to be impractical or outside the scope of this plan even if they are having a significant impact on salt marsh systems. For example, development in proximity to tidal marshes negatively affects the wetland ecosystem and bird communities in several direct and indirect ways. However, it was not considered practical (i.e., likely to be effective) to develop a strategy to address *existing* housing development adjacent to marshes. Similarly, implementing policies and regulations to mitigate or reverse climate change (e.g., to reduce carbon output) related to sea-level rise is beyond the scope of this plan. Rather than attempting to address sea-level rise and increased precipitation due to climate change, we focus on practical strategies to reduce or ameliorate nest flooding.

Table 4. Summary of overall threat ratings for salt marsh birds in the U.S. Atlantic Coast from Maine to Florida.

Direct Threats	Summary Threat Rating
Nest flooding and habitat loss due to sea level rise	Very High
Historic modifications to salt marsh	Very High
Land use incompatible with marsh migration	High
Transportation infrastructure that restricts tidal flow	High
Reduced sediment supply (e.g,. due to upstream dams)	High
New residential development in marsh migration zones	Medium
Shoreline hardening	Medium
Invasive/Problematic Species	Medium
Burning of marsh vegetation inconsistent with species' needs	Medium
Oil spills	Medium

Additional threats and stressors, such as elevated levels of contaminants found in salt marsh birds (Tsao et al. 2008) and nest depredation (Roberts et al. 2017), which may be affecting salt marsh bird populations are also not addressed in this plan as they were considered less important to the entire suite of salt marsh birds than threats associated with the conservation strategies selected.

NEST FLOODING AND HABITAT LOSS DUE TO SEA LEVEL RISE

Saltmarsh Sparrow chicks are susceptible to drowning as more frequent and higher flooding events inundate nests. Jeanna Mielcarek, SHARP

Nest flooding is considered to be driving the decline and disappearance of at least two and perhaps all three Tier A species. Sea-level rise and an increased frequency and intensity of storms due to climate change may ultimately be the single greatest threat to *all* salt marsh bird populations. Sea-level rise has been accelerating around the world since the end of the 20th century and most models predict major changes in the distribution and abundance of marshes in future decades, with large losses of high marsh expected by the end of the century (Ganju et al. 2017). Because sea-level rise causes higher tides throughout the breeding season, it can result in repeated nest flooding (Shriver et al. 2016) and increased nest failure rates for birds adapted to breeding in infrequently-flooded habitats. Major rain events and wind-driven tidal surge from more frequent coastal storms have also greatly increased the risk of nest flooding throughout the breeding season. Therefore,this plan focuses heavily on actions that would improve the resiliency of both coastal habitats and native bird populations to minimize the negative impacts of flooding due to sea level rise and storms.

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HISTORIC MODIFICATIONS TO SALT MARSHES

Historic ditches exacerbate flooding and reduce marsh integrity (Winnipaug Marsh in Rhode Island). USFWS

Atlantic Coast salt marshes have been modified by people (Milton et al. 2016) for nearly four centuries (Gedan et al. 2008), first for livestock grazing and hay cropping and eventually for many other forms of development (e.g., housing, transportation). The extent and degree of historic losses (Bromberg & Bertness 2005) and modifications is greatest in the northern half of the Atlantic Flyway (i.e., in New England) and declines as you move south (Kennish 2001). Modifications are less profound in mid-Atlantic states due in part to the region's vast expanses of salt marsh, although there is a high degree of modification in parts of New Jersey and Delaware. The largest and least impaired salt marshes occur from North Carolina to Florida.

Higher-elevation portions of salt marshes that flood least often have been most impacted, as those were most useful for agricultural production. Low dikes or banks often were built to prevent flooding, and extensive ditches were dug and natural channels were widened to improve drainage. Increased drainage increased oxygenation rates in marsh soils, leading to plant decomposition and lower biomass accumulation over time. Restrictions of tidal flow limited the sediment supply which is key to forming and sustaining tidal marshes. Salt marsh ditching became even more widespread in the early 20th century with attempts to control mosquito populations by draining pools where mosquitoes breed and creating access channels for mosquito-eating killifish. Ditch digging in salt marshes was a major focus of the Civilian Conservation Corps (CCC) and Works Progress Administration (WPA) prior to World War II. WPA workers dug 15,000 miles of ditches along the Atlantic Coast (Vileisis 1997) and CCC workers were responsible for work on thousands of miles of ditches in just two Delaware counties (USFWS, date unk.). Although only marginally effective at controlling mosquitos, ditching was carried out for decades, affecting 90% of salt marshes (Tonjes 2013) from Maine to Virginia. In the southeastern U.S., marsh ditching affects a much smaller proportion of coastal marshes.

Ditching and associated widening improves drainage but reduces tidal velocity, resulting in more sediment deposition within channels and less on the marsh platform. This can cause ditch networks to clog with silt and result in waterlogged marshes, which remain wet for long periods of time instead of regular wet and dry periods. Continuous wet conditions prevent plant roots from drying, which prohibits aerobic respiration, decreases the oxygen supply to plants and changes soil chemistry. These effects can reduce biomass production and even contribute to a complete die-off of marsh plants.

Relict ditches and dikes continue to interrupt natural marsh topography and hydrology while rising seas now exacerbate flooding in higher-elevation portions of the marsh where historic agricultural infrastructure traps and delays the exit of tidewater. Today, the platform in many historically-modified salt marshes has subsided and is below sea-level by more than a meter (Weinstein & Weishar 2002) in some areas. Subsidence is most problematic in portions of the coastal plain that are still sinking due to glacial isostatic adjustment. Areas that have experienced considerable subsidence pose a major restoration challenge for managers as reintroducing tidal flow could result in extensive areas of open water and/or tidal flats for many years and perhaps indefinitely due to sea-level rise. Additional sediment may be needed and/or tidal flow may need to be introduced gradually over time to maintain water depths that encourage salt marsh vegetation and allow sediment capture and biomass accumulation (above and below ground) so that the marsh platform can return to a state of positive growth (i.e., accretion).

LAND USE INCOMPATIBLE WITH MARSH MIGRATION, NEW RESIDENTIAL DEVELOPMENT, AND SHORELINE HARDENING

The integrity of a coastal marsh is reduced when developed. psyberartist, Creative Commons

All three threat categories above were considered important to salt marsh birds as they all relate to human development and how it affects salt marsh bird habitat or prevents marsh migration. From Massachusetts to Florida, over 40% of coastal land (i.e., below one meter in elevation) is currently developed and almost 60% (Titus et al. 2009) is expected to be developed in the future. Development adjacent to salt marshes negatively affects habitat quality and resiliency in several ways. The integrity of the marsh bird community is reduced (DeLuca et al. 2004) by sub/urban development within 500-1000 meters of the marsh. Development involves more impervious surfaces which increase marsh flooding and runoff of polluted water (White et al. 2004), especially during heavy rain events. Freshwater flooding events from uplands can contribute to nest losses for salt marsh birds (Shriver et al. 2016) and can degrade high marsh habitat by increasing ponding, particularly in areas where tidal restrictions may slow marsh drainage. Increased nutrients washing in from developed uplands can also lead to higher rates of decomposition in soil organic matter (Wigand et al. 2009), which reduces marsh accretion. Likewise, groundwater withdrawal to supply development or agriculture may also contribute to subsidence of the marsh platform (Beckett et al. 2016) by depleting shallow aquifers.

The ability of tidal marshes to migrate inland is considered to be the single most important way (Schuerch et al. 2018) that we can offset or prevent the net loss of wetlands (Schieder et al. 2018) as sea levels rise. Whether or not marshes will migrate inland depends largely on whether there are anthropogenic barriers or accommodation space (Schuerch et al. 2018) inland of tidal marshes. It is very important to prevent new residential or industrial development in marsh migration zones and enact policies that improve land use planning (e.g., zoning, permitting of activities) at local, county, state, and federal levels to protect upland areas with good potential for future marsh migration.

Shoreline hardening to protect coastal property from waves or tides (via sea walls, dikes, bulkheads, jetties etc.) is one of the most serious impacts of human development near salt marshes. Shoreline hardening is in place on 14% of the entire U.S. coastline and affects more than 50% of the shoreline (Gittman et al. 2015) in more developed areas. Increased shoreline hardening in a given area can increase water depth (Gittman et al. 2016) and wave energy (National Research Council 2007) in the intertidal zone, eroding and degrading areas of natural (i.e., unprotected) shoreline remaining. This can lead to 'cascading degradation' (Scyphers et al. 2015) where hardening by some landowners encourages or necessitates hardening by others who face increased erosion. In some places this has left little or no vegetated marsh on the seaward side of barriers and effectively blocks the migration of tidal wetlands inland. A diverse suite of methods known as "living shoreline" have been developed as a more natural alternative to shoreline hardening, which is less damaging to coastal ecosystems. Some living shoreline approaches have been effective (Currin et al. 2010) at capturing sediment and maintaining or increasing salt marsh patches. However, they have generally not been implemented at a large enough scale to benefit salt marsh birds, especially species associated with high marsh habitat.

TRANSPORTATION INFRASTRUCTURE THAT RESTRICTS TIDAL FLOW

Roads and railways are one of the primary drivers of salt marsh bird population declines (Correll et al. 2016). The construction of roads and railways (hereafter transportation infrastructure) often requires earthen embankments, which function as dikes and can dramatically affect wetland hydrology. Restricted tidal flow degrades, fragments, or eliminates salt marsh habitat, and deprives upstream areas of natural sediment supply and salinity, often leading to subsidence and changes in plant species composition (e.g.in the northeast and mid-Atlantic, invasive *Phragmites* (Common Reed) now dominates many areas that were formerly salt marshes). Historical impacts from transportation infrastructure to coastal wetlands and salt marsh birds is considerable and new transportation infrastructure continues to encroach upon marsh ecosystems. Therefore, ameliorating the negative effects of transportation infrastructure and preventing further degradation is an important strategy to conserve salt marsh bird habitat.

REDUCED SEDIMENT SUPPLY

The accumulation of fine-grained, suspended sediment (Friedrichs & Perry 2001) plays a fundamental role in the formation and maintenance of estuarine ecosystems (Dame et al. 2001). Salt marsh plants capture suspended sediments from tidal water which, along with accumulated organic matter, forms the marsh platform upon which plants grow. Sediment supply (Kirwan et al. 2010) and biomass production drive the accretion, or vertical growth, of the marsh platform which allows it to keep pace with sea level rise. If seas rise faster than sediment and organic material can accumulate, marshes will be flooded more frequently and may become permanently submerged.

In the past, marsh elevations generally kept up with (Vogel et al. 1996) sea-level rise, but the recent acceleration of sea-level rise and flooding (Ezer & Atkinson 2014) may exceed accretion rates (Beckett et al. 2016) and threatens to inundate salt marshes. The effect of sea-level rise is exacerbated in those parts of the Mid-Atlantic coastal plain experiencing subsidence due to glacial isostatic adjustment (Englehart et al. 2009). Kirwan and others (Kirwan et al. 2016) have argued that sediment accretion will prevent most salt marshes from disappearing, even with accelerated levels of sea-level rise. However, they did not specifically predict whether low marsh or high marsh will predominate or exist in the face of sea-level rise, and their data suggest that low marsh plants are more likely to keep up with sea-level rise, because they have higher accretion rates than high marsh plants. A recent study of Chesapeake Bay shows that even marshes with high levels of accretion were losing elevation (Beckett et al. 2016).

The construction of dams on coastal river systems was widespread from colonial times until the late 20th century, especially in the northeastern U.S. There are 75,000 dams in the United States (Graf 1999), with the greatest density occurring along the Atlantic Coast. New England has the highest density, with 0.059 dams per square mile. Many ecologists have expressed concerns about upstream dams limiting the supply of riverine sediment (McCarney-Castle et al. 2010) that reaches coastal marshes, thus depriving the marshes of a critical component of their sustainability. Removing upstream dams could provide an important source of sediment to certain salt marshes which may be in need of such inputs to keep up with sea-level rise. Concerted conservation efforts in recent decades have resulted in many--including some large and high-profile--dam removals. Most dams were removed to improve aquatic connectivity and habitat quality for fish and mussels, not to benefit salt marshes. Some of those projects may have improved sediment flow to tidal marshes. However, it is not clear whether there has been any assessment of which dams--if removed--could provide the greatest benefits to salt marshes. We need to better understand the effects of upstream dam removals on salt marsh integrity and sediment budgets, and their potential benefits to salt marsh bird populations.
In river systems with tidal marshes thought to be sustained by river-borne sediments, dam removal efforts should be coordinated with marsh restoration efforts so that partners can prioritize dam removals that would benefit aquatic species *and* high priority salt marsh habitats.

INVASIVE/PROBLEMATIC SPECIES

Salt marshes are more susceptible to invasion by non-native species (Byers 2009) than are other marine habitats. Introductions of several non-native plants, molluscs, crabs, and mammals (e.g., nutria) have radically changed salt marsh communities, although not all invasive species are detrimental (Coverdale et al. 2013) to salt marshes. In the northeastern U.S., an invasive form of Common Reed (*Phragmites australis)* colonizes and thrives in the lower-salinity areas behind tidal restrictions and dominates many former salt marshes. It is less of a problem in most of the southeastern U.S., but warrants management attention as far south (Ward & Jacono 2009) as South Carolina. *Phragmites* quickly forms a tall, dense monoculture, which excludes most other plant species and dramatically lowers the habitat value for most wildlife, including priority salt marsh bird species. Currently, few invasive species impact salt marshes to the extent that *Phragmites* does. However, regular monitoring should occur, especially in the southeastern U.S. where introductions of invasive species are frequent and on-going.

Strategic Control of Phragmites

Invasive monotypic stands of *Phragmites* cover (Correll et al. 2018) approximately 256 km² of tidal marsh area from Maine to Virginia—nearly ten percent of the total area of coastal marsh habitat. Despite the fact that invasive *Phragmites* stands typically host relatively few native salt marsh birds, *Phragmites* control is not necessarily considered an important restoration strategy for salt marsh birds. This is due in part because *Phragmites* may be better able to keep up with (Rooth & Stevenson 2000) sea-level rise than some native marsh grasses, mainly through underground biomass accumulation, and thus can contribute to marsh stability in areas experiencing serious erosion from waves. Also, *Phragmites* control may not be the best return on investment in comparison to other management options that could improve salt marsh habitat. Effective control of *Phragmites* where it is well established is often difficult, costly, and requires ongoing resource investments. However, its control may be necessary in marsh migration zones where *Phragmites* can otherwise become dominant and prevent establishment and successful migration of native salt marsh plants. In such areas, the benefit may be worth the cost of ongoing control. There are many ways to control *Phragmites*, but chemical herbicide is most effective. New biocontrol measures are being tested in Canada and the U.S., and early results have been promising.

Because *Phragmites* is relatively intolerant of salt water, it is usually eliminated if tidal flow is restored to restricted areas. Although restoring or increasing tidal flow may control *Phragmites,* subsidence behind the restriction may lead to loss of suitable elevation for high marsh habitat (Elphick et al. 2015). Therefore, investing in tidal flow restoration should not be done solely to control *Phragmites*; it should be done where it is most likely to restore higher-elevation marsh habitat.

Invasive plants like non native Phragmites out-compete native salt marsh plants. Chesapeake Bay Program, Creative Commons

NEST PREDATORS

Although nest-flooding is an important cause of nest mortality in some salt marsh bird populations, notably along the north Atlantic Coast, nest mortality due to depredation is also significant (Greenberg et al. 2006). In fact, in some places nest depredation is the single-most important factor (Roberts et al. 2017) affecting salt marsh bird breeding productivity. There are few studies identifying which nest predators have the greatest influence on focal species and it may vary by state or region. In some areas, raptors or corvids (i.e., crows and relatives) are thought to be important; in other places it may be mid-sized mammals such as racoons (*Procyon lotor*) and skunks (*Mephitis mephitis*) or, in urban marshes, non-native rats (*Rattus norvegicus*) and house cats (*Felis catus*) may be most significant, especially where their populations are subsidized by human activities (e.g., garbage, agriculture, feeding). Snakes are major sparrow nest-predators in the southern U.S., and several species are found in salt marshes.

Although nest mortality by native predators is a natural aspect of salt marsh bird ecology, it can be a limiting factor for breeding productivity and may require management attention in the future, especially in marshes known to be particularly important for their contribution to the species overall population. Salt marsh birds may face a trade-off between nest flooding and depredation (Greenberg et al. 2006), which may be additive or compensatory. Nests that don't get flooded may be more likely to get depredated and those that are flooded may be rebuilt higher in the vegetation where they are more vulnerable to predators.

The salt marsh snake is one of many likely predators of salt marsh birds. Andrew Hoffman, Creative Commons

Prescribed fire must be used carefully to restore habitat and avoid harming salt marsh birds. US Army Corps of Engineers

PRESCRIBED FIRE

Prescribed fire is used for salt marsh management, particularly in the Southeast, where it is often used to control encroachment by woody and/or invasive plants that can degrade marsh quality. Fires are a natural disturbance in salt marshes and one from which they can recover relatively quickly (Schmalzer et al. 1991), but salt marshes are not generally recognized as fire-dependent systems. Burning can promote higher biomass, plant species richness, stem densities, and a higher marsh platform (McKee & Grace 2012), but can also damage plant roots and the peat layer, reducing or eliminating plant species that are important to salt marsh birds. Therefore, burning has to be done properly and carefully to avoid conflicts and undesirable impacts on priority species.

Burning can have a negative outcome on target species (e.g., Black Rail) if done too often or too infrequently, at more vulnerable times of year, or when water levels are too low. Burning in a pattern (e.g., "ring fires" or fast-moving head fires) that doesn't allow birds to easily escape a fire can cause direct mortality to individuals if they are present and unable to escape (e.g., during molt) when a site is burned. Such incidental mortality can be avoided if prescribed fire provides adequate refugia within the burn unit as well as escape routes. Prescribed fire that occurs outside of the nesting season and avoids critical life stages (e.g., egg, chick, and molting) will reduce mortality of high priority species and other marsh birds. Use of prescribed fire to control *Phragmites* stands can be problematic, as burning stimulates its rhizome production and adds nutrients to the estuarine system, which benefit *Phragmites* and promote its spread. As an intermediate step between two successive herbicide treatments, however, burning or mowing can be effective at removing aboveground biomass and encouraging establishment by native plants.

OIL SPILLS

Although rare, oil spills are an important threat. A single event at the wrong time and place could have a significant impact on populations of priority salt marsh birds, especially those with relatively small populations and/or range. A major oil spill during the breeding season in certain areas (e.g., coastal New Jersey, Chesapeake or Delaware Bay) could affect a substantial portion of the global population of a subspecies such as Coastal Plain Swamp Sparrow, and greatly increase extinction risk. A spill affecting large areas of the southeastern U.S. could affect many species during breeding, migration, and/or wintering. It is critical that priority marshes be integrated into spill response plans.

Oil spills can have a devastating impact to birds and habitats for years. Massachusetts Department of Environmental Protection

Section 4:

CONSERVATION APPROACH

The fundamental goal of this plan is to secure populations of all avian species expected to undergo measurable population declines due to changes in salt marsh habitat over the next 50 years. Given the high rate of decline documented for highest priority species throughout the ACJV, the most immediate need is to halt population declines. Once we have successfully stabilized populations we can work towards desirable population recovery goals, which ACJV partners have established for Saltmarsh Sparrow and Black Rail, as described in their respective conservation plans.

A FOCUS ON HIGH MARSH

Within salt marshes, it is the higher-elevation marsh habitat that is facing the most serious and imminent threat and is expected to be the most difficult to sustain in the face of sea level rise. Consequently, the highest priority species in this plan are dependent on high marsh for nesting. Salt marsh bird conservation will be most effectively achieved if partners approach it through the lens of high marsh conservation needs and priorities. Partners should pursue strategies and actions that maximize benefits to this habitat and its associated species whenever possible. Under the principle of “first do no harm,” conservation implementation at a site should explicitly consider whether or how management actions may negatively affect existing high marsh habitat. Negative impacts should be avoided or minimized unless they are absolutely necessary or there is a high level of certainty that the action will provide clear benefits to high marsh habitat over the medium or long-term.

High marsh habitat in New York. Sandra Richardson, Creative Commons

A SHIFTING MOSAIC

Supporting focal species at target levels over the long term will require that we maintain a consistent amount of high-quality habitat that is capable of supporting stable or increasing populations. Achieving this goal will require a clear focus on habitat quality in addition to quantity. For example, sustaining a target population of 25,000 Saltmarsh Sparrows requires providing and conserving--over the long-term--at least 84,000 acres of high-quality high marsh throughout their breeding range, in a condition that allows population growth. The contribution of specific areas may change from year to year and over decades. Some acres will be lost to sea level rise, others gained through marsh migration, while others will be restored or degraded. Therefore, it will be important for land managers to protect, restore and maintain as many of the highest priority marsh patches and marsh migration corridors as possible to ensure the coastal marsh system has the ability to support a shifting mosaic of high quality habitat over multiple decades.

ADAPTIVE MANAGEMENT

Although there is a considerable body of past and ongoing research and implementation focused on restoring and improving tidal marshes, there are few examples that directly benefit high marsh habitat for focal species of salt marsh birds. This plan calls for the immediate development and implementation of a menu of new management actions and approaches focused on high marsh habitat, across multiple states, to halt declines of focal species. Many of the conservation actions recommended in this plan represent relatively new approaches that need to be tested and evaluated. It is therefore critical to develop and employ an adaptive management framework whereby all of the habitat conservation actions described in this plan—protection, restoration, and enhancements—are monitored and evaluated to determine whether and the degree to which they are working. That kind of experimental approach to management will allow partners to understand whether their actions are working as expected, under what conditions they are successful or not, and how they contribute to population stability or growth. This allows partners to improve the effectiveness and efficiency of conservation efforts as rapidly as possible and understand the cost-effectiveness of various management options to inform future investments. This is discussed further below, in the Monitoring & Evaluation section.

Artistic swirls of Spartina patens. Dana Filippini, NPS

Section 5:

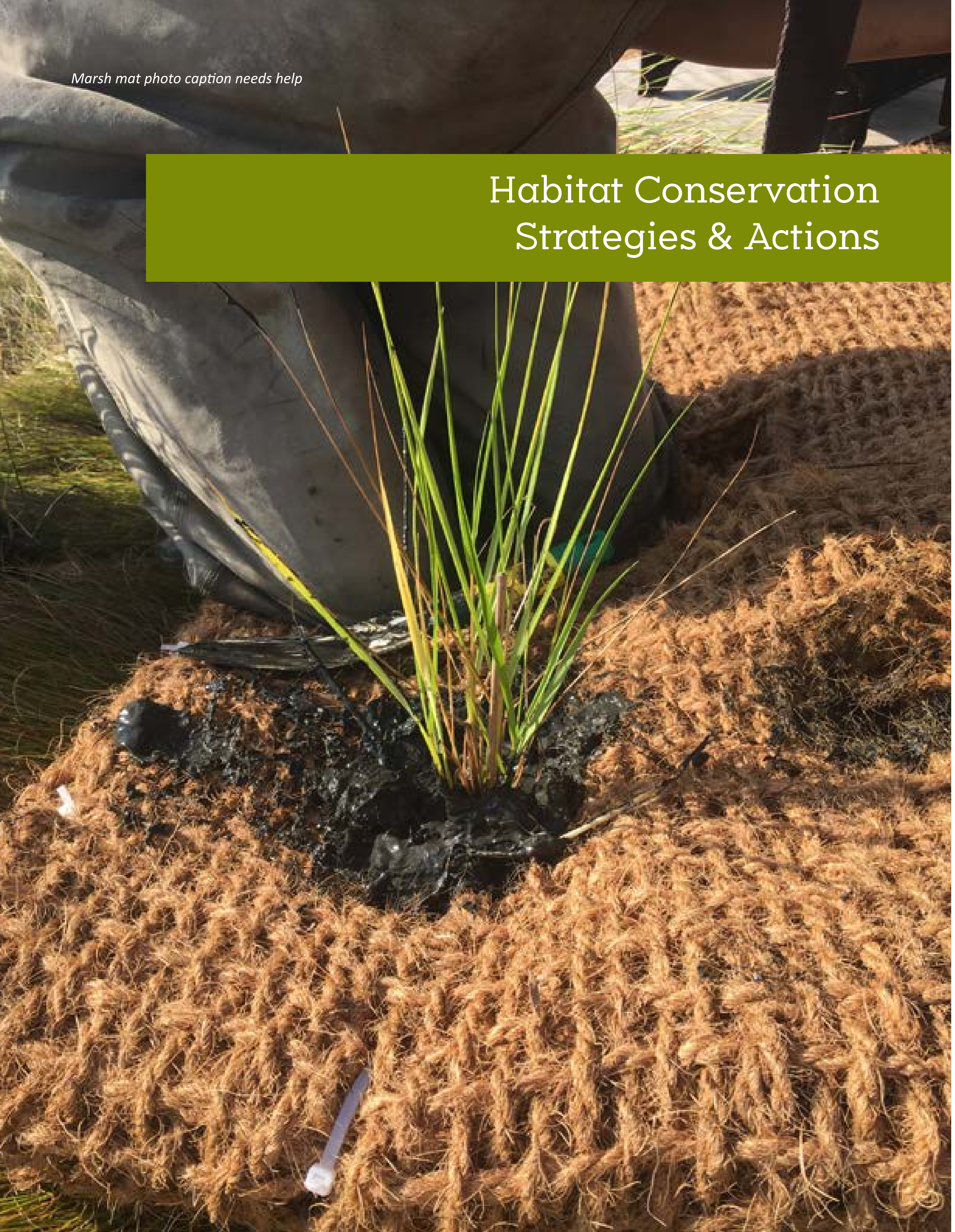
IMPLEMENTATION STRATEGIES

It is critical that we initiate conservation efforts immediately for salt marsh bird populations given their steeply-declining trends. In many cases, somewhat novel management actions are suggested to benefit high marsh habitat. Because there is uncertainty about which approaches are most likely to be effective in various situations, implementation should be carried out in an adaptive management framework, whereby management actions are initiated and rigorously monitored and evaluated to understand the efficacy of various approaches. Although there are a small number of "no regrets" actions that we can begin to implement now, such as land protection in areas buffering existing salt marshes, most actions proposed in this plan will require some degree of testing, replication and evaluation before broad scale recommendation is possible. This experimental or adaptive approach is necessary to rapidly increase understanding and determine the most effective—and cost-effective— implementation approaches for various species and situations.

This plan details eight major strategies considered to meet the highest priority conservation needs, address major threats, and achieve species and habitat goals in the ACJV area. Each strategy has a corresponding set of activities and actions considered necessary to reach the desired outcome, including specific and measurable objectives. These strategies are all designed to move us toward our shared goal of achieving sustainable populations of salt marsh birds and their habitats (Figure 3). For each major strategy we developed a comprehensive logic model or "results chain." These diagrams, based on theory of change, illustrate the sequence of actions needed to achieve a desired result, including assumptions underlying each step in the chain.

The eight major implementation strategies are grouped into two categories:

- ***Habitat Conservation (protect, restore, and manage areas for salt marsh birds)***
  - Restore and Enhance Degraded Salt Marsh
  - Prioritize Transition Zone Acquisition
  - Develop and Implement Best Management Practices (BMPs) to Facilitate Marsh Migration and Offset Losses
  - Increase Use of Dredged Material to Benefit Salt Marsh Habitat
- ***Policy, Planning, Outreach (incorporate conservation into various agency policies)***
  - Integrate Salt Marsh Conservation into NRCS (Farm Bill) Programs
  - Engage Transportation Agencies to Improve Infrastructure
  - Engage/Improve Local Land-Use Planning Process
  - Alleviate Impacts from Contaminants and Spills



Marsh mat photo caption needs help

Habitat Conservation Strategies & Actions

Achieving our overarching goal of stabilizing and reversing declines of priority bird populations will require several key strategies involving habitat conservation work on the ground, including land protection, habitat creation, restoration, enhancement, and management, to achieve specific outcomes. Priority bird populations are declining throughout most of their range due to degraded habitat conditions; populations are stable or increasing at only a small minority of sites. Therefore, it is imperative to improve habitat conditions on a broad scale throughout the ACJV to stabilize bird populations.

It is also crucial to be proactive in order to maintain a sufficient quantity and quality of salt marsh habitat in the future to offset expected losses in salt marsh habitat—especially higher elevation salt marsh habitat—as sea level rises (Schieder et al. 2018). This involves protecting upland/inland buffer zones around existing salt marshes and protecting marsh migration corridors to allow marshes to migrate inland over time. Marsh migration may be compromised by invasive species or other challenges, or may not occur fast enough to keep up with the rate of habitat loss due to sea-level rise. Therefore, we must develop methods to facilitate marsh migration to ensure that enough high-quality habitat exists in the future.

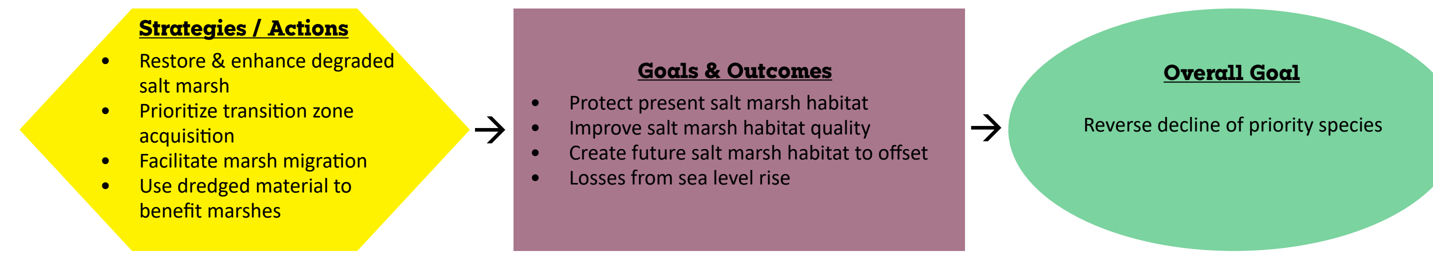


Figure 3. Heuristic diagram of habitat conservation strategies with results chains.

STRATEGY: RESTORE AND ENHANCE DEGRADED SALT MARSH

About half the salt marsh habitat along the Atlantic Coast is already under conservation ownership and the rest is protected to some degree by statutes that prohibit or limit development in and around wetlands. However, most of the existing salt marsh has been degraded, often significantly, due to past land use and rising seas. Restoring and enhancing the functionality and resilience of existing salt marshes is a critical need that must be addressed in order to slow or reverse the negative population trends observed for most salt marsh birds. However, relatively little is known about which restoration or management practices can most effectively improve marsh resiliency and reduce accelerated nest flooding rates. We must work quickly to develop tools that identify the best places to work and the most effective conservation practices to apply in each priority area. The following five objectives have been established to achieve this goal, for the ACJV area:

> ***Objective 1a***: By 2020, create and make available a map of priority marshes for salt marsh birds and indicate where tidal flow restoration or other management is needed to improve habitat conditions (e.g., nest success).
>
> ***Objective 1b***: By 2020, create and make available a map of impoundments to help identify opportunities to manage habitat for priority birds outside of natural tidal marshes (e.g. Black Rail).
>
> ***Objective 1c***: By 2020, create and make available an updated map of Phragmites patches to inform management action.
>
> ***Objective 2***: By 2020, begin to implement a series of restoration / enhancement actions needed for priority species across replicated sites, which can be evaluated in an adaptive management framework to develop BMPs. See Page 44 for more information on design considerations.

Some of these actions are in early testing while others have never been tested but are deemed promising by salt marsh experts. We must test these strategies in as many marshes across as many states as possible to quickly learn what works and what doesn't and revise and adapt our implementation strategies. Successful strategies will be site-specific and will depend on a variety of local factors related to conditions at a given site, including geomorphology, sediment supply, extent of historic stressors (e.g., ditches), distance from harbor/channel dredging activities, etc.

Objective 3: Within one year of identifying priority marshes, communicate promising restoration enhancement actions to landowners, including agencies and NGOs, of at least 50% of priority marshes.
Activity: Develop/publish guide that indicates most appropriate and promising restoration and enhancement actions for various salt marsh conditions
Activity: Identify owners of key parcels, prioritizing largest and most important first.
Activity: Communicate to landowners the importance of their land for conservation.
Activity: Offer landowners incentives for conservation action on their property.

Objective 4: Within 5 years of plan completion, create State or regional-level working groups focused on driving implementation throughout the ACJV region.

Objective 5: Within 10 years of identifying priority marshes, ensure conservation partners have expertise, resources, and funding to restore/enhance 50% of priority marsh areas.
Activity: Develop and circulate a list of experts in salt marsh restoration techniques.
Activity: Develop and circulate a list of funding options for salt marsh restoration.
Activity: Develop and circulate a list of large equipment that can be made available to managers for salt marsh restoration projects (e.g., Marsh Master).
Activity: Conduct workshops to promote most promising techniques, share valuable lessons learned, and stimulate additional work in at least five high priority landscapes.
Activity: Use the publicly accessible ACJV Tracking Tool to house information on restoration projects throughout the ACJV.

Objective 6: Within 10 years of identifying priority marshes, ensure land managers and landowners on at least 50% of priority marsh areas are conducting restoration/enhancement activities such that the following conditions are met:
- ☐ Nest densities and/or productivity equals high-quality reference sites; and
- ☐ Successful breeding of focal species occurs on sites where they were absent; or
- ☐ Site has above-average value as migration/winter habitat for focal species.

Activity: ACJV States, Federal agencies, and conservation organizations include salt marsh restoration in their annual plans.
Activity: Priority private landowners voluntarily enroll in cost-share programs for salt marsh restoration.

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

AT A GLANCE: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING RESTORATION AND ENHANCEMENT

Depending on the site, one or more of the following actions is likely to improve habitat quality for priority birds (see Table 5 for species and regional priority rankings, p.46):

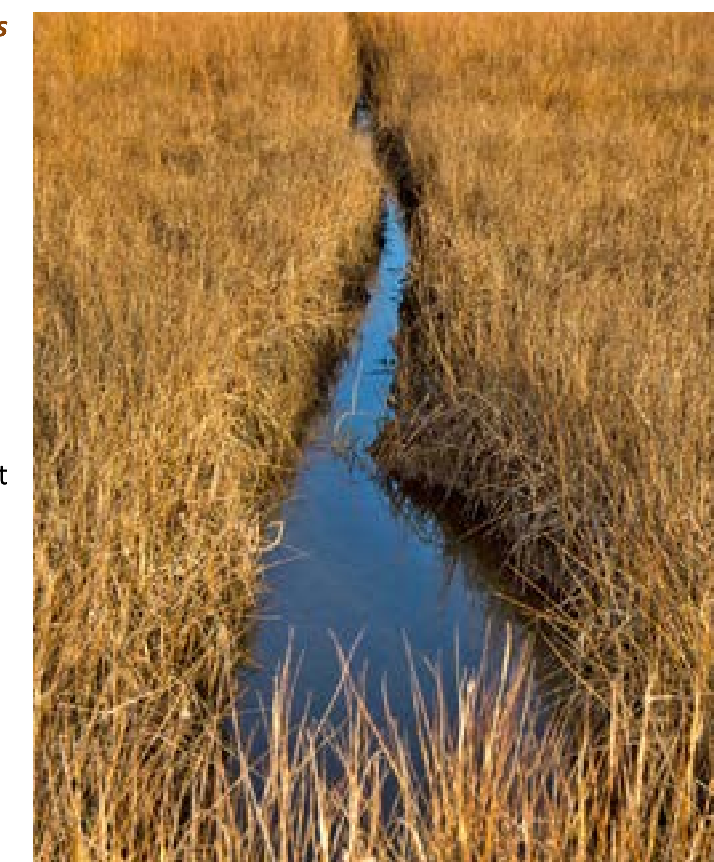
- Use existing infrastructure (e.g., berms and tide gates) to dampen spring tides or storm surge to improve nest success.
- Remove tidal restrictions to restore tidal flow where it will benefit high marsh habitat.
- Improve drainage by remediating ditches, trunks, and dikes to restore more natural hydrology.
- Create runnels to improve drainage of ponded areas.
- Apply thin-layer deposition of sediments to increase marsh elevation.
- Develop methods of improving accretion (e.g., sediment supplementation) in areas where tidal restrictions could be removed.
- Create microtopography/mounds to reduce nest flooding.
- Control predators, where predation is known to be a limiting factor.
- Create living shorelines in areas that would benefit high marsh habitat conservation.
- Use prescribed fire to improve habitat quality.
- Strategically control Phragmites or other invasive plants if it is likely to result in high marsh.
- Strategically remove dams to increase sediment input to priority marshes.

