Saltmarsh Sparrow Conservation Plan

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

ATLANTIC COAST JOINT VENTURE

Citation*:* Hartley, M.J. and A.J. Weldon, eds. 2020. Saltmarsh Sparrow Conservation Plan. Atlantic Coast Joint Venture, acjv.org/documents/SALS_plan_final.pdf

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EXECUTIVE SUMMARY

The goal of this plan is to conserve the Saltmarsh Sparrow, a species restricted to tidal salt marshes along the Atlantic Coast. Saltmarsh Sparrows nest in the highest-elevation, least-frequently flooded "high marsh" portion of tidal salt marshes from Maine to Virginia. This species has experienced a dramatic 87% population decline since 1998 due to low breeding productivity throughout its range. Nest losses are primarily due to nest flooding, although in New Jersey nest predation rates were very high. Saltmarsh Sparrow populations are declining due largely to deteriorating conditions in most Atlantic salt marshes, resulting from a combination of historic loss and degradation of salt marsh habitat—particularly high marsh—and accelerated sea level rise. Sea level rise now represents the primary threat to Saltmarsh Sparrow and to their high marsh habitat. Several other bird species that rely on salt marshes are also experiencing sharp population declines. In 2019, Atlantic Coast Joint Venture (acjv.org) partners developed a Salt Marsh Bird Conservation Plan for the Atlantic Coast that identifies threats, prioritizes species for conservation action, and lays out a set of eight major strategies needed to conserve this suite of species and their habitat. This document is designed to complement that plan by providing species-specific population and habitat objectives for Saltmarsh Sparrow and describing several additional conservation strategies to enhance its populations and address its conservation needs throughout the year.

Tens of thousands of Saltmarsh Sparrows still remain at thousands of sites throughout most of their historic range; therefore, this species can be saved if partners work quickly to increase nest success by improving high marsh nesting conditions. To ensure that a sufficient quantity of high-quality habitat is available in the short-, medium-, and long-term partners must:

- Implement restoration actions to improve the health and resiliency of salt marshes, particularly "high marsh" areas, to reduce nest flooding;
- Facilitate inland migration of marshes to offset marsh losses as sea level rises by protecting key areas buffering salt marshes and developing Best Management Practices to facilitate migration;
- Maximize Saltmarsh Sparrow productivity at key sites to support population growth;
- Implement and monitor outcomes to determine the most effective and efficient conservation approaches through an adaptive management framework;
- Conduct range-wide population surveys to re-assess population trend and size and evaluate conservation actions; and
- Conduct research to determine habitat use and mortality rates during winter to guide conservation in their non-breeding range.

Saltmarsh Sparrow. Ray Hennessy/rayhennessy.com

TABLE OF CONTENTS

PURPOSE

This implementation plan is a call to action to galvanize and coordinate Atlantic Coast Joint Venture (ACJV) and other partner efforts to conserve Saltmarsh Sparrows and their high marsh habitat. It is essential that partners ramp up conservation efforts immediately, while the species is still found in many sites across most of its breeding range. There are currently many opportunities to improve habitat conditions, slow or reverse habitat loss, and protect areas where marshes can migrate inland but the window in which we must act to reverse population declines is narrowing. It is imperative to take immediate action to save the Saltmarsh Sparrow and the many other salt marsh-dependent species that rely on this vital but threatened ecosystem.

BACKGROUND

Saltmarsh Sparrow (*Ammospiza caudacuta*) is a tidal marsh-obligate songbird that spends its entire life in coastal salt marshes along the United States Atlantic and Florida Gulf coasts (Figure 1). Saltmarsh Sparrow is the only native breeding bird species endemic to the Northeastern United States; it breeds in all coastal states from Maine south to Virginia. Its wintering range includes the southern portion of its breeding range, extending south to coastal North Carolina, South Carolina, Georgia, and Florida (Greenlaw & Woolfenden 2007). Saltmarsh Sparrows forage in a range of microhabitats but generally nest only in the highest-elevation portions of "high marsh" (see Box on next page), those areas of salt marsh flooded least frequently, during twice-monthly spring tides or coastal storm events.