Use existing infrastructure to dampen spring tides or storm surge to improve nest success

Where priority tidal marshes have existing berm and/or tide gate infrastructure in place, these water control structures can be modified to dampen spring tides that cause nest flooding. This can be done as part of an effort to restore or improve tidal flow at a site (e.g., removing under-sized culverts where the berm itself dampens spring tides) or when replacing or upgrading water control structures (e.g., by installing a self-regulating tide gate). Natural tidal flow could be allowed throughout the year except for the highest tides that would cause nest flooding during the breeding season.

Remove tidal restrictions to restore tidal flow where it will benefit high marsh habitat

Where tidal flow is restricted, marsh extent, integrity, and resilience can be improved by removing or enlarging the restriction (e.g., replacing culverts with an open span or larger box culvert). However, care should be taken to select sites that are likely to provide high marsh habitat after tidal flow is restored; past tidal restorations



Runnels are shallow, narrow ditches that help drain off impounded water. Steve Droter

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

often resulted in extensive low marsh areas that do not provide habitat for priority species. Tidal flow should be reintroduced gradually to provide an optimal depth for marsh grass production and accretion. This is especially important where subsidence has lowered the marsh platform and will help to avoid creating extensive areas of open water.

A low ground pressure excavator is moved into position on the salt marsh at Seatuck National Wildlife Refuge to spread freshly dredged sand in waterlogged section of marsh. C. Comber, USFWS

Improve drainage by remediating ditches, trunks, and dikes to restore hydrology

Restoring more natural hydrology is very important in tidal marshes that have been substantially modified, and is often critical to improving or ensuring their resilience in the face of sea level rise. Extensively ditched marshes can be improved or restored by filling at least some (but not all) ditches with sand or sediment (working from the upland edge) or cutting and raking salt hay into selected ditches to trap sediment. This can result in more sheetflow of tidal water across the marsh which increases sediment capture and accretion of the marsh platform. Trunks or water control structures and portions of dikes can be removed to allow tidal flow, or replaced with tide gates that can facilitate gradual reintroduction of tidal flow over time, which may be necessary to restore areas that have experienced subsidence.

Create runnels to improve drainage of ponded areas

Where tidal marshes are water-logged because of impeded drainage, hydrology can be improved by creating runnels--shallow channels that connect to existing tidal creeks. Relatively short and shallow (6-12") runnels can be made by hand using shovels, although long or deep runnels (~1m deep or wide) will require heavy equipment.

Apply thin-layer deposition of sediments to increase marsh elevation

Applying a thin layer of sediment (e.g., spraying a slurry of water and sediment from dredge sites) to the marsh surface can increase or maintain the elevation of the marsh platform. This practice has been successfully used in several marshes where accretion is not keeping pace with sea-level rise. It is usually quite expensive, and is most likely to be practical in marshes where dredging is occurring nearby.

Develop methods of improving accretion (e.g., sediment supplementation) in areas where tidal restrictions could be removed

Sediment transport in and out of marshes is a driving force in marsh formation and resilience and ultimately determines whether restoration efforts succeed or fail over longer time scales (Ganju 2019). Some practitioners have suggested that we may be able to improve accretion by providing additional sediment into the system (e.g., regularly adding sediment into tidal creeks), after tidal restrictions are removed. This could help resolve the challenge related to restoring tidal flow to areas that have experienced significant (e.g., > 1m) subsidence. Although theoretical at this point, this approach merits additional consideration, experimentation, and evaluation.

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RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

Create microtopography/mounds to reduce nest flooding

Related to the idea of thin-layer deposition, practitioners have proposed and are testing the use of sediment, large mats (e.g., made of plastic or natural coir fiber), or other methods to create small "islands" of higher elevation, to create micro-habitats that experience less flooding and thereby improve nest success for priority species.

Control Predators

Where nest predation is known to be the primary limiting factor for breeding birds, one of the most cost effective approaches to stem population declines may be to reduce predator access to nesting habitat (e.g., by fencing) or reduce known predator populations or individuals identified as having a large impact on target species.

Create living shorelines in areas that would benefit high marsh habitat conservation

In some areas, erosion from waves or currents is jeopardizing the size and integrity of large areas of salt marsh and causing widespread losses. Various approaches known as living shorelines, including oyster reefs and rock sills that provide fish habitat, can reduce erosion and provide long-term benefits to the entire tidal marsh ecosystem. To benefit priority salt marsh birds, living shorelines should target areas where substantial high marsh habitat is at risk.

Use prescribed fire to improve habitat quality

Prescribed fire is used to control woody encroachment or invasive species to improve habitat quality, particularly in the Southeast. Fires are a natural disturbance in salt marshes and one from which they can recover relatively quickly, although salt marshes are not generally recognized as fire-dependent systems. Burning must be done carefully and according to best management practices to avoid causing harm to focal species such as Black Rail.

Strategically control Phragmites and other invasive plants

Invasive non-native plants (e.g., *Phragmites australis*) can dominate salt marsh habitat and prevent colonization of native marsh grasses in transition zones where marshes are migrating into upland areas. Where it will likely result in quality high marsh habitat, invasive species control may be a necessary approach to habitat management and conservation.

Strategically remove dams to increase sediment input to priority marshes

Strategically removing dams in coastal rivers may provide an important source of sediment that may be necessary for ensuring that tidal marsh accretion can keep pace with sea level rise. Although dozens of dam removals have occurred in recent years, there are few or no examples demonstrating direct benefits to salt marshes. That could be due to lack of research or because the focus of most dam removals has been on fish passage. Many projects also try to avoid increases in sediment that might reduce water quality for priority aquatic species (e.g., mussels).

RESTORATION SPOTLIGHT

Innovative Restoration Techniques: Ditch Remediation Heals Marshes

USFWS salt marsh scientist, Susan Adamowicz, and wetland restoration professional, Geoff Wilson, have been developing a series of innovative techniques to restore impaired tidal marshes by remediating ditches. Ditches have severely disrupted natural tidal hydrology across nearly 90% of northeastern salt marshes. Adamowicz and Wilson are re-purposing salt hay farming techniques to try to restore a more naturalized tidal channel network within existing ditch infrastructure at Rachel Carson and Parker River NWRs.

Ditch remediation works by "healing" a ditch from the bottom up, using materials and processes that mimic natural peat formation. The ditch remediation process consists of cutting salt hay grass from the marsh surface (after the nesting season) and raking or rolling it into selected ditches within a given tideshed. The grass is tamped down and held in place with untreated sisal twine soaked in vegetable oil and secured around wooden stakes. As the tides flood and ebb through the treated ditches, the hay traps sediment from the water column and gradually builds elevation. When a suitable elevation is reached, *Spartina alterniflora* begins to grow from seeds and rhizomes. The growing plants continue to filter sediment from the water and also start adding below-ground biomass, further building elevation in the ditch.

The goal is to accelerate the healing process for treated ditches and to increase the flow of water through other primary flow channels in order to restore a more natural tidal channel network. Ditch remediation is strategic and is never applied to every ditch. In the pilot sites at Rachel Carson NWR, the rolled salt hay started trapping sediment immediately and S. alterniflora seedlings sprouted within one year. Additional layers of salt hay were added annually for three years in order to more rapidly reach an elevation throughout each treated ditch to better support plant growth. Importantly, ditches are never filled to be level with the surrounding marsh in order to avoid the negative impacts of ditch plugging, which can oversaturate surrounding marsh peat and lead to numerous unintended consequences.

Hurricane Sandy funds led to additional work at Parker River NWR through a partnership with Dr. David Burdick at the University of New Hampshire and Nancy Pau, Parker River NWR biologist. This same technique is now being applied at even larger sites (e.g., approximately 100 acres) on property owned by The Trustees of Reservations in Newbury, MA. A publication describing ditch remediation should be available soon (Burdick et al. 2019 under review, Estuaries and Coasts).

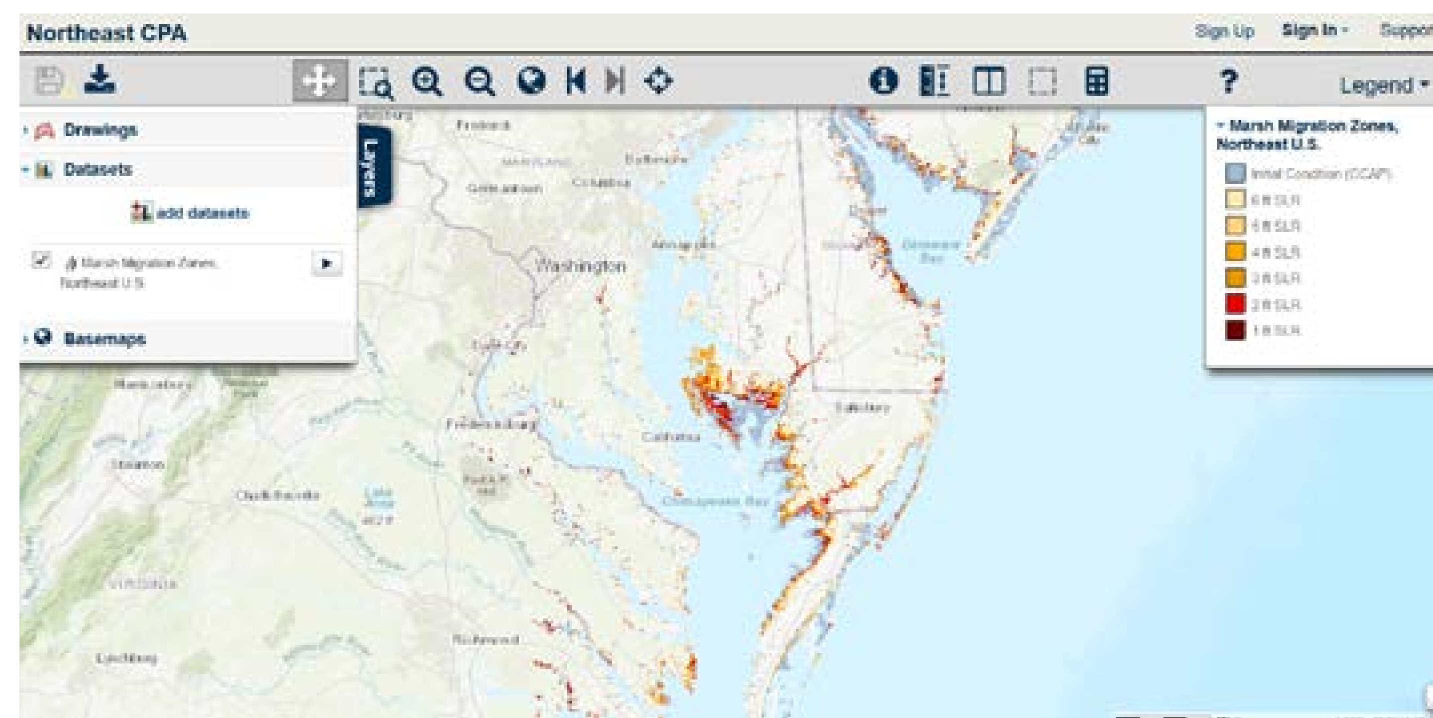
A mowed and rolled ditch at Parker River NWR, April 2011 (left) and August 2012 (right). Spartina alterniflora continues to grow in the treated ditch despite several inches of salt hay rolled into it three times over three years. Susan Adamowicz

STRATEGY: PRIORITIZE TRANSITION ZONE PROTECTION

Regional (Craft et al. 2008) and global (McFadden et a. 2007) assessments of salt marsh loss due to sea level rise predict a 20% to 50% loss of salt marsh habitat by the end of the century. Modeling simulations (Kirwan et al. 2016) suggest that marsh migration into neighboring uplands in the continental U.S. could offset 78% of marsh loss, although this figure does not distinguish lower from higher elevation marsh and the percent of high marsh is likely to be much lower. In addition, new buildings and other development in the future could reduce the extent of marsh migration.

High priority marsh migration zones have been identified and mapped by The Nature Conservancy for the northeast and southeast (available in October 2019). These products provide a roadmap to prioritize land protection under one-foot to six-foot sea level rise scenarios. It is critical to identify and protect the remaining undeveloped areas capable of supporting marsh migration and likely to be important to salt marsh birds. Under predicted development scenarios, opportunities to protect large, unfragmented areas will become increasingly rare, including areas not currently contiguous with current salt marsh but predicted to become future salt marsh. This underscores the urgency to protect key areas as quickly as possible. The following four objectives were established to achieve this goal:

> ***Objective 1***: By 2019, identify priority salt marsh and adjacent lands suitable for marsh migration in at least 10 states, which are needed to meet priority species' population goals based on predicted future habitat loss.
>
> ***Objective 2a***: By 2019, identify funding sources to pursue to protect prioritized marsh migration habitat, in fee or easement, to meet regional priority species' population goals.
>
> ***Objective 2b***: By 2027, secure enough funding to protect 50% of priority marsh migration corridors.
>
> ***Objective 3***: By 2037, at least 50% of priority corridors for migration are sufficiently protected to allow marsh migration to help offset expected losses due to sea-level rise over the next 30 years.



The Nature Conservancy has produced maps to guide conservation in the marsh migration zone. TNC

STRATEGY: DEVELOP & IMPLEMENT BEST MANAGEMENT PRACTICES TO FACILITATE MARSH MIGRATION & OFFSET LOSSES

Protecting land in the marsh migration zone may not be sufficient to ensure that marshes of the appropriate quality and quantity needed by salt marsh bird populations can migrate inland. We must also determine whether and how to facilitate marsh migration into suitable areas to ensure that adequate habitat exist for focal species. There have been relatively few studies to determine which actions are effective at ensuring successful marsh migration.

A healthy marsh allows Saltmarsh Sparrow and other species to thrive. ©Scott Heron, Creative Commons

Marsh migration is occurring naturally in many places, particularly in areas of gentle topography, such as the Mid-Atlantic and Southeast where saltwater intrusion is leading to the creation of 'ghost forests' and unproductive crop lands. However, in some areas salt marsh has not migrated into adjacent uplands presumably because of steeper slopes (Field et al. 2016) (e.g., in New England), lower rates of saltwater intrusion (Smith 2013), or the occurrence of Phragmites.

Even where gentle topography promotes saltwater intrusion, uplands do not always convert effectively to high marsh suitable for salt marsh birds. Ghost forests of dead and dying trees persist for many years after high marsh vegetation has colonized the ground layer, and transitional zones are particularly vulnerable to Phragmites invasion (Smith 2013) because of their lower salinity and partial shade. Transition zones can become waterlogged and convert to open water instead of high marsh.

There has been considerable research into factors affecting the movement of salt marsh plants into upland areas but examples of experimental management techniques to facilitate that process are limited, and more work must be done to understand how to facilitate this process where possible (Anisfeld et al. 2017) and to ensure that new marsh created includes adequate high marsh.

Facilitation techniques could include removing snags to increase light penetration into forest understories and control of Phragmites to facilitate high marsh grass formation in high priority areas. Tidal creek extension can be used to alleviate ponding and increase plant vigor in transitional marshes with sufficient elevation to drain. Given the rapid rate of sea-level rise and how long it takes for plant communities to form and birds to find and use new habitats, there is a pressing need to implement replicated pilot projects throughout the Atlantic Flyway to develop effective management methods for facilitated marsh migration. Implementation methods should be evaluated in an adaptive management framework to enable rapid assessment and adoption of the most effective approaches.

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The following objectives will be necessary to achieve our goals:

Objective 1: By 2023, implement experimental projects in at least 25% of priority migration corridors to identify effective management methods to facilitate marsh migration.

Objective 1b: Institute monitoring protocols to evaluate the effectiveness of various management actions and develop BMPs for marsh migration.

Objective 2a: Within five years of pilot project initiation, convene partners to exchange information and recommend regional BMPs for marsh migration.

Objective 2b: Within three years of BMP development, ensure that 100% of landowners and managers of priority areas can access BMPs in usable format.

Objective 3: Within five years of BMP development, ensure that landowners covering at least 50% of priority areas have the capacity (e.g., knowledge, equipment available to use, incentives, funds, etc.) to manage marsh migration.

- Activity: Develop and circulate a list of experts in facilitated marsh migration.
- Activity: Develop and circulate a list of funding options for facilitated marsh migration.
- Activity: Develop and circulate a list of heavy and low ground pressure equipment that can be made available to managers for marsh migration projects.
- Activity: Conduct workshops to promote the most promising techniques, share valuable lessons learned, and stimulate additional work, in at least five high priority landscapes.
- Activity: Use the publicly accessible ACJV Tracking Tool to house information on marsh migration projects throughout the ACJV.

Objective 4: Within five years of BMP development, all state permitting agencies develop permitting guidelines that allow BMP activities.

Objective 5a: Within 10 years of BMP development, ensure priority land managers and landowners are managing marsh migration on at least 25% of priority marsh migration corridors.

- Activity: ACJV States, Federal agencies and conservation organizations include facilitated marsh migration in their annual plans.

Objective 5b: Within 10 years of BMP development, assist priority landowners with NRCS sign-ups to implement BMPs on at least 10% of priority marsh migration areas.

Removal of this dike restored 35 acres of salt marsh. Chuck Hayes

FACILITATED MARSH MIGRATION: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

AT A GLANCE: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING FACILITATED MARSH MIGRATION

Several different management actions exist that could facilitate the transition of salt marsh into adjacent uplands. The optimal strategy will depend on a variety of site-specific factors such as slope and geomorphology.

- Remove snags in "ghost forests".
- Remove *Phragmites* in priority marsh migration zones.
- Terrace/contour slopes adjacent to existing marshes to expand marsh platform and increase accretion rates.
- Remove barriers that are impeding marsh migration and restore high marsh habitat behind them.
- Convert agricultural and open areas to marsh habitat.
- Extend tidal creeks in transitional marshes to drain areas that have become ponded.

Remove snags in "ghost forests"

In many areas of the Southeast and Mid-Atlantic, "ghost forests" have formed where rising seas have resulted in saltwater intrusion into forested uplands. The presence of snags may deter colonization by salt marsh birds and increase nest predation rates by providing elevated perches for avian predators. A recent study (Marshall 2017) demonstrated that perceived openness, measured by the angle to the horizon, is a greater predictor of abundance for Saltmarsh Sparrow than patch size. Sites with angles to the horizon of zero degrees supported the most birds while abundance dropped significantly at angles greater than 13 degrees. There are limited studies (Taillie et al. 2019) of how snags influence occupancy of other salt marsh birds but at least one study suggests (Marshall 2017) that openness should be a prioritized marsh characteristic. At least one experiment, at Blackwater National Wildlife Refuge (NWR), is investigating the role of snag removal in terms of habitat use by salt marsh birds.

Remove Phragmites in priority marsh migration zones

Areas in the marsh migration zone can become dominated by invasive Phragmites, which inhibits establishment of native tidal marsh plants. Ensuring that habitat in migration zones becomes suitable high marsh may require control of Phragmites on an ongoing basis until salinity levels rise sufficiently to control it naturally.

Dead loblolly pines stand like skeletons over a drowned salt marsh at Blackwater NWR. Sea level rise and land subsidence result in brackish water intruding on forested land and killing trees. Chesapeake Bay Program

FACILITATED MARSH MIGRATION: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

Terrace/contour slopes adjacent to existing marshes to expand marsh platform and increase accretion rates

Vertical marsh development processes are critical (Cahoon et al. 2018) to keep pace with sea level rise. That process is typically driven by sediment capture and accumulation of organic matter—both above and below ground— through vegetation growth. The width and total area of tidal marsh adjacent to upland areas are directly related to its ability to buffer or prevent wave erosion and its accretion rate or ability to keep up with sea level rise. Narrow marshes do little to buffer waves reaching—or prevent saltwater intrusion on—adjacent uplands, and have limited accretion potential, compared to wider and larger expanses of marsh grass. Grading or contouring areas adjacent to salt marshes potentially has several ecological and public benefits, including: expanding the horizontal extent of marsh vegetation, increasing the marsh's capacity for buffering and accretion, facilitating marsh migration where existing slopes may discourage or prevent it, and protecting agricultural fields at higher-elevation from saltwater intrusion. Creating a series of flat terraces (i.e., step-like shelves of similar elevation) may have greater ecological and economic benefits than a field with a linear slope by providing greater size and functionality of salt marsh at any given time as opposed to a narrow fringe of marsh. A narrow marsh zone may have greater ability to gradually migrate up a linear slope as sea level rises, but provides little ecological or economic value during that process, whereas a larger marsh has greater habitat value and potential to keep up with sea level rise through accretion. A terraced slope would presumably still allow for marsh migration eventually.

Remove barriers that are impeding marsh migration

Barrier removal is an important approach to consider, with great potential to restore and improve salt marsh habitat where sediment supply and elevation are conducive for restoring tidal flow and high marsh habitat. Barriers include any structures (e.g., berms, dikes, undersized culverts) that impede inland migration of marsh habitat. However, care must be taken when removing them to avoid unintended conversion of high marsh to low marsh (Hinkle & Mitsch 2005) due to lack of migration space, sediment supply deficit, etc., or open water behind the barrier. Sufficient elevation and sediment supply is required to ensure that high marsh habitat is created. Done appropriately in sites where high marsh habitat can be improved or sustained over the long term, barrier removal can have great potential in allowing migration. For example, removing an historic berm on the Herring River on Cape Cod, Massachusetts is expected to result in recovery of more than 1,000 acres of high quality salt marsh.

Convert agricultural/open areas to marsh habitat

Marsh migration may occur most rapidly in sites with open conditions that facilitate a transition to salt marsh habitat. This includes agricultural areas that are experiencing crop failures due to salt water intrusion and fallow or old fields adjacent to existing salt marshes. Such areas present opportunities to facilitate migration as salinity and elevation conditions are already conducive to support marsh grass development, provided that invasive Phragmites is controlled. Open areas experiencing marsh migration may be occupied by salt marsh birds much faster than ghost forests, which may have very slow rates of avian colonization (Taillie et al. 2019).

Extend tidal creeks in transitional marshes to drain areas that have become ponded

In low-lying landscapes, the gentle topography that promotes saltwater intrusion can also jeopardize the persistence of newly established high marsh on former uplands at sites where tree mortality is accompanied by root ball shrinkage and ground surface collapse, resulting in shallow basin topography. These sites become waterlogged because they are isolated from the tidal creek network, causing interior erosion of high marsh vegetation (Lerner et al. 2013). Audubon has identified many such sites on the Delmarva Peninsula using spatial modeling and--at Farm Creek Marsh in Maryland--has piloted the extension of tidal creeks into ponded areas to drain surface water and reinvigorate marsh vegetation.

STRATEGY: INCREASE USE OF DREDGE MATERIAL TO BENEFIT SALT MARSH

The U.S. Army Corps of Engineers (USACE) regulates and coordinates dredging and maintenance of approximately 25,000 miles of harbors and navigational channels throughout the U.S. The 200 to 300 hundred million cubic yards of sediment dredged each year is a valuable resource that could be used in environmentally beneficial ways, such as nourishment of beaches or development of wetland habitats. One such beneficial use has been to apply it to the surface of salt marshes, a process known as thin-layer deposition, which raises the elevation of the marsh surface and can offset the effects of sea-level rise and marsh subsidence. Some dredging occurs outside of federal navigation maintenance and may be led by entities other than USACE (state, local, private water-dependent businesses) which may present additional opportunities to use dredged material in this way.

The USACE has the authority to use dredge material in environmentally beneficial ways; however, more education on these new opportunities is needed, and new partnerships need to be developed, to implement projects that take full advantage of the USACE's beneficial use policy. Most dredge material originates from maintenance of existing federal navigation projects. Beneficial use opportunities near such dredging operations can be accomplished using federal operation and maintenance funding (i.e. 100% of costs covered by federal funds) if the total project cost falls below the least costly disposal option (the Federal Standard). Where the cost of the project exceeds the Federal Standard, excess costs are shared on a 75% federal, 25% non-federal basis. Successful beneficial use projects therefore require financial commitments and a strong partnership between federal and non-federal interests. Partner leadership on beneficial use projects typically comes from economic development (e.g. ports) or environmental (non-profits, state agencies) communities or both. To the right are some suggested steps to consider when developing a beneficial use project.

The US Army Corps of Engineers (USACE) has a pilot program and periodically request proposals for beneficial use of dredge material pilot projects where the dredged material would:

- Reduce storm damage to property and infrastructure;
- Promote public safety;
- Protect, restore, and create aquatic ecosystem habitats;
- Stabilize stream systems and enhance shorelines;
- Promote recreation;
- Support risk management adaptation strategies; and
- Reduce the costs of dredging and dredged material placement or disposal, such as projects that use dredged material for construction or fill material; civic improvement objectives; and other uses and placement alternatives that produce public economic or environmental benefits.

Sediment dredged each year is a valuable resource that could be used in environmentally beneficial ways, such as nourishment of beaches or development of wetland habitats. US Army Corps of Engineers

The following objectives will be necessary to ensure effective engagement of partners and application of dredge:

Objective 1: By 2020, identify and map the sites where dredging activity is happening in proximity to priority salt marsh patches.

Activity: Assess elevation and potential for successful fill application at priority marshes in proximity to dredge operations.

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Objective 2: Within one year of identifying prioritized marshes near dredging, engage key partners (e.g., USACE, NOAA, DOT/Port Authority and state Coastal Zone Management (CZM) offices) to ensure that regulators are aware of the priority salt marsh areas and consider TLD as an option for disposal of dredge material.

Activity: Work with USACE at state/regional level to manage issues related to appropriate disposal and contamination and ensure that different user groups are involved, including bird conservation partners.

Objective 3: By 2021, ensure that 25% of all dredge projects in each USACE district include TLD to benefit salt marsh birds.

Activity: Synthesize information from existing TLD projects on how to apply dredge material to benefit focal species.

Activity: Develop protocol and standards for partners who will deposit materials to sustain and or improve marsh elevation.

Activity: Develop funding considerations for partners detailing cost-effectiveness of implementing proposed practices.

Although there are many examples of TLD being used to improve the resiliency of salt marshes, direct benefits to salt marsh birds have not been widely demonstrated due to the relatively recent implementation of these projects. Where it is cost-effective, TLD is considered to be an important approach to maintaining coastal resiliency. If it is prohibitively expensive to apply in many areas, it may ultimately be useful in a relatively small set of sites.

STEPS FOR CONSIDERING BENEFICIAL USE OPTIONS FOR NEW AND MAINTENANCE DREDGING PROJECTS: A GENERAL APPROACH

- Initiate a collaborative effort involving USACE, EPA, ports, federal/state/local agencies, environmental interest groups, and other interested stakeholders.
- Identify all potential beneficial uses, including their costs and benefits, during the process of establishing the Federal Standard or base plan option. (Note: Ideally a local planning group could identify beneficial use projects in advance of the initiation of formal planning for a new or maintenance project.)
- If a beneficial use does not qualify as the Federal Standard option, evaluate whether the beneficial use maximizes the sum of net economic development and national environmental restoration benefits, identify potential project sponsors, and identify the appropriate statutory authority for federal cost sharing of the beneficial use project's incremental costs.
- Identify non-federal funding sources (e.g., Coastal America, Coastal Wetlands Restoration Partnership). Build support. Obtain commitments.
- Obtain USACE's approval of beneficial use project.
- Develop Project Cooperation Agreement with local sponsor.
- Design and implement project.

Source: The Role of the Federal Standard in the Beneficial Use of Dredged Material from U.S. Army Corps of Engineers New and Maintenance Navigation Projects, 2007

RESTORATION SPOTLIGHT

Restoring Tidal Flow Creates New Salt Marsh

In 2016, the USFWS completed restoration of the North Pond salt marsh on Blackbeard Island NWR. Blackbeard Island is a coastal barrier island primarily consisting of maritime forest, beach, and salt marsh. In the 1930s two dikes were constructed connecting Bay Hammock to the main part of Blackbeard Island creating North Pond. The salt marsh was flooded with freshwater through artesian wells and stocked with freshwater fish to provide fishing opportunities for visitors. In 2010, the USFWS contracted the removal of 400 feet of the north dike (800 feet long, 6 feet high, and 50 feet' at the base) in four 100-foot' sections, opening the impounded freshwater system to tidal influence, and at that time the south dike remained in place. The vegetation changed almost immediately to Spartina and Juncus but did not have full intertidal flow until the USFWS removed approximately 300 feet of the south dike in 2016, resulting in a fully functional and restored intertidal salt marsh system. Initial costs were $110,000 for the removal of the north dike through a contractor and approximately $50,000 for removal of the south dike with assistance from refuge staff and equipment. Approximately 35 acres of salt marsh were restored.

North Pond, North dike before breach (left) and after (right) to restore tidal flow. Chuck Hayes

Restoring marshes to their natural hydrology improves the quality of habitat for species like Greater Yellowlegs. Fyn Kynd, Creative Commons

TESTING PROMISING MANAGEMENT ACTIONS: DESIGN CONSIDERATIONS

To determine the effectiveness of the promising management actions laid out in this plan (Table 6) we need to adopt an adaptive management framework, with implementation efforts monitored and evaluated to determine the optimal conditions, efficacy, and relative costs of each. Our confidence in those inferences will be proportional to the degree to which implementation efforts follow a robust experimental design, where each management "treatment" has many replicates that cover a range of different marsh conditions. Ideally, key variables (e.g., bird abundance or habitat conditions) will be measured both before and after the management action, and compared to an untreated control or reference site. Therefore, similar projects should be developed in several different locations both within and among states and regions, according to the guidance below.

Design Considerations:

- A minimum of 10 replicates (independent plots or sites) per promising management action should be established to effectively evaluate performance. Replicates should be geographically distributed to ensure at least one replicate per state and three or more per subregion (e.g., New England, Delaware Bay, Chesapeake Bay, South Atlantic).
- Baseline (pre-) and post-treatment bird and plant monitoring must be conducted for at least one or two years prior to and post-treatment, but it may take seven to ten years after treatment for vegetation to reach a new equilibrium. Therefore, longer-term monitoring is desired, but could be done biennially or less often.
- Replicates need not be implemented by the same partner(s) or in a coordinated or concurrent fashion so long as standardized monitoring protocols developed by SHARP are followed, and results are shared in a common database. In the Northeast, a centralized database of restoration projects completed or ongoing since 2012 has been developed and is being managed by SHARP; partners interested in including additional projects should contact SHARP researchers.

Note: an adaptive management database for Black Rail is in development by the ACJV and USGS, which will include a portal for partner projects to be included. The ACJV has also developed an online project inventory that tracks protection, restoration, and enhancement efforts on coastal marshes since 2016, but it was not designed to track research or monitoring across sites.

Restoring rivers by removing dams helps return the natural flow of sediments to rivers and estuaries. USFWS

TESTING PROMISING MANAGEMENT ACTIONS: REGIONAL IMPORTANCE

Table 5. Importance rating (High, Medium, Low) of proposed actions for each Tier A species and for geographic subregions. Expert comments (noted below with superscripts) can be found in Appendix 3.

		Importance Rating High, Medium, Low							
Results Chain	Method	SALS	BLRA	CPSS	ME-NY (LIS)	NY (S. shore)-NJ	DE-MD-VA	NC-SC-GA-FL (Atlantic)	FL (Gulf)
Restore and Enhance Degraded Salt Marsh	Reduce nest flooding using tide gates	H	L	L	H	M	M	L[1]	L[1]
	Remove tidal restrictions (where appropriate)[2]	L	L	L	L	L	L	L	L
	Remediate ditches, trunks, and dikes	H	H	H[5]	H	H	H	H	L
	Create runnels	H	M[4]	M[5]	H	H	H	L	L
	Apply thin layer deposition of sediment	L	L	L	L	L	L	M[8]	L
	Improve accretion where restrictions are removed		L	L				L	L
	Create microtopography/ mounds	H	H	L	H	H	M	H	M
	Control predators	L	M	H	L	M	H	L[6]	L[6]
	Create living shorelines	L	L[8]	M	L	M	M	L	L
	Use prescribed fire	L	M	M	L	L	M	M	H[9]
	Remove Phragmites	M	M	H	M	H	H	M	L[3]
	Strategically remove dams	H	L	L	H[10]	M[10]	M[10]	L[10]	L[10]
Beneficial Use of Dredge	Apply thin layer deposition of sediment	L	L	L	L	L	L	M[8]	L
Facilitate Marsh Migration	Remove snags	M	H	L	L	M	H	H	H
	Remove Phragmites	H	H	H	H	H	H[12]	H	H[12]
	Terrace/contour slopes	L	L	L	L	L	M[11]	L	L
	Remove barriers	L	L	L	L	L	L	L	L
	Convert agricultural and other unforested areas[13]	M	M	H	L	M	H	M(NC/SC); L(FL/GA)	L
	Extend tidal creeks	M	M	M	M	M	M	L	L

TESTING PROMISING MANAGEMENT ACTIONS: IMPLEMENTATION STATUS

Table 6. Status of Promising Management Action Testing in the ACJV.

		Action Category			
	Action	No Regrets	Testing Needed	Testing Underway	Existing Practice Needing Modification
Restore & Enhance Existing Marsh	Dampen spring tides through tide gates		X		
	Remove tidal restrictions to improve salt marsh function/resiliency		X	X	X
	Remediate ditches, trunks and dikes to restore hydrology		X	X	
	Create runnels to improve drainage		X	X	
	Apply thin-layer deposition to sustain high marsh habitat		X	X	X
	Improve accretion to maintain resiliency		X		
	Control predators		X		X
	Create living shorelines to protect high marsh		X		X
	Use prescribed fire to improve habitat quality		X	X	X
	Create microtopography to reduce nest flooding		X	X	
	Control Phragmites strategically		X	X	
	Strategically remove dams to increase sediment input		X		X
Protect Marsh Migration Zones & Facilitate Migration	Protect land in marsh migration zone	X			
	Remove snags in 'ghost forests'		X	X	
	Control Phragmites in marsh migration zone	X	X		
	Terrace/contour slopes adjacent to marshes		X		
	Remove barriers to marsh migration (dikes, berms, etc.)	X	X	X	
	Convert agricultural/open areas to marsh		X		
	Extend tidal creeks to drain ponded areas		X	X	

RESTORATION SPOTLIGHT

Restoring Salt Marsh at Prime Hook National Wildlife Refuge

Prime Hook NWR is a coastal refuge on the lower portion of the Delaware Bay. The Refuge provides essential marsh and beach habitat and a critical buffer to coastal communities from regular storm surge. Over the past decade, Prime Hook has been hit by increasingly severe storms that resulted in numerous breaches along the bay front. Breaching caused erosion and flooding and resulted in portions of formerly freshwater impounded areas reverting to saline conditions. Freshwater plants perished and the transformation of marsh habitat to open water was expected to exacerbate shoreline erosion and flooding within the Refuge and the surrounding community.

Prime Hook National Wildlife Refuge experienced extensive flooding during Hurricane Sandy. These photos show a before and after of the beach between the Prime Hook Beach community and Slaughter Beach. USFWS

In 2013, the Refuge received funding from the Hurricane Sandy relief package to begin work on one of the largest tidal marsh restoration projects in the eastern U.S.. The project restored a former freshwater impoundment system to a 4,000-acre back barrier salt marsh ecosystem. The restoration plan included rebuilding the beach/dune complex to allow for the westward movement of the dune in response to sea level rise and storm surges, construction of 25 miles of re-configured tidal channels, and restoration of more than 1,500 acres of salt/brackish marsh vegetation, including 10 acres of new high marsh habitat by planting 270,000 *Spartina patens* plugs. Over 1,000 acres of *Phragmites australis* located along the upland /wetland boundaries have been sprayed with herbicide over three consecutive years to encourage high marsh regeneration. Strategic Phragmites control will be an ongoing management technique to encourage and enhance migration of high marsh communities adjacent to the low marsh habitats. Delaware DOT partnered with the Refuge to construct a bridge over a re-constructed channel that allows enhanced flow and fish passage between the north and south sides of the marsh and eliminated flooding on the road. Management actions have improved the ability of the Refuge marshes to withstand future storms and sea level rise and enhanced habitat for fish, birds and other wildlife.

Biological responses to the restoration have been significant. Piping Plover, American Oystercatcher, and Least Tern are nesting on the restored beach, horseshoe crabs have returned to spawn and lay eggs that support a suite of shorebirds, and low marsh and high marsh vegetation has re-colonized approximately 25% of the damaged wetlands. Species of concern such as Alewives and American eels have also been observed in the restored channels.

Land managers and biologists all along the Atlantic Coast can learn from the valuable data collected on this project for future management decisions at their own sites. The techniques used for this project may be exported to other estuarine ecosystems damaged by storms and sea level rise. The biological responses to management actions have also provided economic opportunities and ecosystem services to the adjacent communities such as reduced frequency of flooding and access to wildlife dependent recreation.

A nursery for Spartina alterniflora to replant the barrier beaches at Prime Hook, part of the restoration work funded in the wake of Hurricane Sandy. USFWS

SWaTH sensors placed at Prime Hook before storm Jonas in 2016. Storm sensors are one of many tools helping scientists monitor and assess the impacts of storms and storm surges. Christopher Nealen

Recovery efforts at Prime Hook benefit species like Forster Tern. Vijay Somalinga, Creative Commons

Coastal Plain Swamp Sparrow. Steve Collins

Outreach, Engagement, & Policy Strategies

Outreach and engagement with a host of stakeholders is necessary to overcome many significant barriers to successful implementation of salt marsh conservation practices. Persistent and ongoing threats from development and transportation infrastructure must be reduced or reversed by improving land-use planning and transportation policies and practices. The risk of pollution, contamination, and oil spills could be reduced by anticipating potential accidents and proactively planning to prevent, mitigate, or ameliorate damages from any future event.

Priority landowners and key agencies must be engaged to implement practices that benefit salt marsh habitat and birds. Outreach and engagement with key agency partners, such as the U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS), the Department of Transportation (DOT, at all levels, federal, state, county, and local), USACE, and Federal Emergency Management Agency, will be critical to achieving the objectives laid out in this plan. Likewise, we must increase engagement with the National Oceanic and Atmospheric Administration (NOAA), state Coastal Zone Management (CZM) offices, the National Estuarine Research Reserve (NERR) network, national conservation organizations, NGOs operating at more local scales within individual states, local and municipal governments, and academic institutions involved in salt marsh conservation and research.

Figure 4. Heuristic diagram of engagement and outreach strategies with results chains.

STRATEGY: INTEGRATE SALT MARSH CONSERVATION INTO NRCS (FARM BILL) PROGRAMS

High priority salt marsh patches, marsh migration zones, and upland buffers occur on tens of thousands of acres of privately-owned land. These lands require substantial financial resources to ensure adequate protection from development, restoration, enhancement, and/or management to create and maintain the quantity and quality of salt marsh habitats needed to reach focal species population objectives. The Farm Bill programs of the USDA, which are administered by NRCS and the Farm Services Agency (FSA), are the largest source of conservation funding available to private landowners in the U.S.. Farm Bill programs cover both conservation easement and restoration activities on lands with a history of agriculture.

Many salt marshes and nearby lands have a long history of agricultural use for salt hay farming, grazing, and crop production and are eligible for easement enrollment and financial assistance offered through Farm Bill programs. Wetland Reserve Easements are a particularly relevant program that can cover the full cost of wetland restoration activities, including salt marsh restoration, as well as the cost of protecting these wetlands and associated uplands with conservation easements.

These programs have unrealized potential for salt marsh conservation and are limited only by awareness and capacity. More boots on the ground are needed to leverage the millions of dollars of Farm Bill funding for salt marsh conservation projects as NRCS program staff often do not have the capacity to develop new outreach efforts or research new conservation threats, such as the relatively novel threat of sea-level rise on marsh bird habitat. However, leveraged appropriately, Farm Bill programs can fund many of the activities laid out in this plan, including protection of marsh migration zones and upland buffers as well as many of the management and restoration techniques needed to restore the resiliency of existing salt marsh habitats.

Integrating salt marsh conservation priorities into Farm Bill programs will require outreach to individual State NRCS offices to convey the message about the status of salt marsh bird populations, discuss the immediate need for salt marsh habitat conservation, and work with each office to develop effective practices to address salt marsh conservation in their areas. In particular, NRCS and landowners need tools to better evaluate options to restore salt marsh integrity and convert salt-intruded farm lands to high marsh habitat in migration corridors. Employing these practices on the ground will require new resources to conduct outreach to landowners in high priority salt marsh patches or in marsh migration zones. The following objectives will be necessary to effectively leverage this tremendous resource for salt marsh bird habitat conservation:

Objective 1: Within two years of completing this plan, ensure that all coastal state NRCS programs have been engaged by partners and recognize the important role that Farm Bill programs can play in salt marsh conservation, including marsh migration.

Activity: Contact each USDA state office (NRCS and FSA), provide a presentation and other outreach materials that explain the critical need for salt marsh bird conservation, and discuss the shared goals, opportunities, and specific roles for Farm Bill programs in salt marsh bird habitat conservation.

Objective 2: Within three years of contacting coastal states, ensure that all state NRCS offices have developed a menu of practices and scoring criteria to address conservation of salt marsh and marsh migration corridors.

Objective 3: Within five years of completing this plan, eligible landowners covering at least 10,000 acres in priority marsh migration corridors enroll with NRCS.

Activity: Elevate the importance of and increase a programmatic focus on high priority salt marsh birds through existing (e.g., Regional Conservation Partnership Program) or future (e.g, Working Lands for Wildlife) program opportunities.

Activity: Secure resources or commitments for outreach capacity to engage private landowners and facilitate enrollment in Farm Bill programs, in at least half (i.e., seven) of coastal states in the ACJV.

Working with landowners can be rewarding and effective. USDA

RESTORATION SPOTLIGHT

Natural Resources Conservation Service - Helping to Advance Salt Marsh Conservation

Between 2016 and 2018, the Natural Resource Conservation Service (NRCS) Rhode Island office identified salt marsh parcels that would be eligible as Wetland Reserve Easements (WRE) in an effort to advance salt marsh bird conservation. Selection of these easements focused on protecting and restoring high priority wetland habitat. NRCS worked with partners, such as Save the Bay and local landowners, to identify opportunities and over a period of several years, four parcels were identified and are now moving toward easement closure. At closure, the landowner gives up development rights within the easement boundary, but retains the right to passive enjoyment (e.g., hunting, fishing).

The four Rhode Island parcels and landowners fit the necessary eligibility criteria for NRCS, which include: private lands with a history of agriculture at some point in time (salt hay was harvested there many decades ago); the wetlands (salt marshes) are degraded, but can be successfully restored; and the landowners' income does not exceed the allowable Adjusted Gross Income.

NRCS will prioritize applications based on the easement's potential for protecting and enhancing habitat for migratory birds and other wildlife. In many cases, NRCS can pay 100 percent of wetland restoration costs and can cover under existing practices many of the promising management strategies described in this plan. The program also allows at least 50 percent of the easement to be upland, rather than wetland, which supports planning for marsh migration as well.

Jacob's Point salt marsh, an NRCS protected wetland undergoing restoration to remove Phragmites. Gary Casabona. Inset: Saltmarsh Sparrow eggs. Rhonda Smith, USFWS

STRATEGY: ENGAGE TRANSPORTATION AGENCIES TO IMPROVE INFRASTRUCTURE

Bridges, culverts, and roads are a leading cause of wetland loss. InAweofGod'sCreation, Creative Commons

Transportation infrastructure—roads, highways, railways, bridges—has historically been and continues to be a major source of wetland loss and degradation because the construction of roadways and train tracks often involves earthen embankments or berms that function as dikes, which can dramatically affect wetland hydrology. We must engage DOT staff at the local, county, state, and federal levels (i.e., Federal Highway Administration, Federal Railroad Administration, Federal Aviation Administration) in our efforts to ensure that existing and future transportation infrastructure is compatible with tidal marsh conservation goals. Working together, we can improve the functionality and resiliency of salt marshes that are degraded by existing infrastructure and ensure that new infrastructure avoids sensitive areas and does not fragment or degrade tidal marshes. Our ultimate goal is to have "marsh smart" transportation infrastructure in all tidal areas, including areas projected to be tidally influenced in the coming decades. Practices that are "marsh smart" are those that support healthy tidal marsh structure and function and minimize negative impacts. Fortunately, there is great potential to find common ground with DOT agencies and design projects that meet conservation and transportation needs. Sea level rise increasingly threatens transportation infrastructure (Almeida & Mustafavi 2016) as roads and bridges are becoming flooded and damaged more frequently and maintenance costs are increasing rapidly in some tidal areas. Overall, climate change is projected to increase the annual costs of keeping roads in service by $785 million by 2050 (Chinowsky et al. 2013).

Many examples of marsh smart transportation (Almeida & Mustafavi 2016) provide strong mutual benefits to tidal marsh habitat integrity and the transportation network, including elevating existing roads and structures (e.g., bridges), improving drainage capacity, and limiting development in vulnerable areas. As sea levels rise, under-sized bridges and culverts are increasingly considered to be a problem both in the transportation sector and for tidal marsh conservation. Many of the potential solutions will benefit functionality and increase the resilience of both transportation infrastructure and salt marsh ecosystems.

Marsh smart practices need to be incorporated into the design and construction of all new transportation infrastructure as soon as possible, as well as major repairs or updates that will allow improvements to old or existing infrastructure in tidal areas. The USDOT Federal Highway Administration has developed many helpful resources related to this strategy, as part of their Eco-Logical program, which includes a community of practice for transportation liaisons and liaison managers, BMPs, and insights into emerging questions and issues. A recent white paper on Nature-Based Solutions for Coastal Highway Resilience explores many issues and provides important guidance to partners to make transportation infrastructure more compatible with salt marsh conservation. Nature-based solutions such as created marshes and beaches and oyster reefs have been effective at protecting some coastal transportation infrastructure for decades, providing increased habitat value in the process.

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We must provide partners with the tools they need to identify, restore, or remediate tidal restrictions that have particularly strong potential to restore high-marsh habitats and priority bird populations.

Objective 1: By 2022, identify existing roads and bridges of greatest concern for priority species

Activity: State or subregional working groups use existing GIS data layers or develop additional tools as needed to identify the greatest challenges and opportunities for salt marsh bird conservation related to transportation infrastructure, that can be conveyed to DOT.

Objective 2: By 2022, work with relevant DOT, federal landowners and other regulatory agencies to synthesize and distribute existing marsh-smart transportation guidelines and clarify how to effectively maintain high-quality high marsh habitat in priority areas.

Activity: Review and modify existing DOT guidance to adequately address high marsh habitat conservation needs.

Objective 3: By 2023, ensure that 50% of state transportation agencies that manage transportation infrastructure are incorporating marsh-smart transportation guidelines into project planning activities.

Activity: Contact state and federal DOT staff in each state or subregion discuss the impacts of transportation infrastructure on salt marsh birds and the specific role of transportation agencies in addressing conservation needs.

Objective 4: By 2025, ensure that marsh-smart practices are incorporated into 50% of new transportation infrastructure projects in priority areas.

STRATEGY: ENGAGE/IMPROVE LOCAL ALND-USE PLANNING PROCESS

Municipalities and organized governments at all levels (i.e., local, county, regional, state) play a major role in tidal marsh conservation. Local and county governments typically determine zoning, which dictates what kind of development is allowed in different areas and under what conditions. Governments at all levels, including local, state, and federal, also regulate other activities that impact wetlands in positive or negative ways. These government agencies often determine and facilitate appropriate conservation activities and engage directly in conservation efforts. Therefore, governments are major partners in wetland conservation as they can initiate, facilitate, regulate, and prohibit conservation work by other partners.

REGULATORY ISSUES

Many conservation measures included in this plan will require environmental permits from local, state, and national agencies, so widespread implementation will require awareness and buy-in from a diversity of regulators and decision-makers. Permits are designed to prevent harmful projects, that would damage wildlife, people, lands, and waters, from moving forward.

However, existing permitting systems are not always equipped to handle the novel and complex nature of coastal wetland restoration projects designed to improve climate resiliency. Projects that involve novel technologies or that cause short-term damage but that result in improved long-term function (e.g. thin-layer deposition, which may harm some vegetation but improves long-term resiliency) can often encounter challenges in securing permits (Ulibarri et al. 2017), causing delays, inefficiencies or outright denials that drive up costs and delay project benefits. Wetland protection policies should not serve as a barrier to conserving wetlands facing new and existential threats. Projects that include collaboration (Ulibarri et al. 2017)—meeting early and often with regulators—tend to move more efficiently through the permitting process. As a longer term goal, it is also important to identify the laws, policies, and processes that are impeding conservation efforts and work with regulators or legislators to modify them to allow conservation work that is needed to move forward more efficiently.

One of the key immediate actions needed is to develop a series of "Programmatic Permits", where regulators agree on a set of management practices that are needed and can be largely exempt (e.g., requiring only notification of regulators) from permitting if they follow established guidelines. This can begin with federal (e.g., USACE) and state agencies, but ultimately needs to be done at many levels to be effective.

LAND-USE PLANNING

Land-use planners have a critical role in salt marsh conservation, as they ultimately control where future development occurs and integrate practices into policies and planning. Improving the land-use planning and regulatory process to facilitate conservation implementation is critically important but also complicated and challenging because of the sheer number of jurisdictions—municipal, state and federal—that are involved in coastal wetland conservation.

The following objectives will be needed to acheive or regulatory and land-use planning goals.

Objective 1a: By 2021, identify wetland laws or policies in each state that are creating barriers to conservation and suggest whether or how they should be modified or eliminated to allow important implementation activities.

Objective 1b. By 2021, identify programmatic permits that federal and/or state agencies can develop to facilitate conservation implementation.

Objective 2a: By 2022, identify key advocates in 75% of priority communities that can engage with and raise the awareness of land-use planners and regulators (i.e., local, county, and/or regional governments, and state agencies such as Office of Coastal Zone Management) of their important role in facilitating coastal wetland conservation.

Objective 2b: By 2023, engage at least 25% of key advocates in actively communicating with local and state regulators to encourage marsh-smart planning and facilitate restoration activities to benefit salt marshes.

Activity: Develop and provide materials that promote salt marsh conservation and the important benefits that tidal marshes provide to the public, such as protecting property from flood damage, improving water quality, supporting commercial and recreational fisheries, providing recreation areas to people, and providing vital habitat to birds and other wildlife.

Objective 3: By 2025, ensure that 50% of municipalities, counties, and states in priority areas have guidelines in place to encourage marsh-smart planning.

Activity: Identify, synthesize, and distribute examples of marsh-smart guidelines for local municipalities.

Massachusetts salt marsh. Slack12, Creative Commons

STRATEGY: ALLEVIATE IMPACTS FROM CONTAMINANTS AND SPILLS

Evidence of an oil spill in a coastal marsh. Massachusetts Department of Environment Protection

The impact of most pollutants and contaminants (e.g. mercury) on salt marsh bird populations is poorly understood and thus addressing non-point source pollutants is largely outside the scope of this plan. However, although the risk is low in any given marsh, large oil spills can have significant impacts on salt marsh bird populations and their habitats. Conservation partners can have a significant role in addressing this threat to avoid or alleviate impacts in the event of a spill.

By pro-actively engaging agencies during their spill response planning process, conservation partners can help ensure the protection of important areas of salt marsh habitat by ensuring that priority habitat patches are included in the "high priority" response areas. In the event of a spill, these areas are immediately boomed to prevent or minimize damage. Spill remediation is guided by a Natural Resource Damage Assessment (NRDA) process, which is carried out by state and federal agencies. Conservation partners can provide critical information needed in the NRDA process, to help ensure that spill remediation efforts such as booming and oil removal maximize benefits to salt marsh birds, such as by directing financial resources to high priority habitat areas.

Objective 1a: By 2020, make existing breeding tidal marsh bird density estimates in New England and Mid-Atlantic available to regulatory agencies that use them to inform the remediation process and provide benchmarks for restoration planning.

Objective 1b: By 2025, make existing non-breeding tidal marsh bird density estimates for Mid-Atlantic and Southeast available to regulatory agencies that use them to inform the remediation process and provide benchmarks for restoration planning.

Objective 1c: By 2025, complete coordinated inventory of tidal marsh birds in Southeast and Gulf Coast regions and share it with regulators.

Objective 2: After 2020, ensure that salt marsh habitat is included in Environmental Sensitivity Index maps, pre-spill response plans, and subsequent updates of relevant regulatory agencies.

Objective 3: By 2025, make a menu of prioritized actions (e.g. ditch remediation, thin-layer deposition, etc.) and their predicted impact and associated cost estimates available to regulators, so that they understand the desired remediation activities that would benefit salt marsh birds, and their costs, to guide the Natural Resource Damage Assessment process.

Section 6:
MONITORING & EVALUATING SUCCESS

The success of this plan depends on our ability to track our performance and collective progress towards the plan's objectives, and to monitor focal bird populations to determine if our efforts improve their population status. In the short- to medium-term we want to ensure that the plan's objectives are being implemented and assess the efficacy of our approach to make course corrections along the way. Over the medium- to long-term, it is critical to understand the effects of our actions on salt marsh bird populations. This means that monitoring bird populations is a critical component of our conservation efforts and necessary for success, not just a scientific endeavor to improve our understanding. The ultimate measure of our success will be reaching and maintaining populations of tidal marsh birds at desired levels. Determining success will require both large-scale monitoring, to understand population change, and evaluating management actions at individual sites. The combination of site and large-scale monitoring will allow an adaptive management approach to achieve the short-, medium-, and long-term goals of this plan.

LARGE-SCALE MONITORING NEEDS

The overarching goal of this conservation plan is to stabilize declining populations of focal species of salt marsh birds by providing a sufficient quantity and quality of wetland habitat to sustain them at desirable levels now and in the future. The only way to determine whether we achieve that goal is to periodically measure population size and/or trend of focal bird species. Existing national survey efforts such as Breeding Bird Survey or Christmas Bird Counts do not adequately sample salt marsh habitat (or secretive marsh bird species), so it is necessary to conduct comprehensive regional surveys that target salt marsh bird species.

Breeding Season Surveys

A comprehensive regional survey of breeding salt marsh bird populations needs to be conducted at least once every five years. Surveys done by SHARP in the Northeastern U.S. in 2011 and 2012 provided regional population estimates and demonstrated serious declines in most salt marsh bird species. It is important to follow up on that effort with another comprehensive regional survey by 2021/2022 to estimate changes in populations and trends.

Biologists monitor the health of Saltmarsh Sparrows. USFWS

Comprehensive regional surveys have not been done in the southeastern U.S., although there has long been interest in expanding the geographic scope of SHARP's breeding season surveys to cover the entire U.S. portion of the Atlantic Flyway. The SHARP protocol has been adapted and used to survey breeding salt marsh birds across the Gulf Coast (e.g., TX and LA) and could be adapted for other southeastern states. The Gulf of Mexico Avian Monitoring Network (GOMAMN) has been working on a Strategic Avian Monitoring Plan for the northern Gulf of Mexico with species-specific monitoring needs and recommendations for implementing avian surveys, data management, and data reporting. GOMAMN partners also developed a "Monitoring and Adaptive Management Procedures and Guidelines Manual". Any comprehensive monitoring program in the southeastern U.S. will likely involve coordination with GOMAMN partners, so their approach could be considered as a starting point for developing a similar program in the ACJV area.

NOTE: The recommendation for comprehensive regional surveys will effectively sample most salt marsh bird species but would not adequately sample Black Rail, which is a highly secretive and mostly nocturnal species with consistently low detectability rates. Given the numerous difficulties surveying Black Rail, unresolved methodological and design issues, and the use of emerging technologies such as autonomous recording units (ARUs) and game cameras, a group of partners began meeting in spring 2019 to examine these issues across the Eastern Black Rail range and develop recommendations. Those efforts are on-going. In the meantime, partners have been using regional variations on the 'Conway protocol' such as the 'Maryland Protocol' (Wilson et al. 2009) to survey Black Rails.

Biologists showcase high quality Black Rail habitat in a Spartina marsh. Craig Watson

Sampling Considerations

Most salt marsh bird surveys are conducted via a number of point counts, sampled twice or more per year. The power to detect a meaningful change (e.g., 5-10% annual decline) is largely driven by the number of points surveyed (i.e., sample size), as well as the number of years sampled and the abundance of focal species at each point. SHARP's Northeast regional breeding season monitoring of salt marsh birds (Weist et al. 2016) was carried out using a sampling framework consisting of 40 km^2-hexagons (Carr et al. 2002) along the East Coast that contain tidal marsh habitat. They recommend that at least 12 hexagons be sampled in each geographically homogenous region (i.e., a state, or region with similar avian and vegetation communities, tidal amplitude, and geomorphology), with points surveyed twice per season.

State-Based Surveys

Surveys conducted at the scale of a state or subregion may have limited statistical power unless sampling is sufficiently robust in space and time (i.e., covers multiple years). For example, to estimate trends in breeding Saltmarsh Sparrows in coastal Connecticut, experts recommend selecting at least twelve 40 km^2-hexagons in Connecticut, with a number of survey points in each that are sampled twice per season, biennially, for eight to ten years. That recommendation is supported by a regional-scale power analysis based on that sampling framework and 76 points in Delaware, which equated to greater than 0.80 power to detect a 5% annual decline in Saltmarsh Sparrow abundance in Delaware.

Non-Breeding Surveys

Although some researchers are investigating salt marsh bird distribution and densities during the non-breeding season, there has been no standardized or regional assessment. Therefore, only limited (and fairly localized) non-breeding distribution data are available. A comprehensive survey of salt marsh birds during the non-breeding season is needed to understand which salt marsh areas are most important for focal species during migration or winter. To determine priority areas, non-breeding surveys need to be carried out over multiple seasons, years, and states, because the importance of a given area may vary by season or year.

Specific techniques or protocols for non-breeding surveys of salt marsh birds have been suggested, but remain largely untested or have not been widely evaluated. Researchers at the University of North Carolina Wilmington (UNCW) are currently developing and testing methods to estimate density and regional abundance by combining abundance data from mark-recapture surveys with local movements from radio telemetry. Further, UNCW is developing methods to detect Seaside and Saltmarsh Sparrow with visual transect surveys and area searches by dragging ropes.

EVALUATING MANAGEMENT ACTIONS

This plan emphasizes the critical need to evaluate promising management actions to determine whether and to what extent they contribute to focal species' population stability or growth. This is especially important given the novel nature of many of the management actions suggested and our desire for an adaptive management framework for implementation. For each management action, it is important to determine whether it works as expected, under what conditions it is successful, and how it affects population dynamics.

We strongly recommend that evaluations of management actions be required of all restoration or management efforts. That should involve site-level monitoring of focal species, ideally across a set (or sample) of several managed sites, which serve as experimental replicates. If focal species are not present prior to the management action, occupancy may be a suitable indicator of success. If focal species are present, changes in abundance, density, or productivity need to be evaluated. Ultimately, recommending specific management actions should hinge on clear evidence that the intervention will improve productivity of focal species.

Site-Based Surveys

Point count data are generally not useful for making inferences about population trends at an individual site because most sites will not be large enough to accommodate enough independent point counts (more than 10) or have abundances high enough to provide sufficient statistical power to detect meaningful differences. Therefore, it is more practical to estimate densities (e.g., map territories) or measure nest productivity at a site and track these over time or in response to management changes. If the site is unoccupied by target species prior to restoration or management, occupancy rates are a simple metric that may be sufficient to adequately assess restoration success.

To ensure that our efforts are affecting population trends, it is important to do demographic studies. David Eisenhauer, USFWS

Monitoring Demographics

Ultimately, the most appropriate indicator of habitat quality is breeding productivity. We need to gauge reproductive success, especially at managed or restored sites, to understand how our conservation actions are affecting population growth. Because demographic data collection (e.g., nest searching, mist-netting) is intensive and expensive, we may only be able to get a clear sense of how management affects population growth at a small sample of managed sites. Those results could be extrapolated to all sites managed similarly across a region. A recent study by SHARP (Fields et al. 2017) researchers demonstrated that studying demographics at approximately 10 to 15 sites distributed across the region provided a robust understanding of population dynamics (i.e., survival, fecundity, and population growth rates), at least for Saltmarsh Sparrow.

Based on these findings, we recommend establishing 10 to 15 sites where demographic data are collected every year. That would provide an understanding of inter-annual variation and survival, which wouldn't be provided by visiting more sites less frequently. Ideally, demographic rates would be assessed at a range of sites that represent excellent, good, average, and poor habitat conditions, to avoid misleading results that may occur if demographic sites represent 'the best of the best' habitat for focal species rather than average conditions.

SHARP is currently developing a 'rapid demographic' sampling protocol that would allow collection of productivity data with a relatively small amount of sampling effort. If reliable, use of that protocol could provide insights about reproductive success across a larger number of sites throughout a region at a fraction of the cost of intensive demographic studies. Currently, the rapid demographic protocol is only being considered for sparrows, not for rarer or more secretive species such as rails. Also, the protocol does not generate estimates of annual survival, although sparrow populations appear to be more affected by reproduction than by survival.

In comparison to nesting productivity, occupancy rates or nest density are relatively poor indicators of breeding habitat quality. However, both variables can provide useful information, especially if monitored over time at many sites. If either occupancy rates or nest density were trending upwards or downwards across many sites in a given state or region, it would reflect an expanding or contracting population.

VEGETATION MONITORING

Vegetation data should be collected on any sites where bird surveys are being carried out. Vegetation data can demonstrate marsh changes over time and are critical to understanding the effectiveness of restoration and management. We do not recommend collecting vegetation data in the absence of avian productivity data, as it may provide insufficient, or even misleading, information because factors such as sea level rise may impact salt marsh bird reproductive success (and population dynamics) more quickly than they affect habitat structure. Therefore, habitat that appears to be quality high marsh based on the presence of vegetation may actually be a population sink due to increased nest flooding rates. New or improved vegetation mapping (e.g., with drone photography) could be useful to evaluate whether or not management actions appear to be beneficial (e.g., increasing coverage or quality of high marsh at a site). However, only nest productivity data will determine if restored habitat conditions represent a productive site for breeding birds.

In addition to vegetation data, there are several other variables that could provide important insights into the structure and function of salt marsh ecosystems if they are measured. Such variables include the nature and degree of historic modifications, sedimentation dynamics, rates of horizontal or vertical erosion, and the water table, all of which drive important processes related to the sustainability or rate of loss of marshes, and which may be affected by management actions. Standardized protocols to measure these variables should be developed to facilitate pooling of data and making comparisons across sites.

Guana Tolomato Matanzas National Estuarine Research Reserve's Education Team sets up it's new Living Lab Series "Migrating Marshes" and monitors the vegetation. GTM NERR.

PROTOCOLS

The SHARP protocol, which is also used to monitor Salt Marsh Integrity (SMI) on National Wildlife Refuges, provides a simple approach to sampling both birds and vegetation. Avian call-back protocols have been developed for each of nine ecological subregions and are widely used by partners to facilitate monitoring and understand population trends along with how birds and vegetation respond to management. Using this protocol in the Southeast may require some modifications. Any changes in protocol should be carefully considered to ensure that data are comparable across regions in the future. A standardized Black Rail survey protocol is currently in development, and existing state-specific Black Rail protocols are being used in the interim. Protocols need to be developed for non-breeding surveys of salt marsh birds.

CONSERVATION ACTION TRACKING

This plan includes 40 distinct objectives across eight different conservation strategies. These objectives include science, management, outreach, and engagement activities, and rely upon our diverse partnership to work in a coordinated fashion to advance bird conservation throughout the Atlantic Coast. A centralized and publicly accessible tracking tool is being developed to measure the status of the overarching strategies, the various actions taken, and progress towards agreed-upon objectives. This tracking tool will provide current information about the approaches and actions underway in a given area and the stakeholders or landowners involved. It will allow managers to search for examples of successful management actions and identify gaps in coverage across the landscape. The tool will provide a centralized location for partners to assess progress overall and toward specific plan objectives (e.g., number of acres of a particular management practice put in place on the ground). The tracking tool website will also provide partners with various data products and conservation tools that have been developed. The Atlantic Flyway Shorebird Initiative (AFSI) has developed a 'Dashboard' to track progress towards objectives laid out in the AFSI Business Plan and we intend to use their dashboard as the model for a Salt Marsh Bird Conservation Plan tracking tool. We anticipate completion of this tool in 2020.

SUMMARY OF MONITORING RECOMMENDATIONS

- A comprehensive regional survey of breeding salt marsh birds should be done every five years to understand population trends and determine whether conservation measures are working.
- Existing coordinated efforts in the Northeast to survey salt marsh birds must be expanded to include the Southeast.
- Comprehensive non-breeding season surveys of salt marsh birds are needed to understand which areas are particularly important during migration and winter.
- Vegetation data should be collected on all sites where bird surveys are being carried out.
- Standardized protocols developed by SHARP should be used to monitor both birds and vegetation.
- Demographic data should be collected where possible, especially in response to management action, but at a minimum should be consistently monitored at 10-15 sites across a region that collectively represent the range of habitat quality for focal salt marsh bird species.
- The outcome of management actions called for in this plan should be monitored and evaluated to understand and improve their effectiveness. In particular, evaluating effects on reproductive success is critical to determine their benefit to priority bird populations.
- Other ecological factors should be considered when monitoring and evaluating conservation actions, such as the degree and nature of historic modifications, rates of erosion, sediment supply dynamics, and the status of groundwater.

RESTORATION SPOTLIGHT

Evaluating Thin-layer Sediment Placement to Enhance Marsh Resilience

One of the most urgent salt marsh conservation needs is to understand how proactive conservation can mitigate the loss of salt marshes to sea level rise. Ideally, testing management strategies should occur in a replicated experimental framework across many marshes in many states.

Narragansett Bay and Elkhorn Slough National Estuarine Research Reserves are leading efforts to test and monitor thin-layer deposition application through replicated restoration experiments conducted at eight reserve sites across the nation. The purpose of the project is to examine the effectiveness of TLD as a marsh adaptation strategy. TLD is a technique used to raise marsh surface elevation to offset the effects of sea-level rise and marsh subsidence. The goal of the project is to fill critical data gaps and provide information that will increase efficiency of future TLD projects in places where they will be most effective.

The project aims to determine:

- Whether TLD is an effective adaptation strategy for marshes given sea level rise;
- How marsh resilience responds to different levels of sediment addition; and,
- How low versus high marsh habitats differ in their response to TLD restoration.

The project will largely follow the before-after-control-impact approach, which requires monitoring both before and after sediment addition in experimental and control plots.

Resulting products will be shared and will include:

- A technical report detailing the methods, experimental design, monitoring results, and lessons learned;
- Project monitoring protocol;
- Statement identifying conditions and sites where this strategy will be most successful in bolstering marsh resilience;
- Synopsis of permitting considerations; and
- User-friendly summary, presentations, webinars, and outreach materials.

Read the full project summary to learn more about the partners, project locations, and methods here.

Thin layer deposition projects like this one at Blackwater NWR, spray sediments to compensate for its natural tendency to sink and the effects of sea-level rise. Dave Harp, Chesapeake Photos

Section 7:

FUNDING NEEDS

In this plan's first iteration, we focus on providing a range of cost estimates, based on information that is available for the various conservation approaches recommended in this plan. We have begun to collect project-specific financial data from partners to address this issue and will use that information to refine cost estimates to help guide partners in selecting management strategies that are appropriate for their local site and their budget. In the long-term, evaluations of management approaches, along with monitoring data and population assessments, will allow us to attain a more comprehensive understanding of the specific kinds of conservation that are needed to recover and sustain populations of salt marsh birds. Combining that information with cost estimates of different projects and management actions will allow a comprehensive cost-benefit analysis of different management options.

IMPLEMENTATION COST ESTIMATES

Estimating the cost of implementation activities should be done on a state-by-state basis because many factors will vary widely within and among states: land-use, available alternatives, landowner attitudes, land values, etc. The data below provide some initial perspective on costs, but are not state-specific.

NAWCA Grants

The North American Wetland Conservation Act (NAWCA) grant program has been a major vehicle for habitat conservation in the ACJV for nearly 30 years, resulting in the conservation of more than two million acres of habitat for migratory birds. Although NAWCA project activities and affected habitats vary widely, most NAWCA projects have focused on coastal wetlands, especially in recent years. Therefore, the costs of land protection, restoration, and enhancement associated with recent NAWCA projects provides useful information to estimate costs for some of the work recommended in this plan. In the last five fiscal years (2014-2018), NAWCA grants in the ACJV protected in fee or easement 157,661 acres and restored or enhanced 28,399 acres, at a cost of $227,373,215, including grant, match, and federal or non-match funding. That equates to $1,222 per acre conserved. It is not easy to break down costs of protection versus restoration/enhancement because they are pooled in summary data. Full NAWCA proposals contain tract- and activity-specific costs, so more detailed breakdowns could be tallied by activity and state.

New York City Case Study

One recent and comprehensive study done for the New York City area estimated costs for various activities to conserve salt marsh and marsh migration areas, including land protection, restoration, and enhancement. For that urban area, they estimated the total cost, including related activities such as design, engineering, and project management, as follows:

Protection of private land (i.e., acquisition, transfer, and easement):	$1M to $5M /acre*
Transfer to or easement on public land:	$65.8k to $1.98M /acre
Restoring flooded hard surfaces:	$1M / acre
Thin-layer deposition of sediment:	$549k / acre
Marsh edge (e.g., living shoreline) restoration:	$624k / acre

*Related activity costs pushed totals to $1.27-7.08M per acre; this wide range is due to the extremely high real estate values in major urban areas such as New York City.

Northeast National Wildlife Refuges

NWR managers from across the Northeast region compiled a table of cost estimates for salt marsh management actions (Table 6 below), as part of a structured decision making and optimization process (Neckles et al. 2016). Much of the information in Table 6 represents estimates based on professional knowledge, though in some cases they are based on actual costs. The authors noted the need to improve these estimates: "Finally, the constrained optimizations performed here were based on approximations of management costs. As salt marsh management is implemented around the region, a list of actual expenses can be compiled so that future iterations of the decision model can include more accurate cost estimates."

NOTE: Given that many of the actions in this plan have not yet been implemented, there are limited data available for estimating costs. Determining short- or long-term implementation costs accurately requires the identification of the most appropriate measures to take, how much work is needed, and where, on a relatively local (e.g., state-based) scale. This first version of the conservation plan is focused at the flyway scale, and many actions have not been specified or stepped down to state scales. We are collecting information from partners that can inform and improve our cost estimates for futire versions of the plan.

The Carolina Wetlands NAWCA project is in an area of North Carolina that was the historic stronghold for Black Rail in North Carolina, and undoubtedly provides valuable wintering habitat for Saltmarsh Sparrow, American Black Duck, and a whole suite of priority birds that rely on tidal marshes during their annual life cycle. Janice Allen, Coastal Land Trust

Table 7. Cost Estimates of Salt Marsh Management Actions. From Neckles et al. 2018.

Category	Management / Restoration Action	Unit	Cost/Unit	Contributing Refuge
Breach	Remove/breach impoundment dikes and recontour basin	acre	$1,000	Bombay Hook
Breach	Open tidal flow to beach (breach dunes in 2 places)	breach	$850,000	Cape May NWR
Breakwater	Rock/rip-rap to slow water flow, wave attenuation, etc. (1900 ft)	linear foot	$3	Cape May NWR
Breakwater	Rock/rip-rap to slow water flow, wave attenuation, etc.	linear foot	$429	
Breakwater	Breakwater remediation	linear foot	$500	
Bridge	Expand bridge to improve tidal flow	acre	$9,972	
Bridge	Improving tidal flow (expand bridge to widen waterway underneath, one time cost)	bridge	$3,500,000	Cape May NWR
Bridge	Remove wing walls	linear foot	$61	Cape May NWR
Bridge	Remove Upper Bridge Road (1450 ft l X 24ft w 34800 sqft @ 4.50 sqft)	sq ft	$5	Cape May NWR
Building	Shed removal/create salt marsh		$25,000	RI NWR Complex
Burn	Burn the marsh	acre	$100	
Channel	Increase sinuosity of creeks (5700 ft)	linear foot	$43	Cape May NWR
Channel	Increase sinuosity of creeks (4400 ft)@ $650 per ft	linear foot	$650	Cape May NWR
Channel	Stabalize cuts in bank along Sluice Ditch	stream mile	$100,000	Bombay Hook
Channel	Stablize cuts in bank along River	stream mile	$100,000	RI NWR Complex
Contaminants	Contaminants Education	unknown	$500	
Culvert	Under road connection to cattail marsh (design, materials, build)	culvert	$120,000	RI NWR Complex
Culvert	Improving tidal flow (widen 2 culverts)	culvert	$1,600,000	Cape May NWR
Culvert	Improve tidal flow through culvert and woods (300 ft + culvert under road)	linear foot + culvert	$3,000	Cape May NWR
Culvert	Design and construct culvert replacement under Bayview Avenue	total cost	$365,000	Forsythe NWR
Ditch remediation	Grid-ditch remediation (fill, sinuosity, etc., 5700 ft))	linear foot	$44	Cape May NWR
Ditch remediation	Grid-ditch remediation using coir logs	linear foot	unk	Long Island
Ditch remediation	straw wattle for erosion control 9”x25 ft; 300 ft per pallet	pallet of12 (300’)	$300	
Ditch remediation	Coir log 12”, 16” or 20” x 10 ft ($	per 10 ft log	$71	
Ditch remediation	Coir log 16” x 10 ft	per 10 ft log	$126	
Ditch remediation	Coir log 1 ft x 10 ft	per 10 ft log	$188	
Ditch remediation	Coir log 20” x 10 ft	per 10 ft log	$202	
Fence	Build fence to restrict grazing	linear foot	$3	Chincoteague
Fence	Remove fence at old south corral	total cost	$1,000	Chincoteague
Fill	Fill in pools (15.5 ac)	acre	$38,710	Cape May NWR
Fill	Fill in Goose Pond (40 ac)	acre	$150,000	Cape May NWR
Grading	Marsh platform gradation	acre	$4,063	
Grazing	Rotational grazing between marsh units	acre per year	$1,388	Chincoteague
Invasive Control	Phragmites control	acre	$109	Cape May NWR
Invasive Control	Phragmites Control (30 ac)	acre	$183	Cape May NWR
Invasive Control	Phragmites Control (contractor cost includes initial plus follow-up; 1.75 is for 3 years of diminishing effort)	total cost	$2,680	RI NWR Complex

Table 7 (Cont). Cost Estimates of Salt Marsh Management Actions. From Neckles et al. 2018.

Category	Management / Restoration Action	Unit	Cost/Unit	Contributing Refuge
Island	Islands for TMOs (1 @ 0.5 acre $17.18 /sqft)	sq foot	$18	Cape May NWR
Living Shoreline	Living shoreline (study, 600 ft, coir logs, oyster shell bags, labor)	linear foot	$67	
Living Shoreline	Install oyster castle to attenuate wave action	linear foot	$150	Chincoteague
Living Shoreline	Living shoreline	linear foot	$375	
Living Shoreline	Living Shoreline (Hybrid, with low-profile breakwaters)	linear foot	$375	Bombay Hook
Living Shoreline	DE Bay offshore protection / living shoreline	linear foot	$429	Bombay Hook
Living Shoreline	Living Shoreline (High energy shoreline, offshore breakwaters)	linear foot	$429	Bombay Hook
Living Shoreline	Living shoreline (coir logs along interior of creek)	linear foot	$500	Cape May NWR
Living Shoreline	Living shoreline (1900 ft)	linear foot	$500	Cape May NWR
Living Shoreline	Armor Sedge Island Rock/soil/salt marsh mix	total cost	$60,000	RI NWR Complex
Marsh Creation	Low marsh creation	total cost	$60,000	RI NWR Complex
Marsh Migration	Recontour adjacent upland and plant to facilitate marsh migration, control Phrag	acre	$2,650	
Marsh Migration	Forced marsh migration (remove dead trees, girdling some others)	acre	$16,667	
Planting	Planting TLD area	acre	$703	RI NWR Complex
Planting	Native plant replacement (with B, Phrag control .70$/ 2” plug/sq.ft)	sq ft	$1	Cape May NWR
Planting	Native planting (to create transistion zone, change in elevation with Phrag control)	sq ft	$70	
Poles	Remove telephone poles	per pole	$2,750	Forsythe NWR
Predator	Trap meso-predators to increase sparrow population**		unk	Forsythe NWR
Road	Remove Road	sq ft	$5	
Runnel	Runnel: Hand dug	acre	$224	RI NWR Complex
Runnel	Runnels: machine & operator	acre	$650	RI NWR Complex
Runnel	Small channel excavation	linear foot	$17	RI NWR Complex
Runnel	Small channel excavation (10,000ft, addtional to restoration project)	linear foot	$17	Cape May NWR
Stonewall	Partial stonewall removal to faciliate hydrology and marsh (3 openings/day)	acre	$600	Supwana Meadows
Stormwater	Mumford Brook Stormwater BMP	total cost	$175,000	RI NWR Complex
Stormwater	Narragansett Park Stormwater BMP	total cost	$175,000	RI NWR Complex
TLD	Thin layer deposition to achieve 40% inundation or less	acre	$145	RI NWR Complex
TLD	Thin Layer Deposition	acre	$148	RI NWR Complex
TLD	Thin Layer Deposition	acre	$170	RI NWR Complex
TLD	Thin layer deposition: mechanical, trucked in and spread (Ninigret Barrier Island)	acre	$11,250	RI NWR Complex
TLD	Thin Layer Deposition/ Dredge Source	acre	$13,333	RI NWR Complex
TLD	Thin Layer Deposition	acre	$25,000	Chincoteague
Trestle	Trestle removal (underwater at head of Pett Cove)	total cost	$45,000	RI NWR Complex

MONITORING COSTS

Evaluating the efficacy of specific strategies or management actions and measuring the ultimate success of this plan will require monitoring the suite of salt marsh birds at multiple scales, sites, and regions. At the largest scale, comprehensive regional surveys of breeding populations of salt marsh birds should be conducted at least once every 10 years. Surveys done by SHARP in 2011 and 2012 provided population estimates for the Northeastern U.S., at a cost of $560k. It would cost approximately $300k per year to revisit and re-survey the same ~1,700 points.

This plan emphasizes that management actions must be evaluated and monitored to be linked to conservation outcomes. Monitoring of practice performance should include biological response (e.g., of vegetation or birds) as well as evaluation of desired and/or unexpected effects. Therefore, cost estimates for management actions should consider not just implementation costs but also monitoring and evaluation costs. Pilot project implementation should always include baseline monitoring before and after management (primarily vegetation sampling), and/or comparing treated sites to untreated controls. Monitoring should be conducted for a minimum of at least 2-3 years.

Monitoring that includes bird surveys costs approximately $10k per site per year, based on a SHARP project that monitored 52 independent sites. Their project costs include a full-time project manager, graduate research assistant, regional coordinator, technicians for vegetation and bird surveys, and some degree of data management. Monitoring at a smaller scale (e.g., several sites in the same state) could be done at a much lower cost. If the same protocol is used, we could pool data from independent monitoring efforts.

FUNDING SOURCES

Table 8 lists major funding sources for salt marsh bird conservation implementation efforts. We will build on and update this list over time and encourage partners to suggest additional options.

Marsh mat experiments require longterm monitoring and funding. USFWS

ACJV SALT MARSH BIRD CONSERVATION PLAN | 2019

Table 8. Funding Sources

Grant Type	Program
Federal	
U.S. Fish and Wildlife Service	
	North American Wetlands Conservation Grant Program
	National Coastal Wetlands Conservation Grant Program
National Oceanic and Atmospheric Administration	
	Coastal Zone Management Funding
	Community-based Restoration Program
EPA	
	National Estuary Program
	Wetland Program Development Grants
	5 Star Wetland and Urban Waters Restoration Program
	Clean Water State Revolving Fund (SRF) and Wetlands
	Water Pollution Control Section 106 Grants
	Nonpoint Source Water Pollution Section 319 Grants for States and Territories
	Indian Environmental General Assistance Program (GAP)
	EPA and Other Federal Grants that Include Wetlands Restoration
	Catalog of Federal Funding Sources for Watershed Protection
U. S. Department of Agriculture, Natural Resources Conservation Service	
	Agricultural Conservation Easement Funding
	Watershed and Flood Prevention Program and Resources
U.S. Department of Transportation	
	Transportation Investment Generating Economic Recovery, or TIGER I and TIGER II Discretionary Grant programs
U.S. Federal Emergency Management Agency	
	Flood Mitigation Assistance Program
National Fish and Wildlife Foundation	
	Chesapeake Bay Stewardship Fund
	Delaware Watershed Conservation & Delaware River Restoration Funds
	National Coastal Resilience Fund
	Small Watershed Grants
	Southeast Aquatics Fund
Regional Funding Sources	
	Chesapeake Bay Trust
State In-Lieu Fee Programs	
	Connecticut
	Florida
	Georgia
	Maine
	Maryland
	Massachusetts
	New Hampshire
	New York
	North Carolina
	Virginia

Appendix 1:

FOCAL SPECIES PRIORITIZATION

During the initial meetings that launched this conservation plan at the 2014 Northeast/Southeast Partners in Flight Meeting, discussion often focused on species prioritization. The outcome of those discussions was an initial set of species tiers, which were revisited and modified slightly during the summer of 2016 when planning restarted. The details below are pasted from the original draft "business plan scoping document" developed by SHARP and other partners. This content is presented to provide historical context of group discussions prior to the adoption of the planning process by the ACJV.

From the Scope Section:

- The group set the taxonomic scope to include species, subspecies, and distinct population segments. An approximate guideline would be any population that would be a likely target for listing under the U.S. Endangered Species Act.The process for determining this is described on the SHARP website.
- The group opted not to include species simply because they had been listed as State SGCN species because of the variation in how states rank species and issues associated with range limits (i.e., states listing species because of factors only relevant at a local scale). Given the much larger geographic scope of the plan, the group concluded that issues that are not relevant to a population throughout its geographic range should not be major considerations.
- The group opted not to limit the plan to obligate tidal marsh species because doing so would exclude some species that occur predominantly, but not exclusively, in tidal marshes or that use the habitat only during certain parts of the year.
- The group opted not to include species that occasionally use salt marshes, but for which management actions in salt marshes are unlikely to provide any tangible benefits at a population level.
- The group opted to focus on protecting species, rather than taking a more general or "coarse filter" approach on the ecosystem as a whole or on particular habitats, because the Plan is being developed under the aegis of Partners in Flight, which has bird populations as its central remit.

FOCAL SPECIES

After setting the scope for the Plan, the original group compiled a list of species, subspecies, and distinct population segments (hereafter referred to as "species," in the ESA sense) that the plan should focus on. They first identified all species that meet the criterion of being likely to undergo noticeable declines due to changes in the amount, quality, or types of salt marsh habitat. They explicitly decided that they would not consider any species for which changes in this habitat would have a trivial effect on the population, even if they are a species of high conservation concern. The rationale being that conservation planning in salt marshes is not the best way to address the needs of those species.

The group also classified each species into one of three priority groups:
(A) Imperiled species that may need consideration for ESA protection
(B) Those likely to become imperiled in the relatively short-term (10 to 20 years),
(C) Those which might become imperiled in the longer-term (more than 20 years),
(D) Those for which there is insufficient data to classify ("data deficient").

The group recommended that conservation actions focus on species in groups (A) and (B) in the short term. Species in group (C) are not the immediate focus of conservation actions implemented under the plan, but will be identified within the plan with the recommendation that the priority rankings be revisited periodically.

The group had not yet set a firm schedule for how often the prioritization should be revisited, but given the rapidly changing conditions in tidal marshes, and projections for future change, a time-line of approximately every five years is probably warranted. For species in group (D), the only conservation action is to obtain sufficient information to assess the species' threat status.

Group A

- Black Rail (eastern tidal marsh populations
- Whooping Crane*
- "Coastal Plain" Swamp Sparrow (nigrescens
- Saltmarsh Sparrow
- Eastern Henslow's Sparrow (susurrans)*

Group B

- Mottled Duck*
- American Oystercatcher*
- Lesser Yellowlegs
- Whimbrel (hudsonicus and Mackenzie Delta breeding population of rufiventrus)
- King Rail

Group C

- American Black Duck
- Wood Stork (U.S. breeding population)
- Tricolored Heron
- Glossy Ibis
- "Eastern" Willet (semipalmata)
- Greater Yellowlegs
- Laughing Gull
- Forster's Tern (eastern coastal population)
- Clapper Rail**
- "Worthington's" Marsh Wren (griseus)
- "MacGillivray's" Seaside Sparrow (macgillivraii)
- Other Seaside Sparrow subspecies (excluding Cape Sable, which is outside our scope)
- Acadian Nelson's Sparrow (subvirgatus)**
- Boat-tailed Grackle

Group D

- Yellow Rail
- "Sennett's" Seaside Sparrow (sennetti)
- "Interior" Nelson's Sparrow (alterus, nelsoni)

*For species listed in groups (A) and (B), the group further limited the scope of the plan by identifying species on these lists that are already the subject of other major conservation planning efforts. So as not to duplicate effort they opted to defer all

Coastal Plain Swamp Sparrow. Steve Collons

American Oystercatcher. Doris Rafaeli

Tricolored Heron William Majoros

conservation planning to those other efforts for the following species:

- Whooping Crane – defer to ESA recovery planning team
- Mottled Duck – defer to North American Waterfowl Management Plan
- American Oystercatcher – defer to American Oystercatcher Business Plan

They did not make a similar evaluation for species in group (C) as they will not be subject to immediate conservation planning, but such an assessment would be warranted if the prioritization changes and several species in group (C) would be treated in the same manner.

*The group also opted to defer any actions for taxa currently considered to be extirpated from tidal marshes, but note the need to evaluate evidence for the population's persistence:

- Eastern Henslow's Sparrow (susurrans)

All of these species will remain in the plan, but will not be the basis for action planning, other than to inform the leaders of the other conservation plans that these species have been identified as priorities. If partners of these other plans believe it would be helpful and appropriate to incorporate these species into salt marsh bird planning activities, the group will do so.

**Clapper Rail and Acadian Nelson's Sparrow (subvirgatus) were moved from Group C to Group B in future iterations of this prioritization. See 'Changes to Species Prioritization' below for details.

Additional species were considered but not included on the list (contact -- for details as to why each was excluded):

- Other dabbling ducks
- Snowy Egret
- White Ibis
- Northern Harrier
- Virginia Rail
- Purple Gallinule
- Marbled Godwit
- Least Sandpiper
- Least Tern
- Short-eared Owl
- Peregrine Falcon (Delmarva population)
- Sedge Wren

White Ibis. William Majoros

ACJV SALT MARSH BIRD CONSERVATION PLAN | 2019

OUTSTANDING ISSUES

A few species were discussed but no consensus was reached on how they should be ranked. Decisions on these species were deferred to seek additional data and expert opinion:

- Least Bittern – uncertainty over what proportion of the population uses salt marshes; view was that it is probably not enough to warrant inclusion, but additional input is sought. For now this is considered a potential category D species because we lack sufficient information on the proportion of the population that uses salt marshes.
- Gull-billed Tern (eastern coastal population) – much uncertainty over the status of this species, with declines reported on the East Coast, but increases on the Gulf Coast. Also questions about how reliant it is on salt marshes: Does it meet the standard that changes in salt marsh habitat would influence population status? Consensus was that it may warrant inclusion in category B, but that we needed additional data to be certain.
- Eastern Marsh Wren – uncertainty over what proportion of the eastern population winters in salt marshes; view was that it is probably not enough to warrant inclusion, but additional input is sought. For now we consider this a potential category D species because we lack sufficient information on the proportion of the population that uses salt marshes.
- Tree Swallow – uncertainty over what proportion of the population uses salt marshes, but massive flocks are known to roost along the Gulf Coast in winter and perhaps along the Atlantic Coast during migration; view was that numbers may not warrant inclusion, but that additional input should be sought from species experts.

CHANGES TO SPECIES PRIORITIZATION

In September of 2016, the original species prioritization results from 2014 were briefly revisited. Two species were moved up from Tier C to Tier B:

- Clapper Rail
- "Acadian" Nelson's Sparrow

There was general agreement by the Steering Committee for these changes, based on the rationale that the current evidence of declines is stronger than previously thought. There was considerable discussion about whether it was sufficiently clear what the phrase "in trouble" means since we hadn't set a specific rate of decline as a threshold. "In trouble" means that they would be likely to move into Tier A within 20 years.

There was clear evidence of Clapper Rail population declines in the Northeast and Mid-Atlantic, though it was less clear about their trends in the Southeast, given the lack of regional survey data there. Those declines were consistent across multiple data sets. A huge majority of the Clapper Rail population is in the Southeast; it's not clear if the Northeastern population was ever that big (though was 300,000 in the range that SHARP surveyed). Clapper Rails in the Southeast do not seem to be declining, though they are declining by 5% annually in some areas (and in some northern areas declining by 12% annually). In Georgia, they seem to be doing well but their habitat is decreasing and threats from sea level rise are looming.

SHARP data for Acadian Nelson's Sparrow indicate a -4.2% annual population decline, although recent data from Maine (which has 96% of the U.S. breeding population) did not indicate strong evidence of population change (i.e., the 95% Confidence Interval includes zero). Nest survival for Acadian Nelson's Sparrow in Maine was lower than for other salt marsh birds studied; their reproductive success was highest at the farthest upriver marshes. According to SHARP estimates, median time to extinction for Acadian Nelson's Sparrow in Maine was 30 years (95% CI = 15 years, >50 years).

Another species for which an increase to Tier B was considered was McGillivray's Seaside Sparrow. That species was undergoing a Species Status Assessment (SSA) by the USFWS for listing under the ESA. The group was waiting to see the evidence of whether McGillivray's Seaside Sparrow is a good candidate species for listing. At the time it was discussed, it was agreed that while it may reflect our collective ignorance, we haven't seen evidence that they are declining. It may be that no one has provided evidence, there is just the expectation that they are in a habitat that may be affected by sea level rise. There has definitely been a decrease in the number of occurrences in FL (perhaps because range is so small); in GA, it looks to be a healthy population; in SC it does not occupy all marshes but locally abundant where they are found. In December of 2018, the USFWS determined that listing was not warranted for MacGillivray's Seaside Sparrow. The Service's SSA determined that the South Carolina population is likely stable and more resilient than the Georgia-Florida population, due to higher nest survival rates and birds that inhabit higher elevation marshes. Although not as resilient as the South Carolina population, the Georgia-Florida population was found to be more abundant.

Nelson's Sparrow. Scott Somershoe

Appendix 2:

THREAT RATINGS

For more detail about the threat rating process, please see this document.

An initial threat rating was developed prior to the 2016 salt marsh conservation planning workshop; results are here.

At the 2016 workshop, threat ratings were reviewed for each focal species (Table A2-1), and considered for each region when attendees voted for the importance of each strategy by region (see above). On the basis of these threat ratings, the Open Standards rules (see Note below) and the scope of the plan, overall threat ratings were determined for all eastern salt marsh birds (Table 4, above).

Table A2-1. Threat ratings across focal species

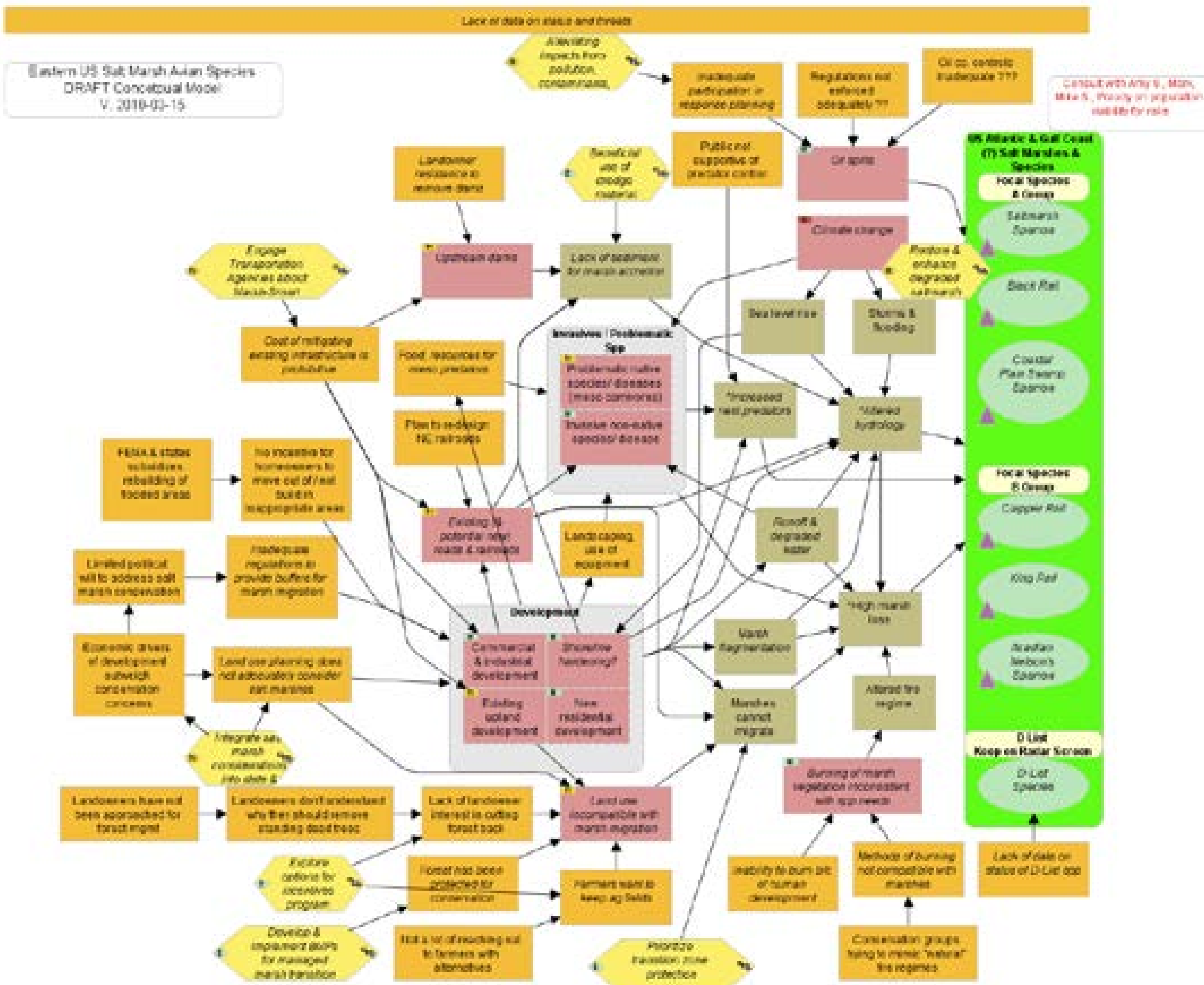
Threats \ Targets	Saltmarsh S...	Clapper Rail	King Rail	Acadian Nel...	Black Rail	Coastal Plai...	D-List Speci...	Summary Threat ...
Burning of marsh vegetation inconsistent with spp needs	Low	Low	Low	Low	High	Medium	Not Speci...	Medium
Commercial & industrial development	Medium	Medium	Medium	Medium	Medium	Medium	Not Speci...	Medium
Existing (& potential new) roads & railroads	High	Medium	Medium	High	Medium	Medium	Not Speci...	High
Existing upland development	High	Medium	Medium	Medium	Medium	Medium	Not Speci...	High
Increased GHG (climate change)	Very High	High	Very High	Very High	Very High	Very High	Not Speci...	Very High
Invasive non-native species/ disease	Medium	Medium	Medium	Medium	Medium	Medium	Not Speci...	Medium
Land use incompatible with marsh migration	High	Medium	High	Low	High	High	Not Speci...	High
New residential development	Medium	Medium	Medium	Medium	Medium	Medium	Not Speci...	Medium
Oil spills	Medium	Medium	Medium	Low	Medium	Low	Not Speci...	Medium
Problematic native species/ diseases (meso carnivores)	Medium	Medium	Medium	Medium	Medium	High	Not Speci...	High
Shoreline hardening?	Medium	Medium	Medium	Medium	Low	Medium	Not Speci...	Medium
Upstream dams	High	Medium	Medium	High	Medium	High	Not Speci...	High
Summary Target Ratings:	Very High	High	High	Very High	Very High	Very High	Not Specifi...	Overall Project Rating: Very High

NOTES

Open Standard rules were followed to to combine threat ratings across all six targets we were considering (i.e., Tier A and Tier B species). Their rules consider "medium" threat ratings for five targets as equal to a "high" rating for one target; two "high" ratings result in an overall threat rating of "high." Therefore, as a function of our having six targets and generally considering all threats to be medium (or higher), any threat that is rated high for one target means it gets a high rating overall. In the case of one threat, "Invasive/Problematic Species" its overall threat rating was "high" due to a high rating for Coastal Plain Swamp Sparrow (related to predation by meso-carnivores); the threat rating was "medium" for the other five focal species. Because that species has the smallest geographic range of all our focal species (Figure 1C), we decided this threat was a relatively local issue, and would be most appropriately dealt with by a subset of partners working at those locations, with site- and species-specific knowledge of the areas where Coastal Plain Swamp Sparrow breed.

Appendix 3:
CONCEPTUAL MODEL/RESULT CHAINS

The salt marsh plan started with partners developing an overarching conceptual diagram of all factors thought to positively and negatively influence salt marsh habitat and bird species. Based on the conceptual model and threat assessment process, factors and actions were combined into strategies at the 2016 workshop. Strategies were rated by their importance in each region, then attendees voted to determine the highest priority strategies for the entire ACJV area. The conceptual model for the salt marsh conservation plan is below.



RESULTS CHAINS

The initial iteration of the salt marsh conservation plan includes complete results chains for eight major strategies:
1) Restore and Enhance Degraded Saltmarsh
2) Prioritize Transition Zone Acquisition
3) Develop & Implement BMPs to Facilitate Marsh Migration and Offset Losses
4) Increase Use of Dredge Material to Benefit Salt Marsh Habitat
5) Integrate Salt Marsh Conservation into NRCS (Farm Bill) Program
6) Engage Transportation Agencies to Improve Infrastructure
7) Engage/Improve Land Use Planning Process
8) Alleviate Impacts from Contaminants and Spills

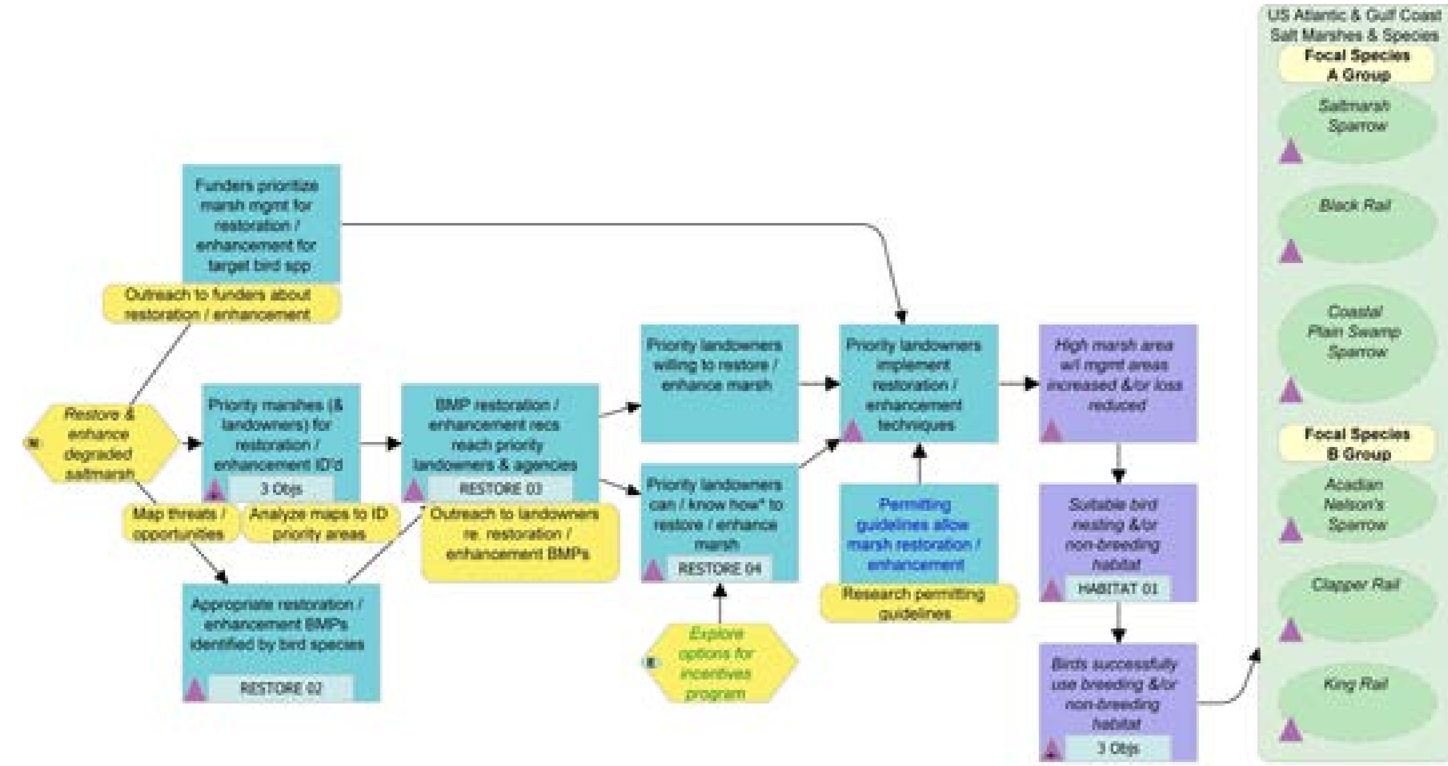
Some of these strategies overlap to a degree, and some objectives, actions, and indicators are shared among more than one strategy. The ultimate goal of all strategies is to reverse declines and increase salt marsh bird populations to reach population goals.

At a 2016 workshop bird conservation partners identified and ranked 18 strategies to address the major threats facing salt marsh birds.

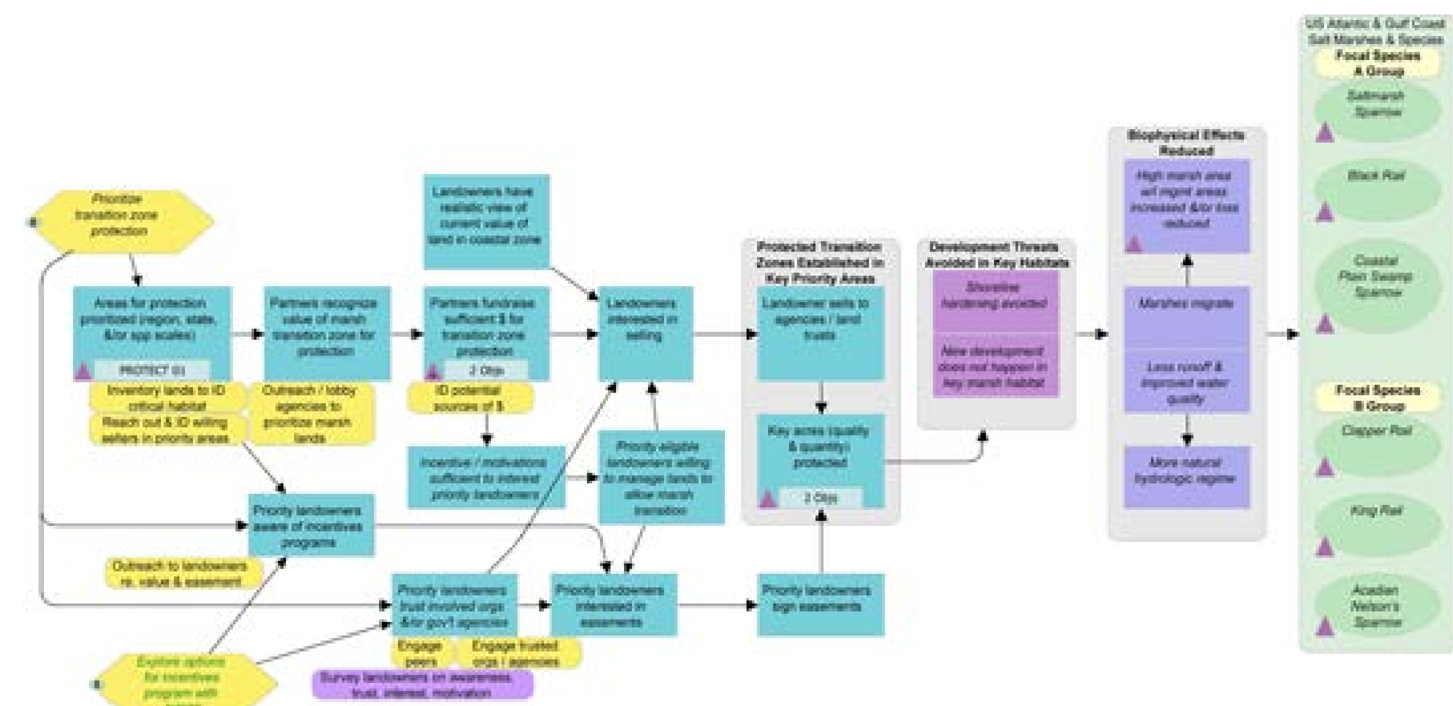
Table A3_1. Importance of proposed strategies by region and overall (numbers indicate number of votes). Each participant was allowed three votes in each of the regional and the overall categories and voted only in regions where they had familiarity. From 2016 workshop. Regions are NE (New England, NY), MA (NJ through VA), SE (NC to FL).

Strategy	Details / Notes	Overall	NE	MA	SE	Threat Group
A. Prioritize Transition Zone Acquisition	Need to conserve land for long-term marsh bird persistence	22	5	6	7	
B. Integrate Salt Marsh Conservation into NRCS (Farm Bill) Program	Make use of NRCS programs for forested and agricultural lands in tidal and migration areas	15	1	2		Incompatible land use
C.Increase Use of Dredge Material to Benefit Salt Marsh Habitat	Maintain Marsh Elevation	14	3	7	3	Sediment
D.Develop & Implement BMPs to Facilitate Marsh Migration and Offset Losses	Establish experimental demonstration sites (e.g., tree removal, salt added) to determine effective methods	11	1	4	1	
E. Alleviate Impacts from Contaminants, & Spills	Improve protection of salt marsh in oil spill response planning; facilitate conservation into NRDA	10			4	
F. Engage Transportation Agencies to Improve Infrastructure	Improve existing/future transportation infrastructure	10	2		1	Railroads, culverts, roads
G.Engage/Improve Land Use Planning Process	Improve marsh-friendly planning. Tie land use to economics (e.g., fisheries, tourism) of coastal areas	10		1	9	New development, incompatible land-use

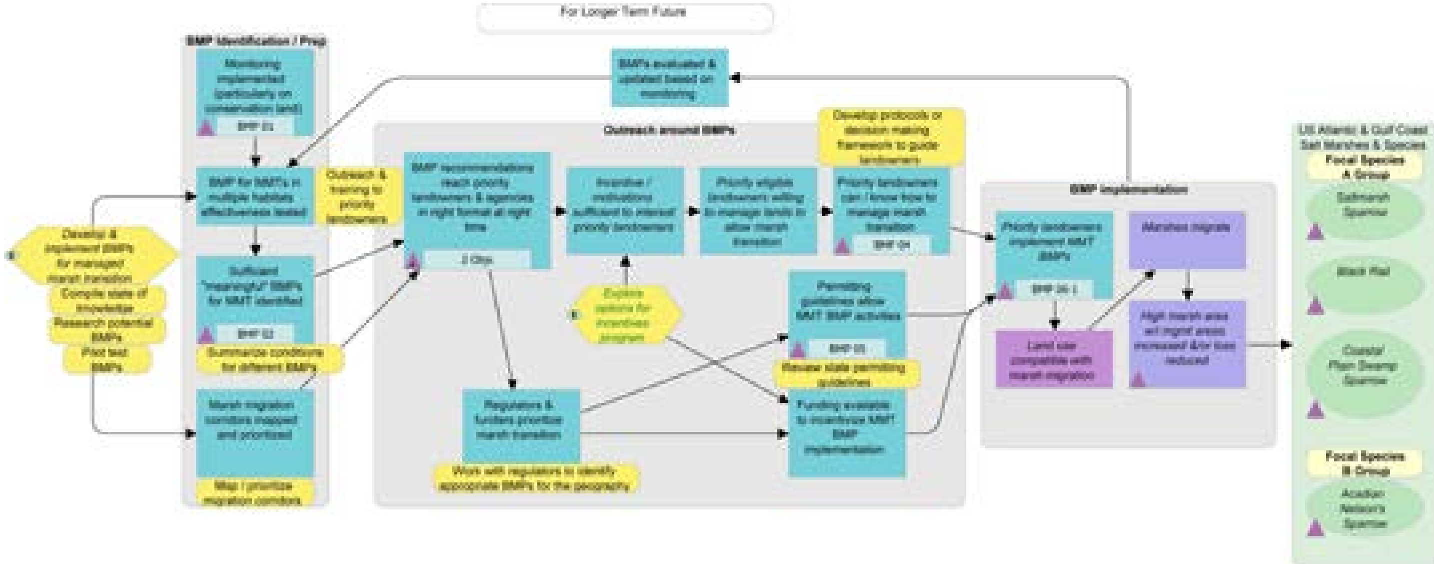
Strategy	Details / Notes	Overall	NE	MA	SE	Threat Group
H. Restore and Enhance Degraded Saltmarsh	Prioritize areas for restoration and enhancement for breeding marsh birds	8	1	1		
Landowner Outreach (Forest Mgt)	Demonstration sites for agencies, landowners highlighting different methods	5		1	1	Forest mgmt
Manage Impoundments for High Marsh	High impact on storms for SE, Black rails Very feasible in SE Medium feasibility in NE	4		1	11	Climate change
Remove / Modify Dams	Allow for sediment transport	3	6	1		
Develop BMPs for problematic spp	Identify potential tradeoffs and unintended consequences of controlling invasives and problematic native predators	2				
Control Water Levels (e.g., tide gates)	Does not include ditch plugs. Aimed at improving nest success (esp. relevant for NE)	1	6			Climate change
Living Shorelines (Bilkovic et al. 2016)	Reduce wave energy, erosion. Increase sediment capture in marshes. Reef balls, terraces.	1	1	2		Coastal engineering (others also)
Research on Burning	Describe methods, results of burning (e.g,. periodicity, intensity, spatial and temporal pattern) for bird populations. Are mechanical methods adequate in some places?	1		1	1	Burning of salt marshes
Outreach to Landowners / Policy Makers	Tie salt marsh conservation to water quality & management of run-off	1		1	1	Run-off, degraded water quality (development)
Engagement to Avoid Listing	Engage and improve partnerships through desire to conserve species before they are listed	1			1	
Ensure Water Use Rights	Focused on marsh accretion					Sediment



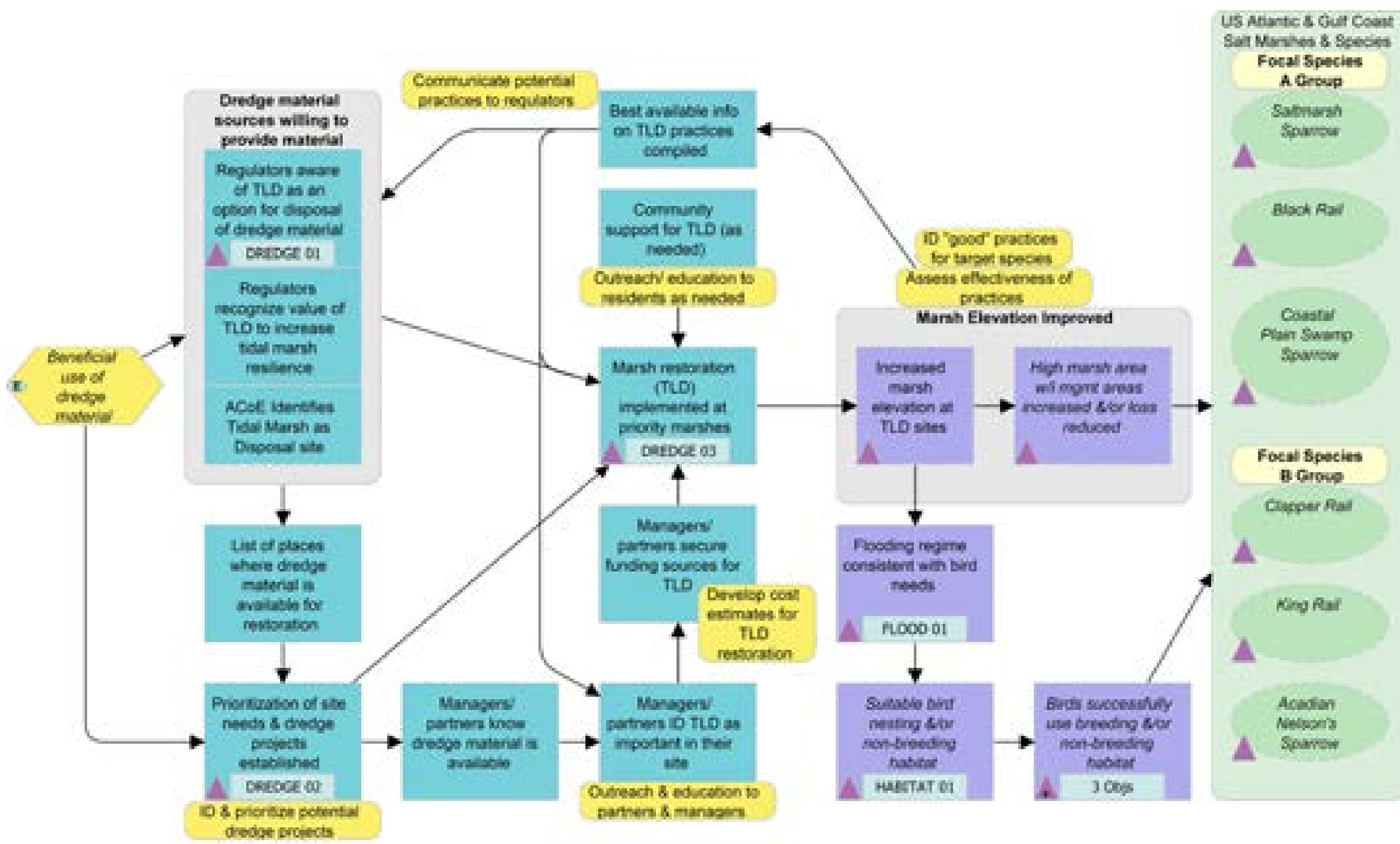
1. Restore and enhance degraded marsh



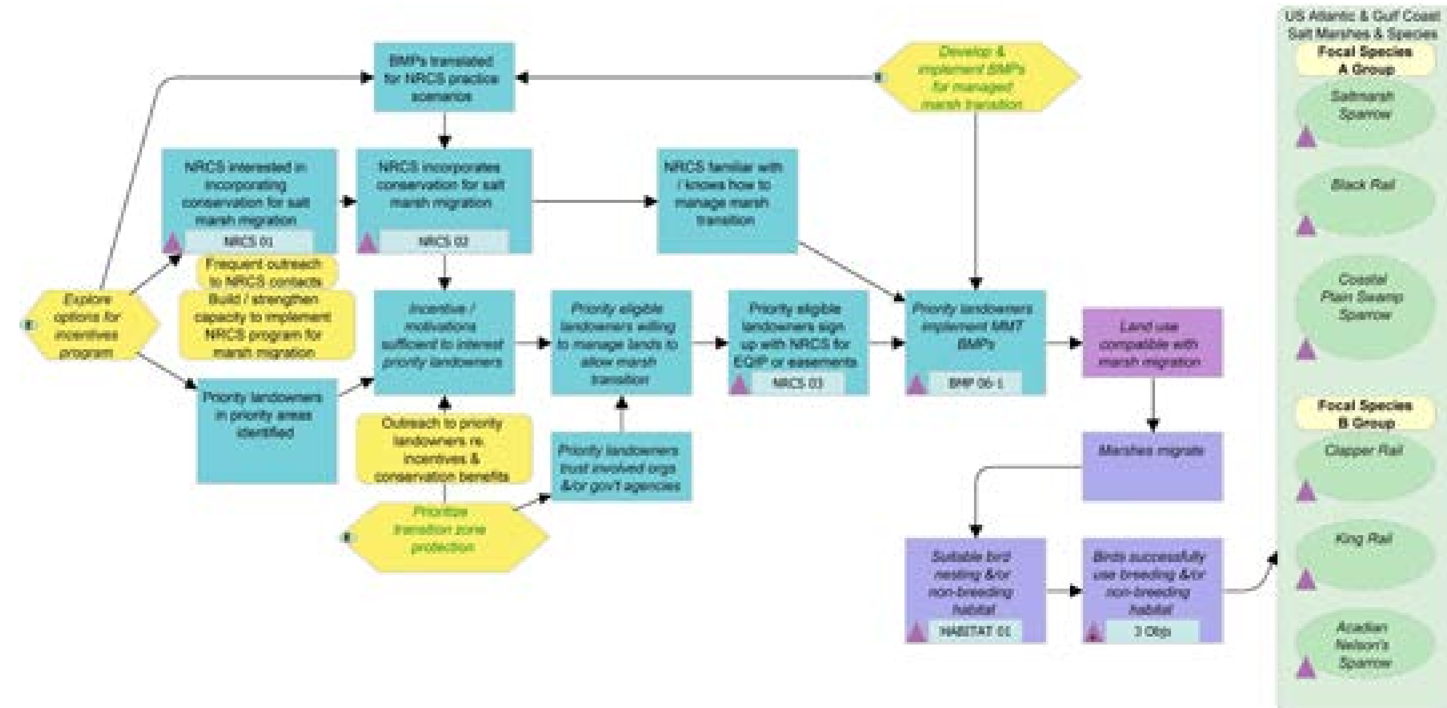
2. Prioritize transition zone acquisition



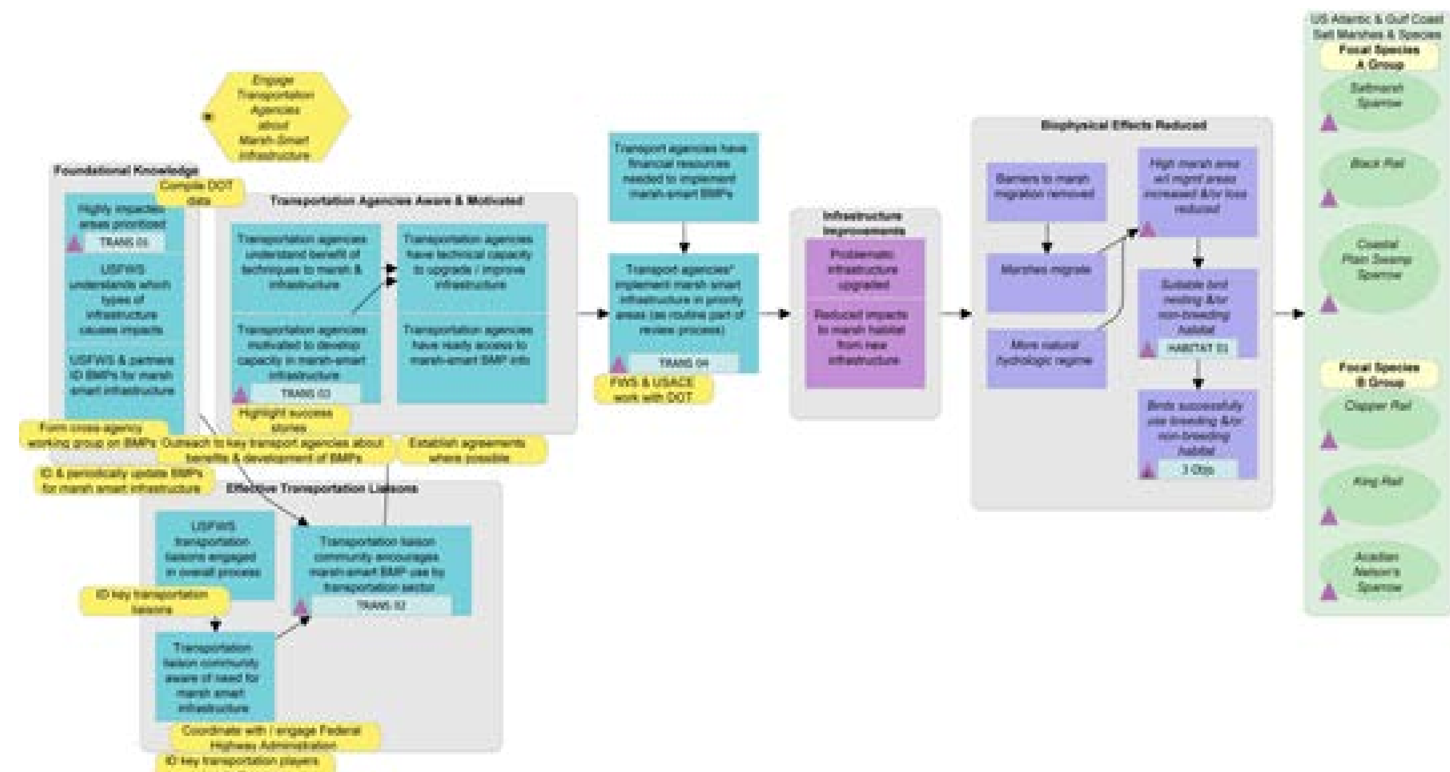
3. Develop & Implement BMPs to Facilitate Marsh Migration and Offset Losses



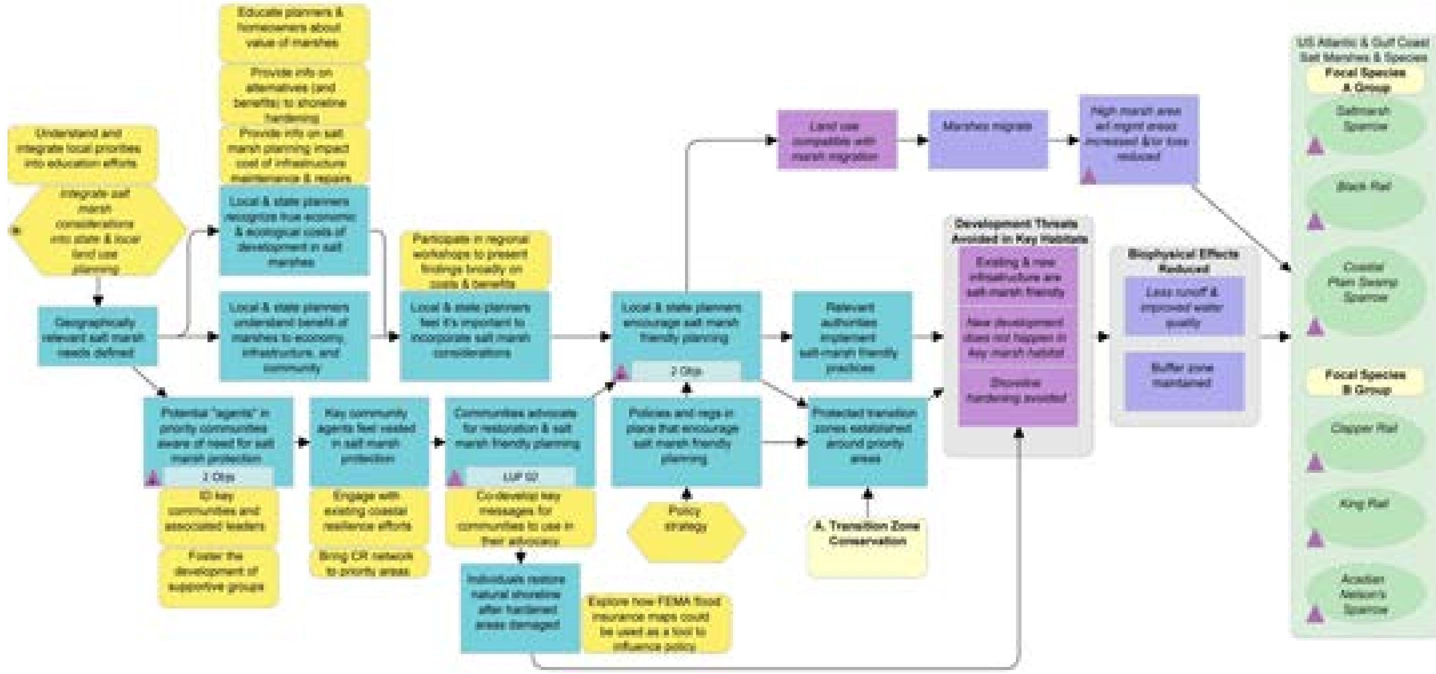
4. Increase Use of Dredge Material to Benefit Salt Marsh Habitat



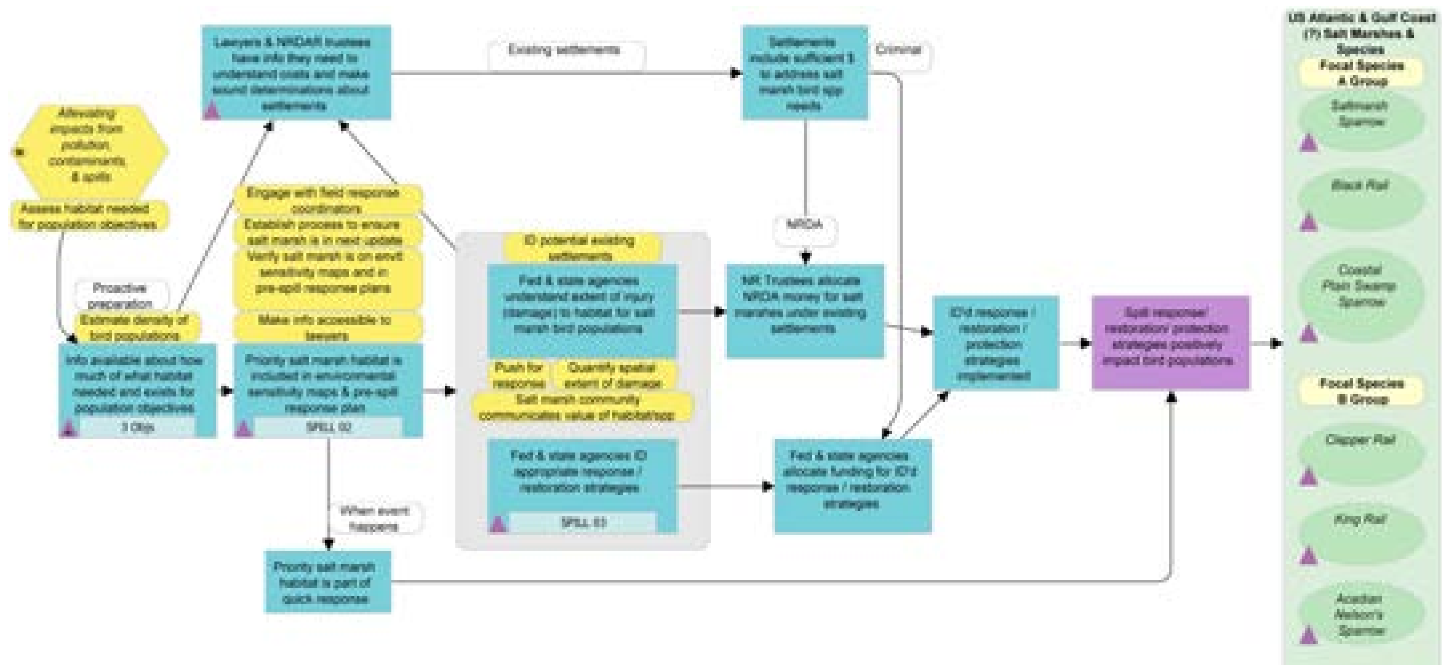
5. Integrate Salt Marsh Conservation into NRCS (Farm Bill) Programs



6. Engage Transportation Agencies to Improve Infrastructure



7. Engage/Improve Land Use Planning Process



8. Alleviate Impacts from Contaminants and Spills

Table A3_2. Expert input into importance ratings of proposed actions for each tier a species and for geographic subregions.

Super-script	Comment
1	In SE most flood tides are due to tropical storms and hurricanes; not typically a problem for nesting.
2	Low rating due to fear of being applied inappropriately; existing evidence suggests that it may work only in cases where sediment flow is going to be available or increased, otherwise it may result only in low marsh conditions (and possibly reduce Phragmites or cattails) or open water, not high marsh; therefore, unlikely to benefit high marsh birds. A bit counterintuitive given the sense that tidal restrictions are part of the problem historically, but we don't expect those marshes to return to natural high marsh anytime soon.
3	Different species in different regions. In the Gulf coast it's currently not a big problem but early monitoring and early removal may be very important if this is seen as an emerging problem.
4	BLRA - changed from "H" to "M" since this is a low issue for the SE and 3 of the 4 BLRA population centers are in the SE. NJ/MD area bumps this up from "L" to "M".
5	This may actually be bad for CPSS, as there is some anecdotal evidence that standing water created by muskrat activity is preferred for nesting and may lessen some depredation. If improving drainage increased the width of the shrub zone on the terrestrial fringe, both of these would be high priorities, so it depends.
6	Feral hogs are predators but also disturb habitat considerably in the SE; monitoring sites for presence to curtail the problem early is valuable. Predator control may not be effective in many situations, but may in some cases.
7	May have greater opportunities in SE with ongoing maintenance dredging for SE ports, so costs may be lower there. However, feasibility may be low still and therefore perhaps should be a "L" ranking like other coastal areas. Also there are higher-priority methods in the SE Atlantic.
8	Changed BLRA column from "M" to "L". Only important in areas where erosion is truly threatening loss of important high marsh breeding habitat.
9	Burning mostly happens in southern portions of Atlantic Flyway, more so in Gulf Coast than Atlantic Coasts. Reflects natural disturbance regimes as well.
10	Abundance/impact of dams is much higher in the north and less as you move south. Sediment is a fundamental requirement of healthy salt marsh, and some areas are sediment poor. So we do not currently know which dams need to be removed, but it may be an important tool in the right places.
11	Starting to be done in Mid-Atlantic where lower areas are restored to salt marsh to increase sediment capture and keep up with sea-level rise. Possibly opportunities in GA & NE FL where there is more steep elevation and grading that could facilitate marsh migration by smoothing elevation.
12	On Gulf Coast, live tree removal may be important; removing snags from ghost forests is being studied in MD. Marsh migration seems to happen readily at open sites with no shading from trees.
13	In some places pine plantations are an important land use and may be targeted for accelerated marsh migration. These places would be considered for the methods above for removing trees/snags. Opportunities for this to benefit key species are not common in many places, as salt marshes are abutted by forest not agricultural land. This may apply to BLRA only on freshwater wetlands in agricultural fields, which could be important for them but not benefit other salt marsh-dependent species. We need to consider how to include techniques (such as freshwater wetlands on agricultural fields) that do NOT benefit salt marsh habitat, even while benefiting salt marsh birds like BLRA. A lot of actions to benefit MacGillvray's Seaside Sparrows may benefit that species much more than others. How much opportunity (i.e., high acreage of agricultural lands) exist in NC & SC? Are opportunities so limited that this would be M priority at most or even L?

Spartina patens in flower. Sandra Richard, Creative Commons

Appendix 4:

STATE SUMMARIES

Each state in the ACJV developed its own summary report, which includes the states' responsibility for or distribution of priority species, locally specific threats, and implementation priorities based on the consensus of ACJV partners in that state.

Great Egret. William Majoros

CONNECTICUT

Brandford Connectocut salt marsh. ©slack, Creative Commons

HABITAT STATUS

Coastal marshes occur throughout Connecticut's coastal area, principally within sheltered embayments and at the mouths of tidal rivers. Connecticut has lost over 50% of its original tidal wetlands and now only has approximately 12,200 acres of salt marsh. Much of the existing salt marsh is grid ditched and/or tidally restricted. Salt marshes in the state are relatively small, with only 21 marshes over 90 acres in size.

SPECIES STATUS

Most of the salt marsh obligate species in Connecticut are declining. Willet and Seaside Sparrow are the only species that exhibit a stable population trend. Targeted surveys conducted by Connecticut Department of Energy and Environmental Protection (DEEP) since 2004, along with the SHARP surveys, indicate steep declines in Clapper Rail, Saltmarsh Sparrow and American Black Duck in coastal marshes.

Status of Tier A and B species in Connecticut: Population estimates are for individuals.

Species	State Breeding Population Estimate	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	Likely Extirpated	710-1,630$^{\phi}$	0%
Saltmarsh Sparrow	1,600	60,000 (40,000 - 80,000)*	3%
Clapper Rail	150	>575,000$^{\psi}$	<1%

*$^{\phi}$Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; $^{\psi}$ ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al, 2019, Hunter et al. 2017, Enloe et. al 2017)*

THREATS IMPACTING CONSERVATION

The legacy of mosquito ditching and filling of tidal wetlands is well represented in Connecticut's coastal marsh systems. There are very few large un-ditched tidal systems on the CT coast. Numerous marshes were also historically farmed for salt hay. Salt hay farming has declined over the year due to persistent wet conditions and, currently, there is only one active salt hay operation in the state.

Like many other states in the Northeast, Connecticut's coastline is densely populated, with development often sprawling right to the high marsh boundary. Past development pressure has resulted in extensive draining and filling of tidal marshes in urban areas, and high-density housing developments directly adjacent to many existing salt marshes limit potential marsh migration to relatively small patches of potentially suitable upland areas. Similarly, development near tidally restricted tidal marsh limits tidal flow restoration where it could increase flooding in these developed areas. Relative to other coastal areas of the Northeast, south of the New York-New Jersey Bight where salt marsh largely occupies coastal plain topography, Connecticut's steeper gradient coastal slope shoreline further limits marsh migration opportunities.

Managers developed and have used the Sea Level Affecting Marshes Model (SLAMM) to identify those areas of the coast that lend themselves to marsh migration under various sea level rise scenarios. SLAMM recognizes inherent uncertainty in key model input factors such as marsh surface sediment accretion rates, tide range, sea level rise, etc.. SLAMM considers uncertainty by running the model several hundred times using alternative model input values randomly drawn from data input distributions tables for key parameters. Each modeling result represents one possible future state for the studied area. Research is in its infancy to detail both natural rates of marsh migration and how facilitated marsh migration might occur. This model has also been used to identify those coastal marshes with the least amount of resiliency as sea levels increase. As in most areas of the Atlantic Coast, management actions on a large scale, such as alleviating tidal constrictions, are not feasible if the risk or perceived risk of such actions would result in inundation of private property.

Barn Island WMA saltmarsh habitat showing legacy mosquito ditch and marsh that is transitioning to a much wetter regime. Roger Wolfe

PRIORITY MANAGEMENT ACTIONS

Although salt marshes in CT are protected by existing state statutes, their extent, quality, and sustainability face many threats. In 1980, the State of Connecticut began a tidal marsh restoration program targeting systems degraded by tidal restrictions and impoundments. These degraded systems have little ecological connection to Long Island Sound. The initial management intent was that by returning tidal flow and reconnecting marshes to Long Island Sound, these systems would recover their full ecological function.

In 1986 CT's Wetland Restoration Unit started conducting Open Marsh Water Management (OMWM) in select marshes across the coast. This was in addition to the work that was begun restoring tidal flow to restricted marshes. Further, in 1998, OMWM was expanded into the current Integrated Marsh Management (IMM) program.

The State has experimented with living shoreline projects to try and trap sediment in low energy systems along the coast, most with limited success. A current project using reef balls in a high energy environment at Stratford Point shows promise. Elevations have been increased by over a foot in a year's time and planted *Spartina alterniflora* has rooted. Thin-layer deposition is currently being experimented with at Rocky Neck State Park. This project involves spreading adjacent dredge material from Bride's Brook on the marsh surface, and monitoring elevation and vegetation response relative to control plots.

A sentinel monitoring program has been developed to measure changes in coastal systems. The parameters and methodologies developed lend themselves well towards allowing, through future research, understanding of rates of marine transgression and the factors influencing them. Plans are in place to continue this monitoring on a scheduled basis so that change can be tracked over time and management actions that are taken can be evaluated, such as facilitated marsh migration through forestry.

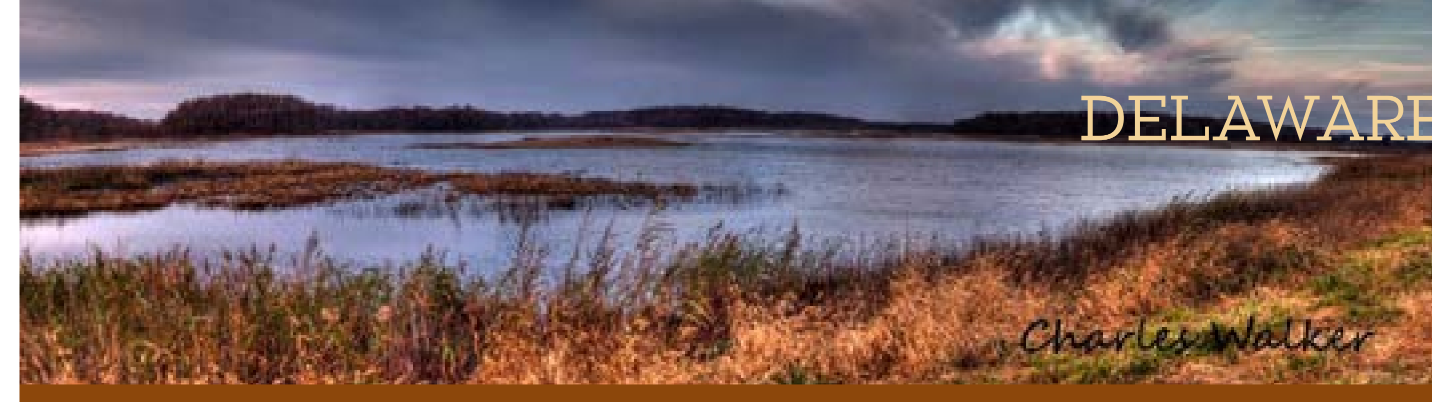
Initial research has also been conducted to better elucidate landowner attitudes towards rising sea levels, marsh inundation, and potential management actions. These surveys have greatly informed managers as to the hurdles that exist and will exist as resource agencies try to implement long-term strategies for marsh protection and enhancement. The CT DEEP is also beginning to work closely with select municipalities to examine how infrastructure will be affected by increasing sea level and how modifications to infrastructure will affect coastal marsh systems.

PARTNERSHIPS/PROJECTS

The CT DEEP has a long history of partnerships geared towards coastal wetland restoration. Numerous projects have been conducted in collaboration with USACE, USFWS, The Nature Conservancy, Save the Sound, University of New Haven, Sacred Heart University, University of Connecticut, Connecticut College, Ducks Unlimited, and CT Waterfowlers Association to enhance and restore tidal wetlands and to monitor the impacts of those conservation actions.

Recently Audubon Connecticut (part of National Audubon) has identified Saltmarsh Sparrow and tidal marsh as a high priority; they are undertaking a comprehensive review of the four most important marshes for Saltmarsh Sparrow. They plan to develop restoration plans and recommendations for East River, Hamonnasset, the lower CT River and Barn Island marshes and then help secure funding to implement restoration.

Marsh Wren. ©Matt Smooth, Creative Commons



DELAWARE

Bombay Hook, Delaware. ©Charles Walker, Creative Commons

HABITAT STATUS

Delaware, the second smallest U.S. state, has 77,500 acres of salt marsh habitat (0.05% of land area of Delaware, SHARP 2015) and 9% of the salt marsh in the Northeast region (Anderson et al. 2013; Delaware's Wildlife Action Plan 2015). Unlike neighboring states in the Northeast, Delaware's shoreline has not experienced heavy habitat modification, although shoreline armoring has occurred along Indian River Inlet (Rice 2016).

SPECIES STATUS

Five tidal marsh obligate bird species found in Delaware tidal marshes are of particular concern in the region: Clapper Rail (*Rallus crepitans*), King Rail (*Rallus elegans*), Willet (*Tringa semipalmata*), Saltmarsh Sparrow (*Ammospiza caudacuta*) and Seaside Sparrow (*Ammodramus maritima*). These species have been recognized as conservation priorities in Delaware's Wildlife Action Plans (DEWAP 2015). Two of these species have documented negative population trends: the global population of Saltmarsh Sparrow is declining by 9% annually, and within the Northeast, Clapper Rails are declining by 5% annually (Correll et al. 2017).

Status of Tier A and B species in Delaware. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	0-10 pairs [Φ]	710-1,630[Φ]	0 – 1%
Saltmarsh Sparrow	4,118*	60,000 (40,000-80,000)*	6.9%
Coastal Plain Swamp Sparrow	3,200 **	16,850*	19 %
Clapper Rail	7,669*	>575,000[ψ]	~1.3%
King Rail	Unknown	To be determined	Unknown
Acadian Nelson's Sparrow	None detected*	4,000 - 10,000*	0%

*[Φ]Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; ** Data from SHARP 2015; [ψ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al, 2019, Hunter et al. 2017, Enloe et. al 2017)*

Little information exists for King and Clapper Rail vital rates or habitat selection in the Mid-Atlantic region or Delaware specifically, yet this is potentially an important area for year-round rail conservation (Tymkiw et al. 2019). Coastal Plain Swamp Sparrow (*Melospiza georgiana*) is found at its second highest abundance in Delaware within the northeast region, accounting for 19% of the region's population. Seaside Sparrow is found at its third highest abundance in Delaware within the northeast region, accounting for 16% of the region's population (SHARP 2015).

THREATS IMPACTING CONSERVATION

Delaware's salt marsh habitat has declined and been degraded due to subsidence, sea level rise (including the loss of high marsh and conversion of low marsh to open water), land conversion from wetlands to developed areas and agricultural use, and wetland alterations for insect control and impoundment management (DEWAP 2015). Coast-wide alterations, such as artificial shoreline protection practices, water pollution, residential and commercial expansion and dredging projects, continue to impact Delaware's coastal habitats. Beach tourism infrastructure and development along Delaware's Atlantic Beaches attracts a high volume of visitors in the summer months, yet year-round the state is relatively rural compared to some of its densely populated neighbor states.

PRIORITY MANAGEMENT ACTIONS

Eliminate barriers to marsh migration and identify areas where marsh can retreat. Much of Delaware's undeveloped coastline is on publicly owned land that has potential to be managed for marsh retreat.

PARTNERSHIPS / PROJECTS

Prime Hook NWR completed a tidal marsh restoration in 2016, following a breach during Hurricane Sandy in 2012. This was the largest tidal marsh restoration project in the Eastern U.S., with about 4,000 acres of marsh restored.

Delaware Division of Fish & Wildlife initiated a cooperative agreement with the University of Delaware to provide a Delaware-specific tidal marsh bird monitoring plan that can be implemented into the future to determine the status and trends of focal species. Field work for this project began in 2018 and is continuing in 2019, led by Dr. Greg Shriver of the University of Delaware.

Aerial view of restoration activities at Prime Hook National Wildlife Refuge, Delaware. Richard Weiner

Florida salt marsh. ©Ryan Register, Creative Commons

HABITAT STATUS

Florida has approximately 375,600 acres of salt marsh (FWC and FNAI 2016), which is more than 10% of the salt marsh found in the United States (Greenberg & Maldonado 2006). The State of Florida considers its salt marsh to be in "poor and declining" condition and has identified salt marsh as one of the most threatened habitats in the state (FWC 2012). Unsurprisingly, as this habitat has declined, so have the populations of many obligate salt marsh vertebrates (FWC 2016).

SPECIES STATUS

Black Rails have been found throughout the state in both salt and freshwater marshes, albeit at very low densities (Schwarzer et al. 2018a). During surveys in 2016-2017, Black Rails occurred on 14 of 27 properties surveyed, but were only detected on <1% of surveys and at less than <1% of points surveyed. Marsh bird surveys in Florida during 2011 to 2012 found that Clapper Rail occupancy was >90% and densities of about 3 birds/ha at salt marshes (Enloe et al. 2017). Extrapolating this density across all salt marshes in Florida suggests that the state may support 450,000 Clapper Rails, though this is a crude approach and might be an overestimate; the original study was not designed to estimate populations nor did it report one. However, it suggests that Florida supports the highest population of Clapper Rails of any ACJV state. The same surveys showed a relatively low occupancy rate (23%) and density (0.7 birds/ha) for King Rail, suggesting a small population where it was detected. However, most King Rail detections were in freshwater marshes and Florida's contribution to tidally influenced populations may be minimal.

Status of Tier A and B species in Florida. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	400 - 1,000	710-1,630[◊]	28-31%
Clapper Rail	~450,000 (~300,000 - 600,000)	>575,000[ψ]	~78%
King Rail	unknown	TBD	

[◊]Data taken from Watts, 2016; [ψ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al, 2019, Hunter et al. 2017, Enloe et. al 2017)

Saltmarsh sparrows winter in northeast Florida in large numbers with smaller but still significant numbers along the southwest and Big Bend coasts on the Gulf. No wintering population estimate is available. Both subspecies are present. Nelson's sparrows are also present in significant numbers.

The MacGillivray's seaside sparrow, a resident subspecies, only occurs in South Carolina, Georgia, and northeast Florida. The subspecies has undergone a severe range contraction in Florida since the 1950s and

find
arzer

now only occurs in two counties, Nassau County and the portion of Duval County north of the St. Johns River. Studies indicate that nest survival is poor in this region (Schwarzer et al. 2018b).

find williams

THREATS IMPACTING CONSERVATION TODAY

Development of coastal areas has reduced the quality and quantity of salt marsh habitat as a result of ditching, diking, impoundments, and dredging (Greenberg et al. 2006). In addition, salt marshes are increasingly converting to mangroves (Williams et al. 2014) because of increased global temperatures (Cavanaugh et al. 2013). Furthermore, sea level rise has accelerated the conversion of high marsh habitat to low marsh habitat, and in some areas caused the loss of all salt marsh habitat (Donnelly & Bertness 2001). Sediment accretion and upland migration may allow some marshes to outpace sea level rise, but this is dependent on marsh-specific characteristics (Morris et al. 2002) and is much less likely in highly developed areas with hardened coastlines (Kirwan et al. 2016).

Florida's five northeast counties, which hold 11% of the state's total salt marsh acreage,have seen significant salt marsh loss. Nassau County underwent its biggest loss of marshes with the dredging of the Intracoastal Waterway, while the more urbanized Duval County has lost an even greater amount of marsh. A study of 3.5 miles on either side of St. Johns Inlet and ten miles up the St. Johns River demonstrated that human activities, mostly dredge-and-fill, caused a 36% loss of marsh habitat since 1943. Canals used for drainage and mosquito control reduced the salt marsh area of Lake Worth in the Indian River Lagoon by 51%, while the whole lagoon has lost 85% of its salt marsh coverage. Tampa Bay is one of the fastest growing urban areas in Florida. Ship channel dredging and port construction have caused extensive environmental damage and the Bay has lost more than 40% of its original mangrove and salt marsh acreage over the past 100 years. The dredging in Tampa Bay has primarily been for four purposes: channel deepening, maintenance dredging, shell dredging, and landfill dredging. Meanwhile, Charlotte Harbor has seen a 51% reduction in salt marsh area coverage in the same period. Salt marshes north of Cedar Key, along the Big Bend and into the Eastern Panhandle, have remained largely intact, but these marshes now face the threat of sea level rise.

Florida's human population is expected to double its from 2010 to 2060 and reach up to 36 million people (FWC 2008). Despite the threat of sea level rise, much of that increase in population will take place in coastal corridors. This will likely negatively impact existing salt marshes as well as make it difficult for marshes to migrate.

Snowy Egret. ©Diana Robinson, Creative Commons

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PRIORITY MANAGEMENT ACTIONS

Threats that have been identified in the southeast as the most challenging for salt marsh conservation include climate change and sea level rise, new development and incompatible land use, and the management of impoundments for sensitive species. Of these, the challenges most applicable to Florida are sea level rise and development, although there may be some opportunities for management of impoundments in central Florida along the Atlantic Coast, particularly around Titusville and Merritt Island. As such, the Salt Marsh Plan strategies that are key in Florida are: 1) ensuring the ability of marshes to migrate via land acquisition and easements; 2) beneficial use of dredge material to raise marsh elevation; 3) development of BMPs for marsh migration (i.e. habitat management to assist marsh migration); and 4) improvement of land use planning.

While there are some areas, particularly in south Florida, where marsh migration may not be possible due to already existing infrastructure, the partners in the state should focus on identifying areas where migration is possible and then facilitating that migration. Much of the Big Bend is already under conservation and the high marsh within this region is important habitat for Black Rail. However, with sea level rise, high marsh area will likely be decreased or eliminated in the press between the uplands and the encroaching low marsh. Partners in the state should help determine best practices for maintaining high marsh in the face of these changes and then institute these practices on state, municipal and private lands. It will also be important to identify under-developed areas that may allow for marsh migration but are not yet under conservation management and take steps to make sure marsh migration is allowed to occur. At a local level, using dredge material to raise marsh elevation may ensure that populations of sensitive taxa are not extirpated. Finally, where possible, partners should seek to inform land use planning to consider the threat of sea level rise and the benefits of allowing for marsh migration over other activities such as shoreline hardening.

PARTNERSHIPS/PROJECTS

There are a number of recent salt marsh restoration and projects done by the state of Florida (Florida Fish and Wildlife Conservation Commission's Aquatic Habitat Conservation and Restoration Section), although none have yet been evaluated in terms of quantifying effects on or benefits to salt marsh birds.

There is a lot of ongoing management of salt marsh in Florida, particularly the use of prescribed fire to manage woody vegetation and productivity. Merritt Island, St. Marks and St. Vincent NWRs and Apalachicola River Wildlife Environmental Area all have a long history of either burning marsh directly or allowing upland burns to carry out into the high marsh, and Lower Suwannee NWR has burned marsh in the past. Typically the frequency, timing and type of fire has been determined by the resources available to managers, management priorities, and the type of vegetation, and has not been driven by avian priorities, although the frequency of fire at St. Vincent NWR is in large part based on concern for Seaside Sparrows and Black Rails. A small study there in the *Spartina patens* dominated marsh demonstrated that sparrow occupancy was greater in units that had been burned 2 years prior compared to units that had been burned 1 or 4 years prior. Now the refuge burns each of the main marsh units on a 2-3 year rotation. It is important to note that Juncus dominated marshes typically can not burn more often than every 5 years while Spartina dominated marshes can be burned more frequently, up to every other year. Two studies, one specific to Florida and another across all Gulf states, are currently examining the effect of fire on avian and mammal (Florida only) communities in the salt marsh, with the main goal of providing managers feedback on best practices to support salt marsh avian communities.

MacGillivray's Seaside Sparrow, the resident subspecies that only occurs in Georgia, northeast Florida, and South Carolina. Georgia is critical to the conservation of this bird. Todd Schneider

HABITAT STATUS

Georgia has approximately 350,000 ac of salt marsh and 15,000 ac of brackish marsh habitat. This total accounts for nearly one third of all salt marsh on the U.S. Atlantic seaboard. The vast majority of this habitat is considered low marsh with less than a few thousand acres of high marsh habitat. The steep slope of the mainland and barrier island shorelines, coupled with high tidal amplitude (6-9 feet), results in most marsh areas being inundated too frequently and flooded too deeply to support high marsh vegetation (e.g., saltmeadow cordgrass, *Spartina patens*; saltgrass, *Distichlis spicata*). With a few exceptions, most high marsh habitat occurs in a narrow band (5-20 meters wide) along the upland/marsh ecotone.

Coastal Georgia has a human population of approximately 650,000 people with over half (54%) in Chatham and Effingham counties (the greater Savannah area) on the northern edge of the coast. Additional population centers include Glynn County (Brunswick/St. Simons Island/Jekyll Island) and Camden County (St. Marys) along the southern third of the coast, with 13% and 8% of the population respectively. Tourism is significant with 15 million visitors annually.

SPECIES STATUS

Three of the Tier A and B species, Black Rail, Clapper Rail, and King Rail have been documented breeding in Georgia. The status of breeding Black Rails is undetermined at present. Surveys specifically targeting Black Rails were conducted in 2013-2015 and 2017-2018. These surveys used the same methodologies and call playback recordings as used by several mid-Atlantic and southeastern states. The 2013-2015 surveys included approximately 70 points in high salt marsh with a few points in wet pine savanna (freshwater). The points were visited from one to four times each between April and June. No Black Rails were detected at any of these points.

In 2017, the Center for Conservation Biology (under contract with Georgia DNR) surveyed over 400 points in high marsh, brackish marsh, and coastal freshwater impoundments from April through July. Each point was surveyed three times during the breeding season. No Black Rails were detected during these surveys. An additional 206 points were surveyed from April to July 2018 at points in freshwater marshes mostly in the south-central and southeastern portions of the state. Each point was surveyed three times during this period. Again, no Black Rails were detected.

Status of Tier A and B species in Georgia. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	10-40◊	710-1,630◊	1-5%
Clapper Rail	15,000 (1,000-36,000)	>575,000ψ	14%
King Rail	Unknown	To be determined	Unknown

*◊Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; ψACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017)*

A Clapper Rail population estimate was developed using point count survey data collected at 214 points in 2013 and 2014. These surveys included passive and call playback elements. An estimated 15,000 Clapper Rails occur along the Georgia Coast.

Only limited survey work has been done for King Rails in Georgia and all of this was conducted at freshwater sites, particularly at impoundments at Altamaha Wildlife Management Area. It is unknown how important brackish water habitats might be to this species, and the fact that it sounds very similar to its congener, the Clapper Rail, makes estimating its numbers in saline habitats very difficult.

Saltmarsh Sparrow winter here in significant numbers, although no wintering population estimate is available. Both subspecies are present in roughly equal numbers. Nelson's sparrows are also captured in significant numbers. This includes the Acadian Nelson's sparrow. Population size is unknown. Banding of these species has been ongoing since 2011.

The MacGillivray's Seaside Sparrow, a resident subspecies, only occurs in South Carolina, Georgia, and northeast Florida. An estimated 32,800 individuals occur in Georgia with only a few thousand birds estimated to occur in the other two states, making Georgia critical to the long-term survival of this bird.

Willets nest above the high tide line on isolated beaches and along the marsh-upland ecotone. Numbers are unknown, but a rough estimate made more than a decade ago suggested as many as 800-1200 pairs.

THREATS IMPACTING CONSERVATION

Compared to most states along the Atlantic seaboard, Georgia's salt marsh habitats have been relatively untouched. While this may be the case, there has been significant ditching in some areas for mosquito control and other purposes as well as some filling in of wetlands. Fortunately, in the early 1970s, the Georgia Marsh Protection Act was ratified. This law provides substantial protection of the state's vast salt marsh by providing a buffer along the edge of the marsh and by limiting filling and other harmful activities. While the Marsh Protection Act limits direct destruction and loss of salt marsh, there are still potential indirect threats from increased sediment and nutrient loading from agriculture, industry, and increasing urbanization. Long-term contaminant issues at a number of old industrial sites are of concern, particularly the 800-acre LCP Superfund Site in Brunswick where high levels of mercury, PCBs (Aroclor 1268), lead, and petroleum-related chemicals were released into nearby creeks, rivers, and marshes from the early 1920s to 1994, and the nearby Hercules chemical plant where pesticides, such as toxophene, were manufactured from 1949 into the1990s.

At present, global sea level rise appears to be the greatest threat to salt marsh along the Georgia coast. Data collected over the last several decades show a 3mm annual rise in sea level and most models suggest this rate is likely to increase in the future. Marsh migration is made more difficult by the naturally steep slope of much of the shoreline. Increased shore armoring and new construction will further impede natural colonization of upland habitat by marsh as sea level rises. The coastal area has the second fastest growing human population in the state and is becoming increasingly popular for tourism. Both will put additional strain on resources and increase indirect impacts on the marsh itself. New docks and causeways will restrict water flow. Fertilizers, herbicides, and pesticides from lawns and other sources will affect the marsh. Higher mammalian predator densities (e.g., raccoons, house cats) are likely to occur with increased development. These predators will likely have significant negative impacts on marsh bird populations, particularly in any high marsh areas.

This living shoreline project constructed on Little St. Simons Island is a good example of a strategy to mitigate the effects of sea level rise and the negative effects of "hard" armoring shorelines. Todd Schneider

PRIORITY MANAGEMENT ACTIONS

Identification of marsh migration pathways is the first step in providing corridors for natural colonization of upland habitats by salt marsh as sea level rises. Strategies should be developed to acquire large blocks of undeveloped land and provide funding mechanisms for fee simple acquisition of land or conservation easements within these corridors. The Private Lands Program (PLP) of the Wildlife Resources Division is heavily integrated into the Farm Bill Program, which could be a significant funding mechanism for these efforts. Coordinating with PLP to acquire funding and support for conservation actions by private landowners that will facilitate marsh migration is an important next step. The Coastal Resources Division (CRD) is working with the USACE as well as other partners such as municipalities to conserve salt marsh habitat as well as create new habitat. This includes developing guidelines for dredge spoil deposition that will benefit the salt marsh and wildlife that uses this habitat as well as experimenting with thin-layer deposition of dredge spoil sediment. Coordinating these activities with all partners is imperative.

There are many areas of shoreline along marsh creeks, rivers, and similar areas that could be protected from severe erosion and storm surge by living shorelines or similar structures. Development of demonstration areas and cost incentive programs to aid in the construction of these shorelines and structures should be implemented. Little St. Simons Island, a private conservation resort, has a living shoreline that was installed during the last few years which could potentially serve as a demonstration area.

PARTNERSHIPS/PROJECTS

The USACE Savannah and Jacksonville Districts have designed and implemented a pilot strategy to test thin layer sediment deposition that will restore and maintain salt marsh habitat. This work is being done in conjunction with the Corps' Regional Sediment Management Center of Expertise, as well as other federal and state agencies and nonprofit organizations. The Georgia Department of Natural Resources' Coastal Resources Division (CRD), the Jekyll Island Authority (JIA), The Nature Conservancy, NOAA, USFWS, and EPA have all been involved in developing the pilot strategy. Planning began in 2016 and implementation started in March 2019, when a thin layer of muddy sediment was sprayed onto the target marsh area on the northwest side of Jekyll Island. Scientists from Georgia Southern University and the University of South Carolina are monitoring the sediment deposition and control areas.

The CRD Coastal Zone and Management Program and other programs continue to develop marsh restoration and maintenance projects and information. One large project recently implemented by CRD was a large oyster restoration effort. A benefit of this effort was better protection of the shorelines of several rivers and creeks as well as adjacent marsh.

The bronze glow of Spartina alterniflora in Maine. ©inaweofgodscreation, Creative Commons

HABITAT STATUS

Maine's salt marshes, while ecologically important, comprise a small fraction of tidal wetlands in the Northeast (NE) Region. However, despite comprising <0.01% of the land area of Maine, the approximately 22,500 acres of tidal wetlands in Maine (MDIFW 2015) comprise over 25% of the tidal wetland habitat in New England. Thirty percent of Maine's tidal marshes are presently designated as conserved land (MDIFW 2015). Salt marshes are present throughout the entirety of Maine's coast, but large salt marsh patches are generally confined to southern Maine (e.g., Portland and south). The coast north and east of Portland tends to host small salt marsh patches that fringe rivers.

Maine's tidal marshes have experienced human alterations (i.e. ditching, diking, roads, etc.) since at least the early 1600's but are currently surrounded by a lower human population density and less human development than other states in the Northeast (Wiest et al. 2019).

The Maine Natural Areas Program (MNAP) completed a spatial mapping of the State's tidal marshes in 2014. MNAP also produced spatial layers of projected salt marsh migration locations and coastal undeveloped habitat blocks within 1 meter of sea level rise.

SPECIES STATUS

As with the overall salt marsh land area in the state, Maine hosts a modest percentage of breeding tidal marsh bird species for the northeast region, as it is outside the range of several species and is the northern range boundary for Saltmarsh Sparrows. Maine presently accounts for approximately 2.7% of the ACJV breeding population of Saltmarsh Sparrow. This population estimate is complicated, however, by the fact that Saltmarsh Sparrows hybridize with the closely related Acadian Nelson's Sparrow, of which Maine hosts 92% of their U.S. population (the majority of the global population is in the Canadian Maritimes). Recent-generation hybrids, which occur within the area of range overlap (i.e., all areas in Maine south of Penobscot Bay), cannot be distinguished without capturing individuals. Further, it is currently unknown how hybridization impacts vocalizations in either species. Thus, common methods of population estimation, specifically point-count surveys, result in the presence of three categories: Saltmarsh Sparrow, Nelson's Sparrow, and unidentified sharp-tailed sparrow. This "unidentified sharp-tailed sparrow" can comprise around 20% of surveyed sparrows, and depending on survey location, some fraction of these unknown sparrows are Saltmarsh Sparrows; this group of "unidentified sharp-tailed sparrow" are not included in the State Breeding estimate, however. The convergence of these two species and their hybrids likely results in an underestimate in breeding sparrows where these species overlap (Penobscot Bay, Maine to Cape Cod, Massachusetts).

Status of Tier A and B species in Maine. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Saltmarsh Sparrow	1,620 individuals↗ (404 to 2,835)[1]	60,000 (40,000-80,000)*	2.7%
Acadian Nelson's Sparrow	6,423 individuals (3,670 to 9,177)[1]	7,000 (4,000 - 10,000)*	92%

*↗survey data did not include "unknown sharptailed sparrows" and is likely an undercount; *Data taken from Wiest et al, 2019; [1]SWG report*

Saltmarsh Sparrows are declining faster in Maine than in any other part of their range, -10.6% annual trend in coastal Maine and -7.3% annual trend from Cape Cod to Casco Bay, compared to a -9.0% annual trend across the Northeast (2015 SHARP SWG Report). An analysis of Saltmarsh Sparrow point count data (2000 - 2013, over 50 miles of salt marsh) at Rachel Carson NWR indicated Saltmarsh Sparrows were decreasing significantly, however at not more than 5% annually (Shriver et al 2015). Regardless of the dataset analyzed from Maine, Saltmarsh Sparrows are significantly and rapidly declining. Population trend analysis of point count data collected by SHARP and data from Rachel Carson NWR indicate that the Acadian Nelson's Sparrow is not experiencing significant population declines in Maine, despite a mean annual decrease of 4.2% between 1998 and 2012 across the Northeast US. The marshes of Maine may thus be serving as both the majority of the species range within the US and the home of the country's most stable populations.

Maine's tidal marshes also host nesting Willet (State SGCN species) and American Black Duck. Seaside Sparrow and King Rail occasionally occur during the breeding season but neither are considered to be a regular component of the State's avifauna.

Demographic data indicate that some of Maine's tidal marsh bird populations, however, may be faring slightly better than other states within the Northeast. In fact, Maine salt marsh patches host some of the highest seasonal fecundity rates observed for Saltmarsh Sparrows between Maine and New Jersey (although most are close to the regional mean), and although ¾ of the investigated Maine populations have negative population growth rate estimates (Ruskin et al. 2017b). Taken together, this indicates that although Saltmarsh Sparrows in Maine are declining precipitously overall, researchers have identified some marsh patches in Maine that may support stable site-specific growth rates.

THREATS IMPACTING CONSERVATION TODAY

Salt marshes in Maine have been modified in many ways over the years, including from direct development, modification via mosquito ditches, diking, grazing and agriculture, chemical insect control, channelizing, invasive species introductions (e.g., *Phragmites australis, Carcinus maenas)*, and tidal restrictions. Though human development as a direct threat is less than in other states and 30% of Maine's salt marsh is protected, indirect threats from human development remain relevant. Many seaward edges have been hardened and continue to be developed, cutting off marine sediment supply. In the southwestern portion of the State, development adjacent to salt marshes and within watersheds continue, allowing excess nutrients and runoff to reach the marshes.

Most of Maine's rivers are dammed extensively, reducing upland sediment supply, and a few high profile culvert replacements adjacent to marsh have resulted in disaster. Large-scale dam removal projects, largely driven by sport fish conservation, have occurred in Maine and may increase in the coming years. Maine, therefore, may provide an excellent test case in how dam removal might potentially benefit tidal marsh birds through alteration of the entire estuarine sediment budget.

Saltmarsh Sparrow (left) and Nelson's Sparrow (right) in fall plumage. Hybridization between the two species can make field identification of the two species difficult. Bri Benvenuti

Saltmarsh Sparrow nest flooding rates are high in Maine relative to other parts of the range, even though observed sea-level trend in Maine is lower than other states in the Northeast region (1.95 ± 0.0 mm per year coastal Maine north of Casco Bay, 2.24 ± 0.02 mm per year Cape Cod to Casco Bay). Curbing nest flooding is likely to be the most critical management tool to improve population growth rates for Saltmarsh Sparrows in Maine. Conversely, nest predation rates are low compared to other states within the breeding range, indicating that predator control is not likely to be an impactful management tool in Maine at this time.

Although hybridization is common between Saltmarsh and Nelson's Sparrows, it does not appear to be a major threat because of a lack of early generation (e.g., pure Saltmarsh X pure Nelson's) hybrids and support for maintained species boundaries (Shriver et al. 2005, Walsh et al. 2015, Walsh et al. 2016, Maxwell 2018). While hybrid individuals may be able to occupy a wider range of habitat types that may not be impacted by sea-level rise at the same rate as tidal marshes (Maxwell 2018), there is evidence for differential fitness (i.e., nest success) between Saltmarsh, Nelson's, and hybrid Sparrows. However, the extent of nest flooding currently does not allow for population sustainability in either species (2015 SHARP SWG Report, Field et al. 2017).

A formal assessment of the conservation implications of hybridization between Saltmarsh and Nelson's sparrows was completed by Walsh et al. (2017). This study resulted in the conclusion that despite potentially increasing levels of gene flow between the two species, hybridization appears to have minimal consequences at the population level relative to other imminent threats, such as sea-level rise and habitat degradation.

The Saltmarsh Sparrow rangewide is considered as a medium sensitivity bird to mercury contamination (Whitney and Cristol 2017). Mercury was found to be elevated in several Maine marsh patches, but overall, mercury concentrations in Saltmarsh Sparrow blood in Maine vary amongst marshes and vary throughout the breeding season. Blood collected from southern Maine Saltmarsh Sparrows had mean values between 0.5 ppm < 1.0 ppm (Shriver et al. 2006, Lane et al. 2011), with only occasional birds having mercury levels > 1.0 ppm. Further, mercury is not suspected to influence nest survival in Saltmarsh Sparrows, especially relative to daily maximum water level (Ruskin unpub.).

PRIORITY MANAGEMENT ACTIONS

Restore degraded salt marsh, prioritizing areas for restoration and enhancement for breeding marsh birds. Examples include assessing ditch plug areas to determine whether remediation, modification, or removal is warranted. Restoration techniques should be assessed on a case-by-case basis for Saltmarsh Sparrow populations, as some relic modifications may or may not be beneficial at this point.

Removing tidal restrictions, via culvert or bridge replacement or otherwise addressing road crossings should be carefully considered given evidence from other states (Elphick et al. 2015) that restoring tidal flow to marshes where it had been limited did not improve Saltmarsh Sparrow habitat. Tidal restrictions removed in Connecticut resulted in additional low marsh or mudflat, not high marsh. Communication should be increased between state DOT, Army Corps, and natural resource managers prior to planned management actions to better avoid conflict and complications. Marshes behind tidal restrictions represent the fastest declining populations for all tidal marsh birds in the Northeast, while unrestricted marshes show stable communities on average (from 1998 – 2012). While restoration methods have not been perfected, it is important to recognize that tidally restricted marshes are not sustainable for bird use in the long term. Critically, we need to develop methods to reverse the degradation of restricted marshes, while taking care to preserve successful reproduction wherever it is occurring, so that there are sources for colonization once higher quality habitats are produced.

Removing invasive *Phragmites australis* is defined as a potential management action in the State Wildlife Action Plan. This is another management action that requires caution, as removal of Phragmites can lead to marsh slumping and/or transition to low marsh/mudflat. Additionally, management actions adjacent to important high marsh habitat for Saltmarsh Sparrow may be damaged by mechanical removal. It may be important to consider other management actions, such as thin-layer sediment deposition, in conjunction with Phragmites removal. While thin-layer deposition might be productive in certain sites in Maine, it should be considered on a site by site basis. Care needs to be taken to not harm productive sparrow sites. Degraded habitat areas may be better candidates for this technique

Control water levels (e.g. tide gates and/or other hydrologic modifications) to improve nest success. The relatively small marsh patches with tidal restrictions in Maine provide an opportunity to test the relationship between varied regimes of tidal manipulation and tidal marsh bird population growth. This will help determine whether this management technique is effective and can be used to promote population growth in isolated instances. Maintenance of a single population could assist with the latter colonization of nearby marshes that are undergoing longer term restoration techniques.

Protecting marsh migration space is challenging in Maine because marsh migration is limited by human development, which is greatest in the southern part of the state where most of Maine's salt marsh is found. Marsh migration also is limited by Maine's steep coastal slopes, which typically rise sharply to adjacent forested uplands or human development. Therefore, relatively few areas are likely to have good potential for marsh migration, and these should be identified immediately. Land in Maine is inexpensive relative to the rest of the region, making land protection in Maine a more viable option than in many other places. We need to identify refugia, including upriver areas, modified habitats, and adjacent agricultural lands that may be beneficial for Saltmarsh Sparrow and long-term marsh persistence. Further, increasing or maintaining sediment supply may be a more viable option in Maine than assisting marsh migration, when adequate sediments are available to allow marshes to keep pace with sea-level rise through accretion.

PRIORITIES FOR FUTURE RESEARCH

- Define best practices for modifying road crossings and other tidal restrictions to encourage natural hydrology, accretion, and other internal processes that maintain marsh stability.
- Develop techniques to grow and sustain sod marsh coverage on the marine edge where losses have been or are likely to occur (i.e., prevent conversion to mudflats).
- Acquire more extensive data on sediment accretion rates and calculate sediment balances for all marshes. Develop fine scale elevation models for managed marshes.
- Better define elevational requirements for habitat; recognize differences in what birds may select versus what confers high nest survival.
- Develop a tool to classify marshes by their conduciveness to different management activities (need to know more about outcomes of management, time scale).
- Consider if assisted salt marsh migration techniques, such as altering upland slopes, are suitable for Maine.
- Small scale experimentation to develop potentially beneficial interventions at the scale of both sites (e.g., using temporary plywood covers on culverts to prevent upstream nest flooding during spring tides) and nests (e.g., temporary, water-filled barriers to prevent nest flooding, small-scale sediment additions to provide islands with higher elevation for nesting or other structures to elevate nests).

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- Monitor marshes at the mouths of Maine rivers that have experienced dam removals (e.g., Kennebec and Penobscot) to assess the impacts of dam removal and increased sediment budgets on tidal marsh birds.
- Gain a better understanding of what percentage of the Nelson's Sparrow population exists on Maine's islands (where they are found in non-tidal wetlands).

PARTNERSHIPS / PROJECTS

Rachel Carson NWR has one of the longest running surveys of tidal marsh birds (~20+ years) and was one of the earliest SHARP research sites. USFWS continues to fund salt marsh bird work there (e.g., ongoing point count and demographic surveys).

Researchers are exploring restoration strategies that create or sustain healthy high marsh conditions by using the historic infrastructure in place (i.e., ditches, dikes, berms). This could include removing historic ditch plugs, filling some ditches with hay to trap sediment, creating runnels, and creating microtopography.

Conducting surveys of Saltmarsh Sparrow in Maine. Mo Correll, University of Maine

MARYLAND

Deal Island, Maryland. ©Matt Tillett, Creative Commons

HABITAT STATUS

Maryland supports 213,233 acres of salt and brackish marsh, more than any other state in the Northeast region. The majority of this habitat is located in extensive (more than 1,000 acres) marsh blocks in the lower eastern shore of the Chesapeake Bay (Dorchester, Wicomico and Somerset counties) and in the Maryland Coastal Bays of Worcester County. These large marshes are located away from urban development (with the notable exception of Ocean City in the Coastal Bays), so are less impacted by transportation infrastructure and pollution than marshes in other northeastern states.

Maryland's tidal marshes are highly varied in their ecology. The Coastal Bays support polyhaline salt marsh, dominated by smooth cordgrass, salt hay grass, and salt grass. In contrast, the Chesapeake Bay tidal marshes are brackish, with considerable geographic and seasonal variation in salinity, resulting in a more complex array of vegetation associations. In addition to cordgrass meadows, extensive areas are dominated by black needlerush (*Juncus roemerianus*), and, in wetter, less saline areas, Olney threesquare (*Schoenoplectus americanus*).

Another factor significantly impacting tidal marsh ecology in the Chesapeake Bay is its narrow tidal range of just 0.7 m (2 feet). The Bay's microtidal regime results in marshes with little variation in elevation, and which experience tides influenced as much by wind as by lunar cycles, yielding unpredictable patterns of flooding. In the most extensive tidal marsh block in Maryland, the Blackwater-Fishing Bay marshes, different vegetation types are often found in close proximity because zonation from higher to lower marsh is repeated at small scales across many small tidal creek basins.

Tier A and B Species Status in Maryland. Population estimates represent individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	30 – 60	710-1,630[◊]	2 – 8 %
Saltmarsh Sparrow	15,071 (1,672 – 28,471)	60,000 (40,000-80,000)*	25%
Coastal Plain Swamp Sparrow	9,100**	16,850 **	54%
Clapper Rail	10,735 (4,782 – 16,688)	>575,000[ψ]	~1.9%
King Rail		To be determined	

*[◊]Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; **Data taken from SHARP 2015;*
[ψ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al, 2019, Hunter et al. 2017, Enloe et. al 2017)

Black Rail has experienced a dramatic population crash in Maryland since the early 1990s. The Fishing Bay marshes in Dorchester County once yielded some of the highest counts of Black Rail on the East Coast—now the species is at risk of being lost from the state.

Due to the large extent and relative inaccessibility of Maryland's tidal marshes, spatial patterns of population density of salt marsh specialist birds were not well understood prior to the SHARP surveys of 2011-12. SHARP provided valuable insights into the Tier A and Tier B species in this plan. The SHARP surveys focused on the four counties on the lower eastern shore (Dorchester, Wicomico, Somerset, Worcester) and did not cover the Chesapeake's western shore or the northern portions of the Bay, where marsh patches are small and lie mostly outside the geographic breeding range of Clapper Rail, Willet, Seaside Sparrow, and Saltmarsh Sparrow.

Maryland supports the second highest breeding population of Saltmarsh Sparrow of any state in the ACJV with the highest density of Saltmarsh Sparrow in the Coastal Bays. In the Chesapeake Bay its population density reflects the distribution of vegetation types: it is absent from large areas of marsh dominated by black needlerush or Olney threesquare but significant populations occur where short-statured Spartina (Syn. *Sporobolus*) meadows predominate as at Fishing Bay and Deal Island. One population not sampled by the SHARP surveys is at Rumbly Point Road/Irish Grove in Somerset County where, in 2009, a transect survey counted 49 individuals on a 3-km survey route (Audubon Maryland-DC, unpubl. data).

SHARP surveys revealed that Maryland supports the majority (54%) of all Coastal Plain Swamp Sparrows within the ACJV, with the greatest densities occurring in the marshes at Fishing Bay and the Nanticoke River in Dorchester County.

THREATS IMPACTING CONSERVATION

Historically thousands of acres of tidal wetlands were drained and converted to uplands for agriculture and development. In the Coastal Bays it is estimated that 41% of tidal marshes were altered or destroyed for development or agriculture in the 20th century. However, the larger marsh blocks on the lower eastern shore have been left effectively intact, and that is where the great majority of Maryland's salt marsh birds breed. One of the most frequent forms of wetland alteration in this period was grid ditching, which was widespread in Coastal Bays and parts of the Chesapeake Bay, such as at Deal Island. However, some of the Chesapeake's more extensive marshes escaped being ditched. For example, there is little evidence of grid-ditching in the Blackwater-Fishing Bay marshes.

Past marsh loss at Blackwater was due not just to sea level rise, but also due to herbivory by nutria, an invasive South American rodent introduced in 1943. Nutria became abundant in and around Blackwater and their herbivory destroyed the root mat of marsh plants in large areas which were converted to unconsolidated mudflats. Efforts to control nutria began in the 1990s with the formation of the Nutria Control Partnership, which received sustained federal funding following passage of the Nutria Eradication and Control Act in 2003. Nutria control, focusing on trapping, has been very successful and all moderate to high-density populations have been reduced to near zero on 150,000 wetland acres in Dorchester County and surrounding counties. One key reason for the eradication project's success was the breadth of the partnership, which included not only several government agencies but also more than 400 landowners (CBNEP Strategic Plan 2011).

On Assateague Island, grazing by wild horses may be adversely impacting marshes by altering vegetation structure of the high marsh and reducing its suitability as nesting habitat for Saltmarsh Sparrow. This could be a significant conservation issue for Saltmarsh Sparrow, considering the importance of the Coastal Bays marshes for this species in Maryland. In a similar vein, winter grazing by Snow Geese causes localized damage to marsh vegetation in the Coastal Bays.

PRIORITY MANAGEMENT ACTIONS


Sea level rise has increased marsh loss to shoreline erosion. Chesapeake Bay Program

The greatest current threat to salt marsh in Maryland is climate-driven sea level rise. The current "best" projection of relative sea-level rise in Maryland to 2100 (Boesch et al. 2013) is 1.1 meters, with high and low projections of 0.7 meters and 1.7 meters respectively. The best projection to the year 2050 in Maryland is 0.4 meters. SLAMM models predict that nearly all of the tidal marshes currently in the Chesapeake Bay will be inundated by sea level rise by 2100.

Maryland experiences much higher rates of sea-level rise than the global average because the land surface here is subsiding at a rate of 1.5 mm a year due to geological processes (glacial isostatic adjustment) resulting from the last glaciation (Boesch et al. 2013). Chesapeake Bay's narrow tidal range has resulted in marshes having very little variation in elevation, which magnifies proportional losses of marsh for a given amount of sea-level rise. Sea level rise has increased marsh loss to shoreline erosion; erosion of a number of islands in Chesapeake Bay has been well documented over the past 150 years. As a result of subsidence, limited elevational variation, and sea-level rise, the great majority of marsh loss in the Bay is occurring through interior erosion rather than shoreline erosion. As water levels rise, marshes drown, converting from high marsh vegetation to low marsh and then as the root mat disintegrates, fragmenting as bare patches become pools of water which expand and coalesce. This process is already well underway in the Blackwater River system where the loss of 5,000 acres of marsh interior since 1938 at Blackwater NWR formed a new Lake (Lake Blackwater), serving as the poster child for this issue.

It is essential to take a two-pronged strategy to saving salt marsh in Maryland, with major strategies being:

1. Facilitate successful upslope migration of tidal marsh in marsh migration corridors.
2. Slow the loss of existing salt marsh to erosion due to sea level rise.

Models show that in Maryland upslope migration can only replace a small fraction of marsh that is predicted to be lost this Century. This is not due to a lack of potential marsh migration corridors, but rather the vast extent of the marsh blocks that are under threat and the potential, in Chesapeake Bay at least, for a large proportion of these to become submerged over a relatively short period of time.

To facilitate upslope migration the two most important strategies are: Transition Zone Acquisition and Easements, and Develop and Implement BMPs for Managed Marsh Migration. Development needs to be halted in marsh migration corridors and the State of Maryland should invest in ensuring this land is available for transition to tidal marsh. Although it will not remain as dry land, this land should be relatively inexpensive because of the lack of alternative uses.

BMPs for managed marsh migration include Phragmites control, experimental tree removal to manage processes such as ground surface collapse, and tidal creek extension to introduce tidal hydrology to newly transitioned tidal marsh areas. Tidal creek extension can only be effective to alleviate waterlogging at sites with the elevation capital to allow inundated marsh to drain through the tidal creek network.

In the Chesapeake Bay, the most important strategy for slowing the loss of existing marsh is the Beneficial Use of Dredged Materials (BUDM) with the goal of raising the marsh surface to an elevation ideal for the growth of high marsh vegetation. At sites where marsh is being lost due to submergence and interior erosion there are few other options. Where shoreline erosion is occurring, living shorelines can be effective. In the vicinity of Ocean City the protection of marshes from development should be a priority. The nutria eradication program in the Chesapeake Bay should continue to prevent the potential re-establishment of nutria populations.

PARTNERSHIPS/PROJECTS

The preeminent example of BUDM in Maryland is the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island in the Chesapeake Bay. This 461 hectare island restoration project is funded by Congress and is implemented by a partnership of USFWS, USACE, Maryland Port Authority, and Maryland Environmental Service. The project uses dredged material from the Baltimore shipping channel to create both tidal wetlands and upland habitats. So far seven tidal salt marsh wetlands have been restored and several salt marsh bird species have colonized the island, including Northern Harrier, Willet, Clapper Rail, Seaside Sparrow, Coastal Plain Swamp Sparrow.

Blackwater 2100 is a public-private partnership founded by Audubon Maryland-DC, The Conservation Fund, and USFWS with the goal of ensuring the long term persistence of tidal marsh at Blackwater NWR and across Dorchester County. The partnership has expanded to include Maryland DNR, USGS, and USACE and has implemented several projects focused on piloting innovative climate adaptation strategies for increasing tidal marsh resilience, including tree removal and Phragmites control in marsh migration corridors, thin-layer deposition of sediments on disintegrating marsh, and tidal creek extension at a waterlogged transitional marsh site.


Phragmites control in the marsh. ©Joachim Treptow

Parker River National Wildlife Refuge, Massachusetts. USFWS, Matt Poole

HABITAT STATUS

Despite its relatively small size and dense population, Massachusetts has 43,450 acres of salt marsh, about 6% of the salt marsh habitat in the Northeast region. Although there are many small and medium sized patches of salt marsh distributed throughout the Massachusetts' coast, the Great Marsh in the northeast section of the state represents the largest continuous stretch of habitat, extending from Cape Ann to New Hampshire. The Great Marsh, with more than 10,000 acres of continuous salt marsh habitat, has been designated an Important Bird Area by the Massachusetts Audubon Society and an Area of Critical Environmental Concern by the Commonwealth of Massachusetts.

SPECIES STATUS

According to SHARP researchers, Massachusetts has the largest population of breeding Saltmarsh Sparrow in New England (third highest in Northeast region) and accounts for 10% of the population in the Northeast. In contrast to the range-wide -9% annual decline of Saltmarsh Sparrow, there has been no evidence of a population decline in Massachusetts. This lack of a decline may be, at least partially, the result of relatively high nest productivity rates as SHARP researchers have documented higher nesting success for Saltmarsh Sparrow in Massachusetts compared to other states.

Status of Tier A and B species in Massachusetts. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Saltmarsh Sparrow	6152 (3,406 to 8,897)	60,000 (40,000-80,000)*	10%
Clapper Rail	187 (33-240)	575,000[ϕ]	<1%
King Rail	Unknown	To be determined	Unknown

**Data taken from Wiest et al, 2019; [ϕ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al, 2019, Hunter et al. 2017, Enloe et. al 2017)*

In addition to being an important area for Saltmarsh Sparrow, SHARP identified Massachusetts salt marshes supporting the Northeast's third highest abundance of Common Tern, Virginia Rail, and Yellow-crowned Night Heron and a robust nesting population of Willets (approximately 5,000 individuals). Although Black Rail is rarely observed in Massachusetts, there are historical coastal records of this species in the state. The most recent record was at the Parker River National Wildlife Refuge in 2010 when two birds were heard calling in a freshwater impoundment throughout much of June. A Black Rail nest was found on a salt marsh island in the Merrimack River in 2005, confirmed by Dr. Bryan Watts as the northernmost nesting record for the species. Overall, the Massachusetts State Wildlife Action Plan identifies 19 SGCN associated with salt marsh habitat. In particular, many shorebirds, including American Oystercatcher, Willet, Killdeer, Red Knot, and Spotted

Sandpiper, forage in salt marshes. In summer, wading birds (Snowy Egrets, Glossy Ibis) feed in pools at low tide, and American Black Ducks use salt marshes for both nesting and wintering habitats. A few species, such as Seaside Sparrow, Acadian Nelson's Sparrow and Willet nest there as well, as do occasional Least Bittern and Common Tern. Short-eared Owl, Barn Owl, Snowy Owl, and Northern Harrier use salt marshes for hunting small mammals and other prey. Terns are colonial nesters on ocean beaches on islands and spits, areas often in or near salt marshes, and these marshes are used by all the tern species for loafing (resting) and providing important cover for their mobile young.

THREATS IMPACTING CONSERVATION

Since the arrival of the first Europeans, Massachusetts has lost a large portion of its salt marsh habitat. The Boston area was originally the site of an extensive salt marsh, most of which was lost by the dredging and filling of the Back Bay. Between the end of World War II and the mid-1970s, Massachusetts lost approximately 20,000 acres of salt marsh, a third of the total acreage present prior to the beginning of this period. Fortunately, despite being the third most densely populated state, due to more stringent permitting and regulatory protections, little development now occurs in salt marsh areas in Massachusetts.

Invasive plants like Perennial Pepperweed displace native salt marsh vegetation. Andrey Zharkikh, Creative Commons

Salt marshes are particularly vulnerable to a warming climate that is predicted to result in substantial sea level rise in the coming decades. Although salt marshes are constantly accreting, it is unclear if marsh accretion will keep pace with seal level rise. When not prevented by bedrock, roads, or other structures, salt marshes may migrate landward. However, the rapidity of sea level rise and the vast amount of development behind many salt marshes present a major challenge for a natural landward retreat of the habitat. Additionally, the predicted increases in large storm events can impose damage (e.g., destabilize sediments, erosion, flooding) on the salt marsh that may threaten its persistence. Of course, the presence of salt marshes during storm events is extremely important in mitigating the storm surge and reducing coastal flooding.

Past and present agricultural activities pose a potential threat to salt marshes. Negative impacts of salt marsh haying on birds appear to be minimized in Massachusetts as it is only conducted on a commercial scale in the Plum Island Sound region and only once every few years from late July through fall or even into winter. However, if haying were conducted in June, it would likely result in the destruction of any active bird nests. In addition to current agricultural activities, legacy impacts from ditching, farming dikes (embankments), and Open Marsh and Water Management (OMWM) practices have altered historic hydrologic pathways, interfering with salt marshes' ability to adapt to increasing flooding. Research and restoration techniques being piloted at Parker River NWR have increased our understanding of these infrastructure- altered natural hydrology methods to restore a more natural flooding and draining hydrology that allow marshes to keep pace with sea level rise (Burdick et al. 2017, Pau et al. 2018).

Invasive species are another important threat to salt marshes, especially where the normal tidal influence has been altered. The upland edges of many salt marshes have dense areas of the invasive variant of common reed, as do brackish tidal marshes in several rivers. Perennial pepperweed, a relatively recent invader, can form monocultures displacing native salt marsh vegetation. Purple loosestrife is established in some of the fresher parts of many salt marsh systems, adding a shrub-like aspect to the habitat that previously would not have been present.

Current threats from pollution to salt marshes and their associated species include contaminated stormwater runoff from residential and commercial areas and potential oil spills in the region. Salt marshes are particularly vulnerable to oil spills because they are not only difficult to clean following the spill but can trap and retain large amounts of oil. Nutrient enrichment from stormwater runoff, especially of nitrogen and phosphorus, at levels that exceed native vegetation's ability to process it, leads to rapid degradation of salt marsh systems. Heavy metals (e.g., mercury, lead, and aluminum from industry, combustible engines, and lawn herbicides and pesticides) in stormwater runoff also pose a risk to salt marsh fauna through bioaccumulation.

Wildlife Biologist Nancy Pau talks about the Hurricane Sandy marsh restoration project at Parker River National Wildlife Refuge. Margie Brenner, USFWS

PRIORITY MANAGEMENT ACTIONS

Salt marsh habitat in Massachusetts has been protected by state and local laws for decades with the primary legislation being the Massachusetts Wetlands Protection Act (1972) that prohibits the destruction or alteration of this natural resource. However, the current extent and quality of this habitat remains in jeopardy. It is important for environmental organizations to protect salt marshes supporting populations of SGCN species, and conservation and recovery plans for high priority salt marsh birds should be developed to guide management objectives. To complement land protection and management measures, particular emphasis should be placed on adjacent uplands to provide for potential upslope migration of salt marsh habitat under climate change. Additionally, salt marshes should be evaluated for habitat stressors and degradation (e.g., altered hydrology, presence of invasive phragmites) in order for restoration actions to be considered when necessary. Exploring and implementing restoration strategies will maximize the likelihood of having functioning salt marsh persist into the future despite rising ocean levels.

Salt marsh restoration efforts in Massachusetts include a variety of actions. The Great Marsh Coalition, formed in 2000, utilizes a multi-disciplinary approach to promote conservation of this extensive salt marsh. Recently this coalition gave rise to the Great Marsh Resiliency Partnership that is working on projects involving barrier beach restoration, salt marsh restoration, invasive removal, barriers assessment, hydrodynamic and sediment transport modelling, and resiliency planning. Out of this effort, the Great Marsh Coastal Adaptation Plan was published in December 2017 by the National Wildlife Federation and the Ipswich River Watershed Association. On Cape Cod, the National Park Service in conjunction with the Town of Wellfleet and other state and federal partners is implementing a project to restore flow to more than 1,000 acres of degraded salt marsh along the Herring River by replacing an earthen dike with a new bridge and tidal gates, and addressing other tidal restrictions to adaptively restore tidal flow to the salt marsh. Similarly, the Neponset River Watershed Association has been working to restore salt marsh habitat through excavating dredge spoil deposits to improve tidal flow.

PARTNERSHIPS/PROJECTS

Massachusetts has had a long history of salt marsh restoration efforts and partnerships. Since the 1990s salt marsh restoration efforts have focused on addressing altered hydrology from tidal restrictions, and participating organizations have included a variety of state and federal agencies as well as local municipalities, land trusts, and concerned citizens. These organizations continue to investigate new areas of concern and methods to address salt marsh restoration.

Within the Great Marsh, a coalition of organizations are investigating and implementing a suite of low-tech techniques originally piloted by the USFWS. The Trustees of Reservation (TTOR) is implementing an adaptive ditch remediation project in a relatively small area of the Great Marsh with hope of expanding the effort in the future. This low-tech process is intended to restore the marsh to single channel hydrology and tide shed equilibrium by encouraging the natural processes that lead to peat formation. It involves treating selected auxiliary channels or ditches (based on an understanding of historic alterations) by applying a thin layer of salt marsh hay (harvested by hand-mowing a path parallel to the ditch) and securing the hay to the ditch bottom to encourage the natural deposition of sediment from the water column. Parker River NWR has restored 130 acres, addressing increasing inundation from OMWM, and is in the process of restoring more OMWM marshes. It is also collaborating with University of New Hampshire to improve drainage on large pool complexes through installation of small runnels. This latter project would impact roughly 1,000 acres. Ultimately, the goal of these projects is to nudge the marsh into restoring itself, enhancing natural healing of the ditched landscape, eliminating much of the present waterlogging conditions and permitting natural accretion, which will eventually lead to restoration of high marsh habitat.

Saltmarsh Sparrow chick. Rhonda Smith, USFWS

NEW HAMPSHIRE

Great Bay National Wildlife Refuge, New Hampshire. Greg Thompson, USFWS

HABITAT STATUS

New Hampshire supports 6,000 acres of salt marsh (NH Wildlife Action Plan; NWIPlus), and has lost 18 to 50% of its original extent. There are 31 tidal restriction sites listed by NRCS in 1994, with some since rectified (NH Wildlife Action Plan). The largest portion of this habitat in New Hampshire is within the Hampton - Seabrook Estuary (4,450 acres). Most of the latter is heavily ditched but an extensive portion in the extreme northeastern corner remains relatively untouched.

SPECIES STATUS

With its small coastline and limited amount of salt marsh habitat, New Hampshire does not support large populations of salt marsh specialist birds. The majority of Saltmarsh Sparrows are found in the extensive marshes surrounding the Hampton-Seabrook Estuary, while Acadian Nelson's Sparrow are more common in smaller coastal salt marshes along the north coast and in the fringing marshes around Great Bay, particularly the southern end. These two sparrows hybridize extensively in this part of their ranges. Other SGCN in the state's salt marshes include roughly 30 Willet pairs, 10 Common Tern pairs (no recent estimate), and an unknown number of American Black Duck. Seaside Sparrow and Clapper Rail occasionally occur during the breeding season, but neither is considered a regular component of the state's avifauna.

Status of Tier A and B Species in New Hampshire: Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Saltmarsh Sparrow	1,080◊ (0 - 2772)**	60,000 (40,000-80,000)*	1.8
Acadian Nelson's Sparrow	239 (21 – 457)**	7,000 (4,000 - 10,000)*	3.4

*◊Comparable to an estimate derived for the Hampton-Seabrook estuary by NH Audubon in 2008; **Data taken from Hodgman et al. 2015; *Data taken from Wiest et al, 2019*

THREATS IMPACTING CONSERVATION

High-ranking threats identified in the NH WAP include: restricted tidal flow, sea level rise, degradation due to shoreline hardening, fragmentation, and oil spills. Important medium-ranking threats include stormwater runoff (e.g., erosion, nutrient inputs) and historic mosquito ditching. Direct loss to filling and development occurred historically but is no longer a significant threat.

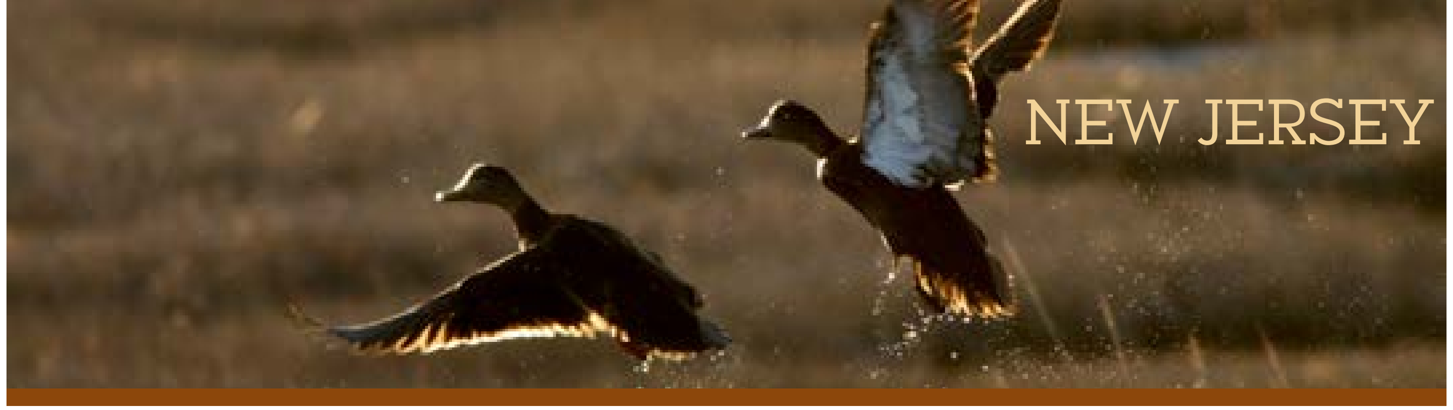
PRIORITY MANAGEMENT ACTIONS

Key actions needed are to manage for marsh migration and restore tidal flow at restricted sites.

PARTNERSHIPS / PROJECTS

The Hampton-Seabrook Estuary Restoration Compendium (Eberhardt & Burdick 2008) provides extensive details about New Hampshire's largest salt marsh complex, including a list of potential restoration projects, maps, and other details.

Willet in the salt marsh. ©Stan Lupo, Creative Commons



American Black Duck at Edwin B. Forsythe National Wildlife Refuge. ©Henry McLin, Creative Commons

HABITAT STATUS

Despite its relatively small size and having the highest human population density in the U.S., New Jersey (NJ) has 202,436 acres of salt marsh, nearly 40% of all salt marsh habitat in the Northeast Region. The state's tidal marshes vary with respect to tidal range and past human impacts, such as ditching and diking, both of which can play an important role in determining marsh resilience to sea level rise and habitat quality for species of conservation concern.

New Jersey's extensive coastline includes a diversity of different tidal marsh complexes with different ecological conditions (e.g., tidal range (Defne et al. 2016), salinity, degree of adjacent development). On the Atlantic coast of New Jersey, tidal marshes of the Barnegat Bay are microtidal (~4 -4.5 inch range) and heavily altered by ditching and open water marsh management (Powell 2018). Upper watersheds there are highly developed, which limits the potential for inland migration of marshes (Lathrop Jr. & Bognar 2001). Farther south, the Mullica River and Little Egg Harbor watersheds are far less developed, allowing a greater capacity for inland marsh migration. Tidal range increases in these areas (>3 feet). The majority of the marshes are extensively grid-ditched. In the southern reach of NJ's Atlantic Coast tidal marshes from Great Egg Harbor to Cape May, tidal range continues to increase (3 - 4 feet). This region harbors what may be the largest extent of unditched salt marsh in the Northeast, totaling approximately 14,000 acres. The marsh landscape here differs substantially from hydrologically-altered marshes (Lathrop et al. 2000), being characterized by dynamic marsh pool hydrology that creates and maintains high vegetated and unvegetated habitat diversity through successive formation, expansion, tidal breaching, and revegetation of marsh pools (Smith et al. 2017). Finally Delaware Bay marshes have the greatest tidal range (5 - 5.8 feet) in the state but approximately half of the marsh area here has been substantially altered (Smith et al. 2017) by the historic practice of diking and draining for salt hay production and agriculture.

Overall there has been a 21.5% decrease in tidal marsh in NJ's Delaware Bay since 1930 but increases in marsh area due to inland migration reduce net loss to 14% (Smith et al. 2017). Former agricultural use is responsible for the majority of interior marsh loss there. On the Atlantic Coast, an analysis of marsh change since 1970 indicates that the altered, microtidal marsh of Barnegat Bay has experienced 24% loss of vegetated area. In contrast, the amount of marsh lost in the predominantly unditched marshes between Cape May and Great Egg Harbor is much lower at 10%. A portion of this loss has been offset by upland to wetland conversion, resulting in a net salt marsh loss of 3.4% in the Cape May to Great Egg Harbor region since 1970. Notably, little of the marsh loss described here is due to direct conversion of wetlands as a result of human development.

SPECIES STATUS

According to SHARP researchers, New Jersey has the largest population of breeding Saltmarsh Sparrow of any state, and the highest breeding population of Seaside Sparrow and Willet in the Northeast Region. New Jersey supports more than 20% of the NE regional population for 13 more bird SGCN associated with tidal marsh, more than any other Northeast state.

Status of Tier A and B species in New Jersey. Population estimates represent individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	80-120	710-1,630[◊]	5-17%
Saltmarsh Sparrow	20,000 (6,000-34,000)	60,000 (40,000-80,000)*	33%
Coastal Plain Swamp Sparrow	2,700**	16,850**	16%[c]
Clapper Rail	34,000 (9,000-59,000)	>575,000[ψ]	5.9%
King Rail	Unknown[↗]	To be determined	Unknown
Acadian Nelson's Sparrow	na	7,000 (4,000 - 10,000)*	0%

[◊]Data from Watts, 2016; [*]Data from Wiest et al, 2019; [**]Data from SHARP 2015; [ψ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017); [↗]Surveys at Supawna Meadows NWR found 21 detections at 40 points

New Jersey is one of the only states left in the Northeast region with a small, remnant Black Rail population. Black Rail are documented (Watts 2016) in marshes along the landward side of barrier islands and salt marshes within estuaries and coastal bays. Highest densities are in the barrier island marsh patches. Estuarine marshes of particular importance include the Tuckerton Marshes along Little Egg Harbor, marshes at the mouth of the Mullica River around Great Bay and the marshes around Manahawkin Bay. Along Delaware Bay, Black Rail use the vast tidal salt marshes that stretch from Cape May west to Salem.

New Jersey is the primary zone of hybridization for Coastal Plain Swamp Sparrow, with northern parts of the state occupied by the inland population of this species, stretching far west and north into Canada, and the salt marsh subspecies occupying southern coastal portions.

THREATS IMPACTING CONSERVATION

Along with other Mid-Atlantic states, New Jersey's coasts have been slowly sinking for thousands of years due to the process of glacial isostatic adjustment (Khan et al. 2015), the "see-saw" effect related to land in the north rising up over the last 10,000 years due to the reduced weight of the glaciers that were pressing them down. This natural subsidence, coupled with global sea level rise, has increased the rate at which salt marshes must accrete vertically, such as through sediment capture or biomass production, to maintain the same marsh area and elevation over time.

Along Delaware Bay, New Jersey's tens of thousands of acres of salt marsh have attracted, since the late 1600s, interest and use for agriculture. Initially used as cattle pastures or for harvesting salt hay (*Spartina patens*), the area's earliest settlers recognized that these extensive wetlands could be managed to improve their utility. By creating banks (e.g., dikes or berms), digging ditches, and installing sluice gates to reduce and control flooding, more productive farmland could be reclaimed. By 1775, some fifty laws were passed authorizing land to be embanked and requiring landowners who benefited from the drained land to participate in the organization and maintenance of the banks. Meadow banking began declining in New Jersey around 1840 as tides and storms made it increasingly difficult to maintain dikes and other infrastructure. Historic ditching, which occurred into the 1900s, and more modern open marsh water management (Powell 2018) (OMWM), which started late in the 20th century and continued into the 21st, have transformed wetland landscapes in many places; the impacts of both of these management activities on wildlife and resilience to sea level rise are still not well understood (Smith & Niles 2016).

Not only is New Jersey the most densely populated state, but most of its population, as well as vacation homes and tourism infrastructure, are located in close proximity to the coast. Buildings, roads, and other infrastructure (e.g., rail lines) have resulted in extensive draining and filling of tidal marshes in urban areas, and high-density housing developments are directly adjacent to many existing salt marshes. That development greatly limits opportunities for marsh migration and restoring tidal flow in restricted marshes, as management will not be allowed if it could increase the risk—or even the perceived threat—of flooding homes or saltwater intrusion in groundwater supplies. However, as noted by Anderson and Barnet (Anderson & Barnet 2017), Mullica and Egg Harbor watersheds and Delaware Bay have a large area with potential for marsh migration, rivaling many other states in the Northeast.

Historically ditched marshes change the natural tidal flow of an area and can have long term impacts to the species that inhabit them. Joe Smith, TNC

PRIORITY MANAGEMENT ACTIONS

Although a high proportion of salt marshes in NJ are within the conservation estate or protected by statutes, their extent, quality, and sustainability face many threats. With such high regional responsibility for breeding habitat for several priority salt marsh specialists, it is very important for NJ partners to maintain large blocks of high quality marsh habitat while proactively implementing strategies to facilitate inland migration of salt marsh to offset expected losses due to sea level rise. Partners should immediately identify potential marsh migration areas that are undeveloped and not under conservation ownership and make their protection a high priority. Existing marshes that are decreasing in extent due to erosion from wind, waves, or storms should be protected, restored, or enhanced with living shoreline (Bilkovic 2016) approaches (e.g., oyster reefs) that reduce erosion and/or trap sediment to limit contractions in marsh area.

Although a few meadow banks still exist today with actively maintained dikes and tide gates, the vast majority of these areas have now been unmanaged for decades or even centuries. The extent of historic infrastructure represents both a challenge and an opportunity for salt marsh bird conservation. Most historic meadow banks likely have been moderately to highly degraded from decreased tidal flow into marshes, reductions in sediment supply, and ponding due to slower drainage of freshwater runoff (i.e., from stormwater). Subsidence and marsh drowning have been documented at sites on Delaware Bay, due to peat collapse from farming (Smith et al. 2017). Some recent efforts have attempted to address management-induced subsidence (Niles 2018). There are likely extensive areas where dikes could be repaired/maintained and new, self-regulated tide gates could be installed and managed to maintain, improve, or create productive and extensive high marsh areas. Through use of self-regulated tide gates, large areas of marsh could experience regular and natural tidal amplitude throughout most of the year, but also be managed to maintain a constant tidal range during the nesting season that prevents or reduces flooding from spring tides and storm surge. Such management could increase avian productivity and support healthy populations of species that rely on high marsh habitat for nesting, such as Saltmarsh Sparrow and Black Rail.

Beneficial use of dredged material may be important for Mid-Atlantic states such as NJ facing the dual threat of glacial subsidence and accelerated sea level rise. Activities like thin-layer deposition are being implemented in places, but dredged material is most commonly used for beach nourishment, not salt marsh restoration. Strategic use of dredge could help maintain elevation and sustain the productivity of key sites, so it is important to identify and prioritize those sites for dredge material. In areas far from any dredging, other

material may be useful for raising elevation in portions of the high marsh. Experimental approaches being considered and tested include synthetic “marsh mats,” or placing material (e.g., sand or natural fiber mats) under peat mats to elevate them.

New Jersey’s salt marshes were highly modified for centuries and, in some cases, that management may have increased the extent of high marsh habitat, to the benefit of the most imperiled salt marsh birds. Therefore, when planning or implementing any restoration activity it’s important to carefully consider and avoid activities that might result in losses or conversion of high marsh habitat into low marsh habitat.

PARTNERSHIPS/PROJECTS

The USACE has some beneficial use of dredge projects in NJ salt marshes, through both their New York and Philadelphia Districts. At Mordecai Island, disposed dredged material is being colonized by marsh vegetation, and providing nesting habitat for shorebirds, horseshoe crabs, and diamondback terrapin turtles, as well as protecting a nearby seagrass bed and increasing resilience to the adjacent residential community. The USFWS’s Partners for Fish and Wildlife Program is working with the Mordecai Island Land Trust to construct a living shoreline consisting of several hundred feet of oyster castles.

To offset elevation loss caused by salt hay farming, employees from American Littoral Society and Wildlife Restoration Partnerships construct a boundary with coconut coir logs to contain dredge material that will increase elevations to levels that can support the recovery of salt marsh. Shane Godshall.

NEW YORK

Seatuck Marsh National Wildlife Refuge. USFWS

HABITAT STATUS

New York supports 27,673 acres of salt marsh, the majority of which occurs on Long Island. New York City and Long Island had an estimated population of 11.4 million people in 2013, making it one of the more densely populated areas in the country, the most populated island in any U.S. territory or state, and the 17th most populous island in the world. Salt marshes on western Long Island have suffered losses of over 75% between 1900 and 1970 and continue to decline at rates of 0.5 to 3% per year. Additionally, urban development has hardened shorelines and starved marshes of inorganic sediment, primarily through the placement of dams and other obstacles that prevent downstream deposition of sediment, making them fragile and prone to fragmentation. Tidal marsh birds tend to nest on or near the marsh surface causing small increases in sea level rise or decreases in marsh elevation to have huge impacts on nestling survival.

SPECIES STATUS

According to SHARP researchers, 21 SGCN were observed in New York's salt marshes during surveys conducted in 2011 and 2012. This is the 4th highest number of species observed in any northeastern state (tied with Connecticut and Maine). Additionally, New York has the 4th highest abundance of breeding Saltmarsh Sparrows in the Northeast, containing 9% of the northeast regional population.

Several species are state and/or federally protected. Black Rail are state-listed as endangered and currently proposed as threatened under the ESA. King Rail are state-listed as threatened. Seaside Sparrows are state-listed as a species of special concern. Saltmarsh Sparrows are currently under federal review for listing.

Status of Tier A and B Species in New York: Population estimates represent individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	0**	710-1,630$^{\lozenge}$	0
Saltmarsh Sparrow	5,260 individuals (3,998 to 6,521)*	60,000 (40,000-80,000)*	8.8
Coastal Plain Swamp Sparrow	Numerous eBird records during breeding season	16,850	
Clapper Rail	1,655 individuals (1,111 to 2,198 individuals)*	>575,000$^{\psi}$	<1%
King Rail	Rare**	To be determined	
Acadian Nelson's Sparrow	None**	7,000 (4,000 - 10,000)*	0

***eBird data includes two 2009 entries for BLRA and two locations for King Rail, and some breeding records for Acadian Nelson's Sparrow; $^{\lozenge}$Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; $^{\psi}$ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017)*

THREATS IMPACTING CONSERVATION

The NY City and Long Island region is one of the more densely populated locations along the Atlantic Coast. Salt marsh is squeezed between urban development and sea level rise. Until recently, salt marshes have been treated as wastelands and have been lost to fill and tidal restrictions. Additionally, much of the remaining habitat has been degraded by ditching, pollution, of which nitrogen enrichment is especially notable, and/or invasive species.

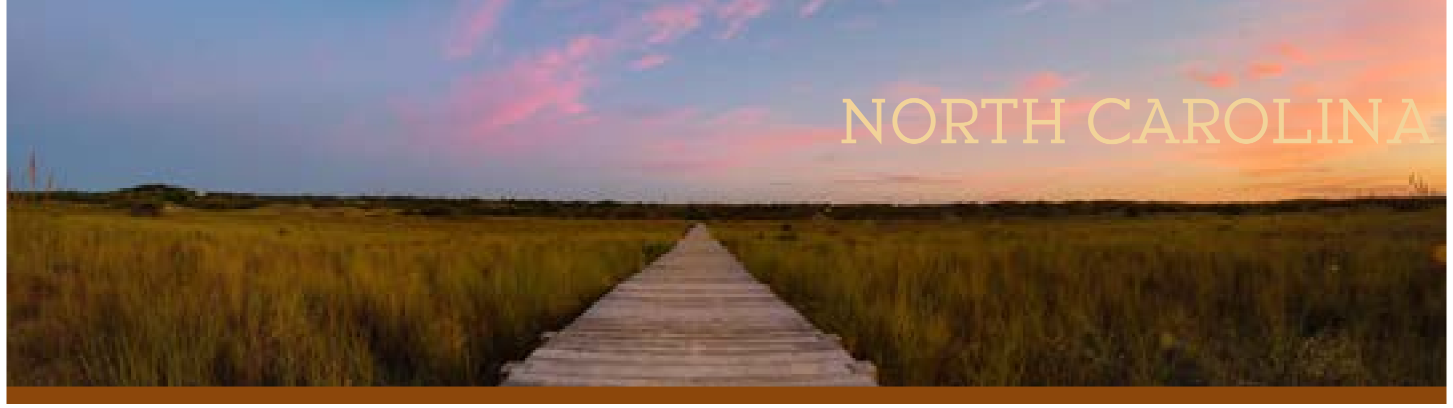
Thin layer deposition is a priority action in New York to help raise marshes from impacts of sea level rise. Wenley Ferguson, Save the Bay

PRIORITY MANAGEMENT ACTIONS

Needed management actions include restoring and enhancing existing habitat by managing invasive species, raising marsh elevations through thin-layer sediment deposition, removing fill, restoring tidal flow, improving infrastructure (e.g., culverts); removing physical impediments to sediment deposition; acquiring and facilitating marsh migration into potential migration corridors; reducing sources of nitrogen enrichment; and, improving land use planning to protect and restore salt marsh.

PARTNERSHIPS / PROJECTS

- NYC Parks projects, including Idlewild Park
- Town of Hempstead projects
- USFWS Long Island NWR Complex projects
- Suffolk County Parks projects, including restoration of over 200 acres at Gardiner Timber Point, W. Sayville, and Smith Point County Parks
- Sunken Meadow State Park and Save the Sound: an earthen berm blocked tidal flow from over 100 acres of marsh, causing the marsh habitat and water quality to deteriorate. Save the Sound and partner organizations began an ambitious restoration plan to address the problem, including: barrier removal of the earthen berm to restore tidal reconnection to marsh habitat; retrofitting an 18-acre parking lot with green infrastructure techniques; restoring 3.5 acres of salt marsh, aided by volunteer planting of the area with native plants; an analysis of fish-passage potential in Sunken Meadow Creek; and, a multi-year outreach/education program for the more than two million annual Park visitors.
- Audubon NY has identified Saltmarsh Sparrow as a highest priority and is actively engaged in furthering conservation for the species.



Frisco, North Carolina boardwalk through a salt marsh. ©Zach Frailey, Creative Commons

HABITAT STATUS

North Carolina contains approximately [266,933 acres of salt marsh](#) habitats. It is the ninth most populous U.S. state with expected growth of roughly [26% in the coastal region](#) by 2034. The NC Division of Environmental Management estimates that roughly 34% of North Carolina's original coastal wetlands have been impaired by development, and of that, 52% have been affected by agriculture, 10% by urban sprawl, and 38% by forestry (Frankenberg 2012).

Marsh habitats classified by the South Atlantic Landscape Conservation Cooperative. Mudflats and Unclassified types were omitted.

Type	Acres
High marsh (brackish-mixed)	62,260
High marsh (Juncus roemerianus)	107,916
Low marsh (Sporobolus alterniflora, medium-tall form)	12,039
Low marsh (Sporobolus alterniflora)	36,977
Other isolated, fresh, and emergent marsh	20,381
Tidal fresh (including rice paddy and impoundments	27,362
Total	**266,933**

SPECIES STATUS

North Carolina lacks comprehensive, long-term monitoring data for salt marsh birds along its coast; however, recent efforts have attempted to address this deficiency by initiating studies for several SGCN. The Center for Conservation Biology (CCB) conducted over 700 primarily nocturnal, play-back surveys for eastern Black Rails during the 2014-2015 and 2017-2018 breeding seasons along the outer Coastal Plain in tidal marshes and impoundments as well as inland wetlands (Smith et al. 2018). Since 2016, the North Carolina Wildlife Resources Commission (NCWRC) has conducted aerial breeding Black Duck surveys inside more than 130, 1-km2 sampling plots from Currituck NWR to Cape Lookout, as well as thermal drone and nest searching surveys along the inner banks of the Pamlico Sound and parts of Pea Island and Roanoke Island on the Outer Banks in 2017 (Williams et al. 2017). During the 2017 breeding season, the NCWRC also performed a total of 507 diurnal, play-back point counts coastwide following SHARP protocols. Lastly, North Carolina State University (Bobay et al. 2018, Taillie and Moorman 2019) has examined marsh bird occupancy in the Albemarle-Pamlico Peninsula (APP) region of eastern North Carolina while UNC-Wilmington is studying the winter population biology of Saltmarsh and Seaside sparrows in southeastern NC (Winder et al. 2012).

Black Rail – present in both summer and winter. Suffers from low occupancy (0.01); however, the population in Carteret County, including Cedar Island and Piney Island, located in irregularly flooded brackish marsh, is believed to be the largest and possibly most stable population north of Florida (Smith et al. 2018). No rails

were detected during recent surveys of interior sites (e.g. wet meadows, pastures, hayfields, farm ponds) (Smith et al. 2018).

Seaside Sparrow. ©Tom Benson, Creative Commons

Clapper Rail – present in both summer and winter. Widespread and abundant along most of the coast; detected at greater than 50% of SHARP survey points (NCWRC, unpub. data).

Saltmarsh Sparrow – present only in winter; population estimates are unknown. Rarest Ammodramus marsh sparrow during the non-breeding season with intermediate estimated apparent survival (Winder et al. 2012).

Seaside Sparrow – present in both summer and winter. During the breeding season, they are widespread and locally common, though occupancy and abundance were highest around the irregularly flooded, higher elevation brackish marshes adjacent to the Pamlico Sound, stretching from Carteret County north to Hyde County (NCWRC, unpub. data). Most abundant Ammodramus marsh sparrow during the non-breeding season but with lowest estimated apparent survival (Winder et al. 2012).

Coastal Plain Swamp Sparrow – present only in winter. Substantial numbers found in brackish marshes around Albemarle and Pamlico Sounds (Greenberg et al. 2008).

American Black Duck - present in both summer and winter. Population estimate of 1,659 pairs extrapolated across 1,860, 1-km2 plots. Mean counts of Black Duck were highest in plots containing more than 40% marsh habitat. Of 47 monitored nests, at least 70% failed due to flooding, depredation, prolonged incubation breaks, and abandonment (Williams et al. 2017).

THREATS IMPACTING CONSERVATION

Dredged material placement has been used very effectively in some areas to create marsh or upland bird nesting areas within estuaries; however, it can also be used to drain or fill natural wetlands with deleterious effects (NCWRC 2015). Ditching can also drain estuarine wetlands, disrupt normal hydrologic cycles, contribute to water quality problems by conducting point source discharges into nearby surface waters, and be a conduit for saltwater intrusion (NCWRC 2015). Land use development has impacted marsh habitat and armoring shorelines to prevent erosion is a growing problem, as is depredation by nonnative predators and the lack of fire to maintain the vegetation structure in marsh sites. Additional concerns include: beach stabilization projects (e.g., inlet channel relocation and efforts to restrict channel movement) that reduce availability of microhabitats; degraded water quality from pesticide use (related to mosquito control); and climate change impacts, primarily sea level rise, leading to shifts in plant composition and more open water habitats (NCWRC 2015).

PRIORITY MANAGEMENT ACTIONS

The NC Wildlife Action Plan (NCWRC 2015) identifies practices that reduce impacts and work synergistically with other conservation actions to enhance the resilience of natural resources. Some of these actions include:

- Protect tidal freshwater wetlands in rivers and upper sounds, some of which will become the extensive estuarine communities in the future.
- Protect buffers and floodplain rivers, thus reducing pollutant input and drastic changes in freshwater input.
- Protect inland tidal freshwater wetlands, which will become extensive estuarine communities in the future, and allow the barrier islands to migrate and new inlets to form.
- Focus on land acquisition and protection on the mainland side of Pamlico Sound where brackish marshes are in private ownership. Acquisition targets should include brackish marsh impoundments, which will then require continued management for maintenance.
- Protect habitats in large enough patches to sustain priority species, reconnect fragmented habitats, restore habitats that have been lost or converted, and enhance the function and structure of habitats that have been degraded.
- Manage habitats for priority species.
- Where practical, restore marsh habitat by filling drainage ditches and installing ditch plugs and water control structures. Ditches may accelerate erosion and the effects of rising sea level such as saltwater intrusion.

PARTNERSHIPS/PROJECTS

- North Carolina is home to four NOAA National Estuarine Research Reserves located near Corolla (Currituck Banks), Beaufort (Rachel Carson) and Wilmington (Masonboro Island and Zeke's Island).
- NC Coastal Federation's (NCCF) 6,000-acre restoration project at North River Farms in eastern Carteret County is one of the largest wetland restoration projects in North Carolina and is among the largest project of its kind in the nation. In addition, NCCF's Living Shoreline projects have reduced storm erosion, increased nursery habitat, and filtered runoff.
- Continue working with the USACE and others to direct dredged material or conduct other management actions to refurbish waterbird nesting islands.
- Implement conservation measures outlined in the Albemarle–Pamlico National Estuary Partnership.
- There are many Important Bird Areas in NC that have important salt marsh habitats, such as Cape Lookout National Seashore, Alligator River Lowlands, and Onslow Bay.

Partners use oyster habitat restoration practices to help restore the eroding shoreline. North Carolina Coastal Federation

OTHER LINKS

- North Carolina Division of Coastal Management
- North Carolina Wildlife Resources Commission
- UNC-Wilmington winter marsh sparrow research
- North Carolina Sea Grant Consortium
- USFWS Coastal Barrier Resources System

RHODE ISLAND

Rhode Island salt marsh. ©Greg Westfall, Creative Commons

HABITAT STATUS

There are currently estimated to be 3,329 acres of tidal salt marshes in Rhode Island (RI). This represents between one to two percent of all salt marsh from Maine to Virginia, and a loss of approximately 53 percent since 1851—a greater proportion than any other state in New England (Bromberg and Bertness 2005). A detailed analysis of 36 marshes in Rhode Island calculated a loss of 257 acres between 1972 and 2011 (3.3%) with one marsh expanding in extent and the rest experiencing losses up to as much as 37% (Watson et al. 2017).

The majority of salt marsh habitat is owned and managed by the State Department of Environmental Management (23%), followed by the Audubon Society of Rhode Island, private lands with a conservation easement, and USFWS. Collectively, approximately 53% of tidal marsh habitat is under conservation and those acres support 56% of the Saltmarsh Sparrow breeding population in the state (Table 1).

Table 1: Estimated abundance of Saltmarsh Sparrow by land ownership, in Rhode Island.

		Occupied Habitat		
Rhode Island Landowners	Abundance	Acres	% of Total	
U.S. Fish and Wildlife Service (Federal)	43	162	4.56	Conserved
RI D.E.M. (State)	268	815	22.93	Conserved
Municipal Land	33	134	3.78	Conserved
Audubon Society	38	215	6.04	Conserved
Land Trust	9	44	1.23	Conserved
Private Non-Profit	29	217	6.1	Conserved
Private Landowner	29	97	2.72	Conserved
Unknown	57	217	6.09	Conserved
Sub-total for conserved lands	506	1,901	53.45	Total Conserved
Unknown ownership	403	1,655	46.55	Not conserved
TOTAL	**909**	**3,556**	**100**	-

Land ownership on protected lands was calculated using data from the Protected Areas Database of the United States (PADUS) version 1.3 (USGS Gap Analysis Program 2012) by Wiest et al (2014).

Extensive research has been published documenting the status and trends of salt marsh habitat in Rhode Island. There is also extensive collaboration and coordination among researchers from the Narragansett Bay National Estuarine Research Reserve (NBNERR), the Atlantic Ecology Division Laboratory of the EPA, State

Coastal Resources Management Council (CRMC) and Department of Environmental Management (DEM) as well as non-profit organizations such as Save the Bay. Long-term monitoring plots were established on NWRs and NBNERR, and a state-wide salt marsh rapid assessment is under development by the Rhode Island Natural History Survey (Kutcher, 2019).

Andrew Neil, a cooperator at the University of Rhode Island, collects elevation along a ditch at Fire Island National Seashore. Points were established using a 20-m grid which covers the range of elevation and vegetation types in the salt marsh. NPS

A detailed assessment of 24 Surface Elevation Tables (SET's) across five marshes from 1999 to 2015 found a mean rate of elevation gain of 1.4 mm/yr. (0.05 in/yr.). This compares to estimates of a 2.7 mm/yr. (0.11 in/yr.) rise in sea level in coastal waters from 1930 to 2012, with the subset of years between 1985 and 2000 averaging 4.6 mm/yr. (0.18 in/yr.), and the subset from 2000 to 2013 experiencing 7.5 mm/yr. (0.30 in/yr.) (Raposa et al. 2017b). Although there was variability among monitored sites, none were keeping pace with current rates of sea level rise, and all are currently below the elevations where maximum productivity would occur for marsh plants (Raposa et al. 2017b).

Additional research has quantified a net loss of high marsh vegetation in favor of more flood tolerant species and/or un-vegetated areas. This includes a conversion of high marsh to low marsh habitat (Donnelly and Bertness 2001, Raposa et al. 2017b) and a shoreward migration of *S. alterniflora* (Bertness et al. 2002). On two Rhode Island marshes, the occurrence of *Spartina patens* declined by 16 to 40% between 1995 and 1999, with S. alterniflora becoming five times more abundant and migrating landward into high marsh areas (Donnelly and Bertness 2001). Statistically significant decreases in S. patens cover and increases in S. alterniflora cover were also documented between 2000 and 2013 (Raposa et al. 2017b). There was also a direct correlation between marsh elevation and the rate of loss such that as marshes became lower in relation to sea level, the rate of loss accelerated (Watson et al. 2017). The majority (87%) of marshes, from a sample of 38 marshes across New York, Connecticut, Rhode Island, and Massachusetts, were below optimum elevation for plant biomass production (Watson et al. 2014) which puts them at increased risk for continued loss (Raposa et al. 2017a).

At sites with elevated nitrogen in Narragansett Bay, the transition zone between the high marsh and low marsh was as much as 0.5 m (1.6 ft.) higher in elevation than sites without enrichment, indicating that the low marsh vegetation was outcompeting the high marsh plants at the same relative elevation (Bertness et al. 2002). Marshes with increased nitrogen input from adjacent development also have more extensive invasion of Phragmites into the high marsh zone (Bertness et al. 2002).

In addition, many of the tidal marshes in Rhode Island have tidal restrictions, historic ditching and/or development in the buffer and they tend to be small (average patch size 15 acres). This all contributes to degraded habitat quality and ecological integrity which in turn makes those marshes more vulnerable to the effects of increasing rates of sea level rise (Olsen et al 2014, Kutcher 2019).

SPECIES STATUS

Population and trend estimates for salt marsh obligate species were derived from surveys conducted in 2011 and 2012 at 54 points across the state, representing 436 ha. Saltmarsh Sparrow populations were estimated at 888 individuals at that time, which represents less than two percent of the global population. Nests and banded individuals were also monitored at two demographic sites resulting in estimates that the population was declining 0.30-0.34 in 2018. Clapper Rail and Seaside Sparrow were detected in the state in low numbers but nests were not monitored.

To assess long-term changes in the population status of breeding Seaside Sparrows in Rhode Island, Berry et al. (2015) repeated surveys conducted in 1982 by Stoll and Golet (1983). During June and July of 2007 and 2008, they surveyed 19 of Rhode Island's largest salt marshes and found that Seaside Sparrow abundance had declined at 9 of 11 marshes where the species was present in 1982. They detected no sparrows at 4 smaller (<20 ha) marshes where they were present in 1982, and Seaside Sparrow abundance increased at 3 marshes. Berry et al. recommended continued monitoring of the species, and a reassessment of the current "special concern" State conservation status of the species.

Two of the Rhode Island NWRs have been tracking productivity and survival of Saltmarsh Sparrow since 2009 and collaborated with the SHARP team to include standardized surveys during 2011 and 2012. These sites represent 2 of the 21 demographic sites that were then used to estimate population trends range-wide. Refuge marshes also participated in a range-wide evaluation of blood mercury levels in Saltmarsh Sparrows from Maine to New York between 2004 and 2008.

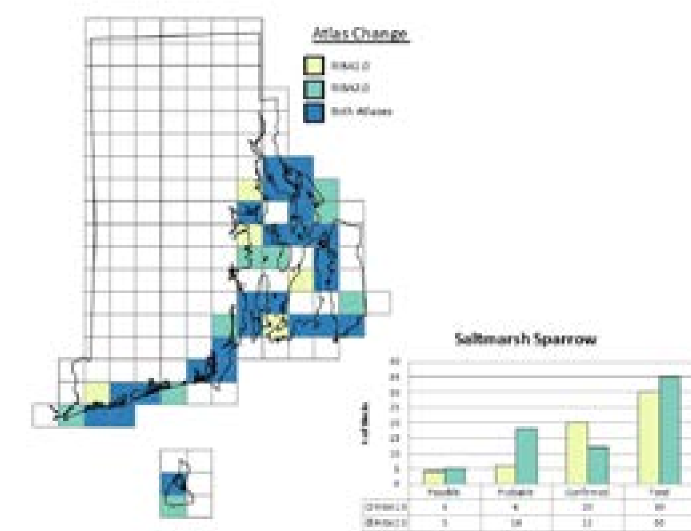


Figure 1. Results of Rhode Island Bird Atlas 2.0

The Rhode Island Bird Atlas 2.0 conducted volunteer-based surveys (comprehensive search of 165 25-km2 atlas blocks) and 6-minute point counts throughout the state during 2014-2019 to compare to the baseline breeding bird atlas data from 1982-1987. Saltmarsh Sparrows were detected in a total of 35 blocks and confirmed as breeders within 12 of those blocks. While there was a 17% increase in the overall distribution of Saltmarsh Sparrows within the state since the first atlas, there was a 40% decline in the total number of atlas blocks in which the species was confirmed to breed (Figure 1). A total of ten Saltmarsh Sparrows were detected at 6 of the point count stations within the state. An additional set of surveys were conducted at 10 salt marsh sentinel sites monitored by the Narragansett Bay National Estuarine Research Reserve (NBNERR) where another 37 individuals were detected (Clarkson, in prep.).
In May of 2017, S. Reinert and D. Robinson (pers. comm, 2019) initiated a five-year study of demographics of a population of Saltmarsh Sparrows occupying a 14-ha salt marsh bordering the east shore of the Warren River on upper Narragansett Bay (see full unpublished report at SALSri.org). During 2019, the third breeding season of their project, their team banded 14 adult females and 20 adult males, and documented the return, since 2017, of 15 marked females, 33 marked males, and 3 Saltmarsh Sparrows originally banded as nestlings. Thus, in 2019 their 14-ha study area provided breeding-season habitat for a minimum of 84 adults (29 females, 53 males, and 3 of unknown gender). Robinson estimates 200 or more SALS on another Warren, RI property (Haile Farm) owned by the Warren Land Conservation Trust (Reinert & Robinson 2018).

Coastal marshes and ponds provide important overwintering sites for American Black Duck. Population estimates and trends should be available from standardized mid-winter waterfowl surveys conducted by RI DEM and USFWS.

Status of Tier A and B species in Rhode Island. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Saltmarsh Sparrow	888 (554 – 1,223)	60,000 (40,000-80,000)*	1-2 %
Clapper Rail	35 (0 – 79)	>575,000 ᵠ	0.03 %

**Data taken from Wiest et al, 2019; ᵠ ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017)*

Juvenile Survival - Little information is available for first-year survival of Saltmarsh Sparrow range-wide, but one study in Rhode Island estimated mean apparent juvenile survival rate was found to be 0.14 (95 percent CI: 0.10–0.19), which was less than half the estimate for adults (DiQuinzio et al. 2001). Only 11% of juveniles banded at this site were found to return in subsequent years. Rates are identified as apparent since there were not comprehensive surveys in surrounding marshes to account for immigration and emigration. Saltmarsh Sparrow nest survival/success rates were 44 percent in a historic study (DeRagon 1988) and 27 percent during 1993 to 1998 (DiQuinzio et al. 2002).

THREATS IMPACTING CONSERVATION

Rhode Island has an extensive history of farming for marsh hay, and mosquito ditching in later years. Therefore, the vast majority of marshes have embankments, ditches, stone walls, and other artifacts of human use over the past few hundred years. As the second most populated state per capita on the Eastern Seaboard, there is also extensive infrastructure, including roads and bridges, that alters local hydrology and impervious surfaces, exacerbating surface water runoff into salt marshes. Coastal developments also often have outdated cesspool and septic that leach nutrients into groundwater.

PRIORITY MANAGEMENT ACTIONS

Management actions that are most important at this time include: 1) continue to implement projects that increase marsh elevation with beneficial use of dredge material where appropriate and feasible; 2) restore degraded marsh to benefit priority bird species (i.e., high marsh focus) which may include use of runnels or other hydrological alterations; 3) provide landowner incentives through NRCS on private lands; 4) acquire habitat in marsh migration zones or to provide buffers; and 5) facilitate marsh migration where appropriate though there are fewer opportunities for this.

PARTNERSHIPS / PROJECTS

There have been several marsh restoration projects within the past five years on NWR, State, and private lands. This includes a comprehensive salt marsh restoration at the John H. Chafee NWR, including physical alterations that involve the placement of sediment on the marsh surface, use of living shorelines, and runnel excavation, as well as measures to improve water quality and reduce impacts from public use. The restoration was accomplished by working collaboratively with numerous partners and stakeholders through a facilitated Structured Decision Making process (Wigand et.al. 2017). Additional thin-layer sediment placement projects were completed along the south shore at both Ninigret Pond (30 acres) and Quonochontaug Pond (30 acres) in collaboration with State, Federal, academic, and NGO organizations. These initial attempts are being evaluated to determine what variables (e.g., sediment depth, grain size, local conditions, hydrology) influence marsh recovery time and will help to inform future restoration strategies (Wigand et al. 2016).

The NRCS in RI has also identified Saltmarsh Sparrow presence as a ranking criterion as it identifies private lands eligible for enrollment and protection through their Wetland Reserve Program, which would in turn make those marshes eligible for habitat restoration funding. This will be an important tool for conservation and management of the 43% of marshes in the state that are not currently afforded any protected status. Additionally, SHARP researchers have established monitoring plots to assess the response of the avian community to these restoration practices (Elphick et al. 2018).

Additional restoration techniques are being implemented in collaboration with a broad array of partners, including creation of runnels to improve hydrology and facilitated marsh migration. Save the Bay has been leading efforts to create runnels in strategic areas with outreach to landowners and on-the-ground support from the RIDEM mosquito abatement coordinator. The Department of Fisheries and Wildlife within RIDEM has initiated projects on state land to facilitate the strategic retreat of public use areas (e.g. parking and agricultural fields at Sapowet Marsh Management Area) to allow for the protection of coastal habitats and future migration of salt marsh habitat (T. Steeves, pers. comm).

Oyster reefs, like this one built at John H. Chafee National Wildlife Refuge are an increasingly utilized technique in building living shorelines. Lia McLaughlin, USFWS

SOUTH CAROLINA

Mount Pleasant looking towards Sullivan's Island, South Carolina. Craig Watson, USFWS

HABITAT STATUS

With over 432,000 acres of salt marsh and brackish marsh (Tiner et al. 1974, Kusler and Kentual 1990), South Carolina encompasses more coastal marsh than any other Atlantic Coast state (SCDNR 2014). At the same time, coastal metropolitan areas in South Carolina are among the fastest growing regions in the country (SCDHEC 2016).

SPECIES STATUS

South Carolina supports the second highest breeding population of Black Rail on the Atlantic Coast (Watts 2016). Although population estimates are not available for Clapper Rail and King Rail, South Carolina is known to provide breeding and non-breeding habitat for both species. Saltmarsh Sparrow and Coastal Plain Swamp Sparrow also occur in South Carolina during non-breeding seasons.

Tier C and D species that are year-round residents in South Carolina include Boat-tailed Grackle, "Eastern" Willet, Laughing Gull, Seaside Sparrow, Marsh Wren, Tricolored Heron, and Glossy Ibis. Species that breed in South Carolina include Forster's Tern and Wood Stork. American Black Duck, Greater Yellowlegs, Nelson's Sparrow, and Yellow Rail are present during the non-breeding season.

Status of Tier A and B species in South Carolina. Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	100 - 200 [◊]	710-1,630 [◊]	7 - 8%
Clapper Rail	Unknown	>575,000 [ψ]	Unknown
King Rail	Unknown	To be determined	Unknown

[◊]Data taken from Watts, 2016; [ψ]ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017)

THREATS IMPACTING CONSERVATION

Along with sea level rise, climate changes resulting in more frequent and/or more severe storms and droughts pose significant threats to Black Rail in South Carolina. High elevation tidal marshes and impoundments where SCDNR has documented breeding (Hand 2018) appear to produce ideal breeding conditions when water depth is maintained primarily by consistent, moderate rainfall. Without adequate water, availability of macroinvertebrate prey may limit reproductive success. Too little water and too much water may be equally detrimental to reproductive success, and more information about water level fluctuations and the resiliency of nests and chicks to water level fluctuations is needed.

Although only a small fraction of the existing impoundments in South Carolina contain high elevation areas suitable for Black Rail, these impoundments offer management opportunities. During drought conditions, water level manipulation in impoundments can also be used to create shallow pools of water; however, lower elevation Black Rail territories may be inadvertently flooded in the process of delivering water to higher elevation territories. Impoundments also play an important role in maintaining stable water levels during extreme high tides.

Installation of rice trunk for water level management. Joe Cockrell, USFWS

PRIORITY MANAGEMENT ACTIONS

Top priority implementation strategies for low marsh species such as Clapper Rail include Restore Degraded Salt Marsh, Management to Facilitate Marsh Transition, and Transition Zone Acquisition.

A relatively small percentage of the existing impoundments are suitable for very high elevation marsh species such as Black Rail, and promoting improved management within these impoundments is an important strategy. Although managed tidal impoundments may delay the effects of sea level rise (Roach and Barrett 2015), maintaining these impoundments may not be sustainable over the long-term due to their vulnerability to severe damage by rising waters and storms. Creating new habitat at sites that are not tidally-influenced, including sites that may use irrigation techniques, may allow for more precise management of water levels and higher reproductive success.

PARTNERSHIPS / PROJECTS

The SCDNR has been working to document habitat conditions in wetlands occupied by Black Rail and to implement and evaluate management actions to benefit the species in managed tidal impoundments within two coastal wildlife management areas. Current conservation activities include: increasing the use of prescribed fire during the non-breeding season to reduce shrubs in high marsh areas of impoundments; fine-tuning water level manipulation within the existing management regimes during the breeding season; and repairing infrastructure, such as trunks and dikes in impoundments that can be managed specifically to benefit Black Rails. In addition to projects on SCDNR properties, SCDNR has partnered with Ducks Unlimited, USFWS Coastal Program, ACE Basin NWR, and private partners such as Nemours Plantation, by providing technical assistance to promote habitat enhancement on these organizations' properties.

Wood Stork. ©Larry Goodman, Creative Commons

VIRGINIA

Assateague Nature Preserve. ©David Reissman, Creative Commons

HABITAT STATUS

Approximately 236,000 acres of tidal wetlands remain in Virginia (Weber and Bulluck 2014). Thirty-seven percent of the wetlands in the state's Coastal Plain are protected under fee-simple acquisition or easement (VDGIF 2015). The greatest threats to the Commonwealth's wetland habitats are degradation of water quality, land conversion/land use changes, invasive species (e.g., *Phragmites australis)*, and sea-level rise/inundation (Wilson et al. 2007; VDGIF 2015). The Coastal Plain is the second most populous ecoregion in the state, containing about 2.75 million people (35% of Virginia's population) in just over 20% of the land (ESRI 2016).

SPECIES STATUS

Virginia lacks comprehensive, long-term monitoring data for many of its avian salt marsh species. Several recent studies, however, have attempted to address this deficiency for several of this plan's s focal species, as summarized below.

Eastern Black Rail: The Eastern Black Rail is a state endangered species and is considered nearly extirpated from Virginia. In 2007 and 2008, the Center for Conservation Biology (CCB) conducted a targeted, systematic Black Rail breeding survey in areas with extensive suitable habitat on the Coastal Plain (Wilson et al. 2009). In 2014, a second round of systematic surveys was conducted that targeted locations where Black Rails were detected in the 2007 survey, a subset of locations where Black Rails were not detected in the 2007 survey, and a selection of new points never before surveyed (Wilson et al. 2015). The number of birds detected during the two rounds of systematic surveys declined from 15 in 2007 to two in 2014, a decrease of more than 85% in just seven years. The extensive salt marshes of Accomack County along the Virginia/Maryland border within the Chesapeake Bay likely supported hundreds of pairs historically (Watts 2016). Wilson et al. (2014) identified several threats confronted by Black Rail in Virginia, including the transformation of high marsh to low marsh due to sea level rise, increased tidal inundation, and nest predation by ground predators. Unlike most other Atlantic Coast states, mosquito ditching has never been a widely used practice in Virginia and, therefore, is not a major contributing factor to the state's loss of Black Rail habitat (Watts 2016).

Saltmarsh Sparrow: Saltmarsh sparrows occur in Virginia year round. The Virginia breeding population is part of the broader mid-Atlantic breeding population (formerly *A.c. diversus* breeding form), which breeds from New Jersey to Virginia. The wintering population includes individuals of both the northern Atlantic (formerly *A. c. caudacutus* breeding form, which breeds from Maine to New Jersey) and the mid-Atlantic breeding population (Smith et al. 2014). Smith et al. (2014) projected a winter population estimate of 50,870 individuals (95% CI range: 40,863 – 65,246 individuals) of which 83% were classified as originating from the northern Atlantic breeding population based on extrapolations of individuals identified in the hand.The numerical dominance of individuals from the northern population indicates a large influx of migrant Saltmarsh sparrows into Virginia for the winter (Smith et al. 2014).

Coastal Plain Swamp Sparrow: In 2005, the CCB confirmed Coastal Plain Swamp Sparrow breeding activity in Virginia. A total of 41 singing males and five nests were documented in a marsh along the Rappahannock River near Warsaw, VA (Watts et al. 2008). This isolated breeding population has declined since that time, but to what extent is currently unknown (Bryan Watts, pers. comm.). Additional breeding activity has been detected on the Eastern Shore of the Chesapeake Bay in Accomack County near the Virginia/Maryland border (Bryan Watts, pers. comm.).

Clapper Rail: Clapper Rail is an obligate marsh specialist that spends its entire life in saltwater or brackish marshes. Clapper Rail occurs in Virginia year-round. The 2011 and 2012 SHARP breeding surveys revealed that Virginia supported the highest abundance of Clapper Rail in the Northeast Region and comprised 50% of northeast regional population estimate generated by the SHARP study for those years.

King Rail: King Rail occurs in Virginia year-round, but is most abundant during the breeding season. Obtaining an accurate breeding population estimate for King Rail in Virginia is extremely challenging because it shares similar morphologies, behaviors, and vocalizations with the co-occurring Clapper Rail. This makes it difficult to distinguish the two species where their distributions overlap. Moreover, the two species are known to interbreed (Coster et al. 2018). The overall frequency of occurrence and exact distribution of hybrids in Virginia remains unknown (Wilson et al. 2007). Coster et al. (2018) examined the degree of introgression within two putative Clapper Rail focal populations along a salinity gradient in coastal Virginia. They detected King Rail alleles in both populations, but identified a pattern of introgression where Clapper Rail alleles predominate in brackish marshes. These results suggest Clapper Rail may be displacing King Rail in Virginia coastal waterways, most likely as a result of ecological selection.

Status of Tier A and B Species in Virginia: Population estimates are for individuals.

Species	State Breeding Population Estimate (95% CI)	ACJV Breeding Population (95% CI)	% of Breeding Population in ACJV
Black Rail	0 – 20	710-1,630 ◊	<2.8%
Saltmarsh Sparrow	4,224 (1,671 - 6,777)	60,000 (40,000-80,000)*	7%
Coastal-plain Swamp Sparrow	Unknown	16,850**	Unknown
Clapper Rail	55,095 (14,087 -96,103)	>575,000 ψ	9.6%
King Rail	Unknown	To be determined	Unknown

*◊ Data taken from Watts, 2016; *Data taken from Wiest et al, 2019; ψ ACJV estimate based on summed population estimates from all ACJV states except NC and SC (Wiest et al. 2019, Hunter et al. 2017, Enloe et. al 2017)*

Clapper Rail chick. ©Ryan Mandelbaum, Creative Commons

THREATS IMPACTING CONSERVATION

Degradation of water quality is one of the threats affecting Virginia's tidal wetlands, more specifically nutrient pollution, sedimentation, chemical pollutants, and fecal matter flowing from riparian and upland areas into streams and rivers (VDGIF 2015). Another major threat to wetlands is land conversion/land use change. The most significant and extensive threat of this type involves filling tidal wetlands to make areas suitable for residential and other types of development (VDGIF 2015). Invasive species also pose a threat to tidal wetlands. Scores of invasive species have been introduced into Virginia and these invasive plants and animals often degrade the quality of wetland habitat through damage or loss to wetland vegetation. Phragmites is the most damaging invasive plant impacting Virginia's tidal wetlands. This species can out-compete native vegetation, creating a wetland monoculture with diminished function and habitat value. Faunal threats include Mute Swan, nutria, and feral hogs (VDGIF 2015). Lastly, sea level rise and inundation have been identified as significant threats to tidal wetlands. As sea levels rise, wetlands may be inundated and convert to shallow open water habitats. Likewise, brackish wetlands may convert to higher salinity marshes, affecting the wildlife that depend on these habitats.

PRIORITY MANAGEMENT ACTIONS

Although a portion of Virginia's tidal wetlands in the Coastal Plain are protected from future development and land use conversion, immediate efforts are necessary to maintain or increase the amount of protected functioning marsh habitat to ameliorate the impacts of climate change and rising seas. Below are Virginia's top four management actions selected from this plan's habitat conservation actions:

1. Transition zone acquisition/easements to conserve land for long-term marsh bird persistence.
2. Beneficial use of dredge materials to maintain marsh elevation.
3. Restore degraded salt marsh to benefit priority birds.
4. Manage impoundments for high marsh habitats to benefit Black Rails.

Construction of cross dike and installation of rice trunk to manage water levels for Black Rail. Nemours Wildlife Foundation

PARTNERSHIPS/PROJECTS

The VA Institute of Marine Science (VIMS) is the lead on a feasibility study to assess the viability of an innovative, actionable, science- and nature- based engineering plan to slow the migration of, and potentially allow for the growth of, southern Cedar Island, one of Virginia's barrier islands. VIMS is partnering with a variety of stakeholders, including local communities and conservation organizations. The ultimate goal of this plan is to determine the feasibility of creating marsh along the landward edge (i.e., bayside) of the island through the placement of marsh-compatible material, thus providing a platform to enable the island to grow laterally and vertically. This, in turn, will allow the "speed bump" to reform, thereby providing a critical storm barrier that can decrease storm flooding impacts on the extensive marsh system behind the island. This project will also determine the likelihood that the introduced marsh-compatible material will feed these sediment-starved marshes and increase their elevation over time. While the specific outcome of this project is an engineering plan for this restoration effort, the lessons learned through the collection of field data, mapping, and project design will transfer to undeveloped barrier islands throughout the U.S. East and Gulf coasts.

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VDGIF sits on the Interagency Review Team (IRT) that oversees wetland and stream mitigation banking in Virginia. Recently, during review of mitigation banking proposals, VDGIF staff have made recommendations to the IRT about how projects—with potential to protect or restore suitable Black Rail habitats in Virginia—can best support conservation of the species. Although this has not yet resulted in the creation of Black Rail-centric mitigation banks, the potential does exist and VDGIF will continue to pursue it. A more immediate opportunity exists to work with The Nature Conservancy (TNC), which is acting as administrator of the Virginia Aquatic Resources Trust Fund (VARTF). The VARTF is an in-lieu fee account into which monies are deposited as mitigation for stream and wetlands impacts taken across Virginia. TNC uses these monies to restore and protect wetland and stream habitats within the watershed of impact, per their approved Conservation Framework. TNC is very active on Virginia's Eastern Shore, the historic stronghold for the Commonwealth's Black Rail populations and where there is great potential for conversion of agricultural lands to wetlands, including high marsh habitats preferred by Black Rails in Virginia. VDGIF will explore with TNC the prioritization of lands under their Conservation Framework that have potential for wetland restoration for the benefit of avian salt marsh species on the Eastern Shore.

Black Rail habitat. Craig Watson

Appendix 5:

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Appendix 6:
WEB LINKS

Page number and text	Link
p5. a multi-billion industry	https://www.fisheries.noaa.gov/resource/document/fisheries-united-states-2016-report
p5. ($37.8 billion in annual sales on the Atlantic coast)	https://www.st.nmfs.noaa.gov/Assets/economics/publications/FEUS/FEUS-2015/Outreach-Materials/FEUS2015_FS_Final3_508.pdf
p5. 1.6 million jobs	https://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2015/index
p6. recently proposed	https://www.regulations.gov/document?D=FWS-R4-ES-2018-0057-0001
p6. saltwater to brackish to freshwater	https://oceanservice.noaa.gov/education/tutorial_estuaries/est05_circulation.html
p6. estuarine	https://oceanservice.noaa.gov/education/tutorial_estuaries/est06_habitats.html
p6. Chesapeake Bay	https://www.chesapeakebay.net/what/maps/keyword/salinity
p7. Atlantic Coast Joint Venture	acjv.org
p9. SHARP	https://www.tidalmarshbirds.org/
p9. Atlantic Flyway Shorebird Initiative	https://atlanticflywayshorebirds.org/
p9. Landbird Conservation Plan	http://www.partnersinflight.org/wp-content/uploads/2016/08/pif-continental-plan-final-spread-double-spread.pdf
p9. Waterbird Conservation for the Americas	https://www.fws.gov/birds/management/bird-management-plans/waterbird-conservation-for-the-americas.php
p9. initial scoping document for the plan	https://www.tidalmarshbirds.org/?page_id=1682
p9. Open Standards for the Practice of Conservation	http://cmp-openstandards.org/
p10. ESA	https://www.ncbi.nlm.nih.gov/books/NBK232366/
p10. IUCN Status	https://portals.iucn.org/library/sites/library/files/documents/RL-2001-001-2nd.pdf
p12. Mottled Duck Conservation Plan	http://www.gcjv.org/docs/GCJV%20MODU%20Cons%20Plan.pdf
p12. Atlantic Flyway Shorebird Initiative	http://atlanticflywayshorebirds.org
p12. grassland birds are often reported	http://www.stateofthebirds.org/2017/wp-content/uploads/2016/04/2017-state-of-the-birds-farm-bill.pdf
p12. population estimates for most grassland bird species in North America are more than one million individuals	http://rmbo.org/v3/Portals/5/Reports/NGP_annual_report_2017_FINAL.pdf
p15. SWAP score/coding varies by state	https://www.fishwildlife.org/afwa-informs/state-wildlife-action-plans
p16. Status IUCN	https://www.iucnredlist.org/
p16. Bird Conservation Regions	http://nabci-us.org/resources/bird-conservation-regions/
p17. Save the Bay	http://savethebay.org
p19. this guide	http://fosonline.org/library/conventions-for-threats/
p.22 National Research Council	https://www.nap.edu/read/11764/chapter/5#51
p23. projects	https://www.dredgingtoday.com/2018/09/06/importance-of-patapsco-river-restoration-program-highlighted/
p24. South Carolina	http://www.dnr.sc.gov/water/envaff/aquatic/phragmites.html
p29. theory of change	http://www.theoryofchange.org/what-is-theory-of-change/
p32. tracking tool	https://docs.google.com/document/d/1zIYZhY8aodU5DYGtS7dGv5MwB2Q3GQvEZWTI_s1iMtw/edit#heading=h.i5brod2dcj85
p32. marsh master	https://www.marshmaster.com/

p33. remediating ditches	http://nerrssciencecollaborative.org/media/resources/Spivak_NSC-Prj-Fact-Sheet_Final.pdf
p34. remediating ditches	http://nerrssciencecollaborative.org/media/resources/Spivak_NSC-Prj-Fact-Sheet_Final.pdf
p37. northeast	https://nalcc.databasin.org/maps/new#datasets=14de01cdcd0b4243b04fce3165cf873c
p39. Tracking tool	https://docs.google.com/document/d/1zIYZhY8aodU5DYGtS7dGv5MwB2Q3GQvEZWTI_s1iMtw/edit#heading=h.i5brod2dcj85
p40. one experiment	https://climatechange.lta.org/case-study/planning-for-marsh-migration-at-the-blackwater-national-wildlife-refuge/
p41. Herring River on Cape Cod	https://www.nps.gov/caco/learn/nature/herring-river-tidal-restoration-project.htm
p42. beneficial ways	https://www.epa.gov/cwa-404/beneficial-use-dredged-material-under-cwa-section-404
p42. (the Federal Standard)	https://www.epa.gov/sites/production/files/2015-08/documents/role_of_the_federal_standard_in_the_beneficial_use_of_dredged_material.pdf
p42. request proposals	https://www.usace.army.mil/Missions/Civil-Works/Project-Planning/Legislative-Links/wrda2016/beneficial_use_dredge_mat/
p43. examples	https://northeastoceancouncil.org/wp-content/uploads/2017/05/Nonstructural-Management-Practices-that-Build-Resiliency.pdf
p45. standardized monitoring protocols	https://www.tidalmarshbirds.org/?page_id=1595
p45. project inventory	https://fws.maps.arcgis.com/apps/webappviewer/index.html?id=336d26df80734331928ad4ed72fbbd86
p54. Eco-Logical	https://www.environment.fhwa.dot.gov/env_initiatives/eco-logical.aspx
p54. Nature-Based Solutions for Coastal Highway Resilience	https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/nature_based_solutions/
p57. Natural Resource Damage Assessment	https://oceanservice.noaa.gov/facts/nrda.html
p57. Environmental Sensitivity Index	https://response.restoration.noaa.gov/resources/environmental-sensitivity-index-esi-maps
p58. SHARP	https://www.tidalmarshbirds.org/
p58. Gulf of Mexico Avian Monitoring Network (GOMAMN)	https://gomamn.org/
p58. “Monitoring and Adaptive Management Procedures and Guidelines Manual	https://www.gulfspillrestoration.noaa.gov/sites/default/files/2018_01_TC_MAM_Procedures_Guidelines_Manual_12-2017_508_c.pdf
p59. SHARP	https://www.tidalmarshbirds.org/
p59. developing and testing methods	https://uncw.edu/news/2019/02/uncw-ornithologist-raymond-danner-receives-234,479-grant-to-study-wintering-habits-of-coastal-sparrows.html
p62. protocol	https://www.tidalmarshbirds.org/?page_id=1595
p62. dashboard	https://fws.maps.arcgis.com/apps/MapSeries/index.html?appid=87690c02be3c4c0094bc59cfbfa5ed28
p63. here	http://nerrssciencecollaborative.org/project/Raposa17
p64. study	http://naturalareasnyc.org/content/3-in-print/3-partner-publications/nycparks_saltmarshstrategyreport_2017.pdf
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