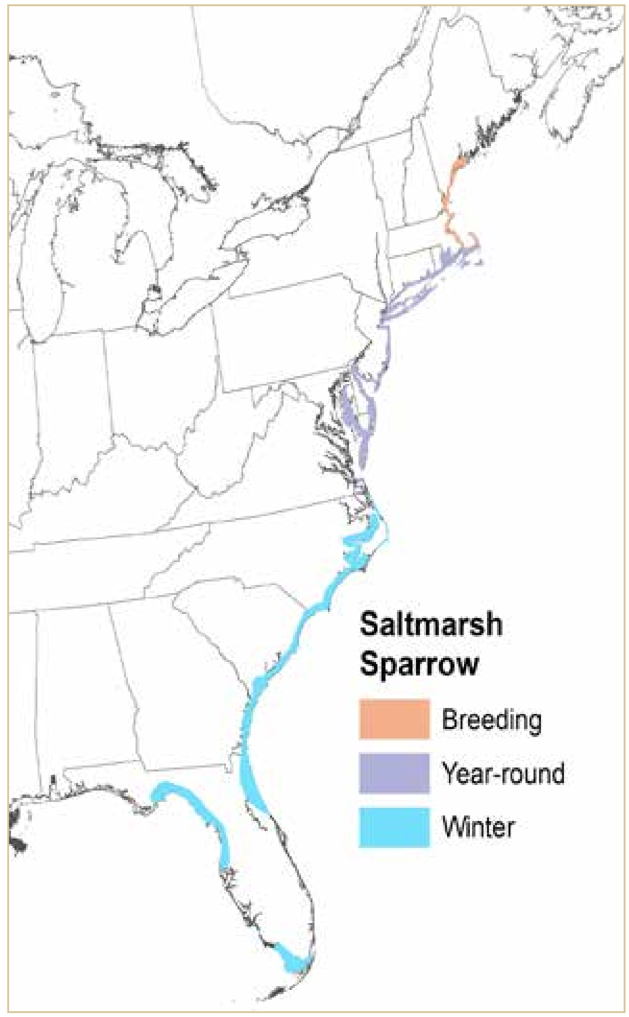


Figure 1. Breeding and non-breeding range of Saltmarsh Sparrow

Saltmarsh Sparrow nests are constructed in salt marsh grasses just above the mean high water level. Their reproduction is particularly well suited to the lunar tide cycle (Shriver et al. 2007). As a result of synchronous nest failure and rapid renesting, Saltmarsh Sparrow nests are often synchronized with spring tides, and are able to withstand temporary tidal flooding if the eggs do not float out of the nest cup. Likewise, hatchlings can crawl up into grasses above flood water once they are about five days old. Their 23-27 day nesting cycle (Bayard & Elphick 2011), including egg-laying (up to five days), incubation (~12 days), and care of hatchlings (~10 days) just fits within the 28-day lunar tide cycle, between successive new, or full, moons. The breeding range of Saltmarsh Sparrow is known as a "hot spot" of accelerated sea level rise (Ezer & Atkinson 2014), where the frequency, duration, and magnitude of tidal flooding has increased more than in other parts of the world. The period of rapidly increasing sea level rise corresponds to a sharply declining Saltmarsh Sparrow population, resulting from high rates of nest loss due to flooding, among other factors, such as predation.

WHAT IS HIGH MARSH?

Salt marshes are often described as having distinct zones, referred to as high marsh and low marsh, which may contain certain features such as pools or pannes in high marsh or mud flats, typically adjacent to low marsh. Low and high marsh are distinguished by differences in elevation, flooding regime, and vegetative community. The elevation difference between low and high marsh is often just a few centimeters, but that can result in very different hydroperiods and salinity, which strongly impact plant communities in each zone. These zones have traditionally been defined as follows:

> **Low marsh**: the lower portion of the marsh platform, within the range of the normal daily tidal prism, is completely inundated twice each day during high tides and drained during low tides. Low marsh is usually dominated by smooth or saltmarsh cordgrass (*Spartina alterniflora*) from the water's edge to the high marsh zone.
>
> **High marsh**: begins at an elevation just above mean high water (MHW) and forms a transition zone between the low marsh platform and upland areas. The conventional definition of high marsh is that it is flooded infrequently, generally only during twice-monthly "spring" (extreme high) tides, which occur around new and full moons, and from storm surge associated with strong coastal storms or runoff from extreme rain events. High marsh is often dominated by salt hay cordgrass (*Spartina patens*) as well as spike grass (*Distichlis spicata*) or salt meadow rush (*Juncus gerardii*) or black needlerush (*Juncus roemerianus*), which can grow in dense swaths, as well as salt-tolerant shrubs such as high tide bush (*Baccharis halimifolia*) and marsh elder (*Iva frutescens*).

The flooding regime of tidal marshes has changed in recent decades with rising seas. Higher-elevation portions of salt marshes now flood more often or drain more slowly, which is changing the plant community. Portions of the high marsh platform that were once dominated by *Spartina patens* may be increasingly occupied by *Spartina alterniflora*, making it harder to define high marsh and low marsh by plant species composition. **For the purposes of this plan, the term 'high marsh' is used to denote portions of the salt marsh platform that are above the MHW level, are irregularly flooded, and form a transition zone between the low marsh platform and upland areas, regardless of vegetative community structure.**

To understand typical characteristics of high marsh habitat used by breeding and wintering Saltmarsh Sparrow, see the callout box on page 12.

CONSERVATION NEED

Saltmarsh Sparrow fledgling. David Eisenhauer/USFWS

Salt marshes have been lost and degraded from centuries of anthropogenic impacts. Marshes were drained and filled for agriculture and development, while transportation infrastructure (road/rail beds) reduced or eliminated tidal flow to many areas. Salt marsh structure and function were extensively impacted in previous centuries by agricultural modifications (e.g., berms and ditches) and extensive grid ditching for mosquito control; more recently, shoreline hardening, invasive species, and increased nutrient inputs from agricultural and urban runoff contribute to ongoing marsh degradation.

In recent decades, Saltmarsh Sparrow declines have paralleled and are strongly linked to changing salt marsh conditions caused by rising seas (Warren & Neiring 1993) and increasing frequency of heavy wind and precipitation events, including flooding from adjacent uplands. The combination of recent climate-driven changes and historic and ongoing anthropogenic impacts to salt marshes has resulted in widespread loss and degradation of high marsh habitat, which are rapidly transitioning from infrequently-flooded areas of dense vegetation to wetter and more open areas, increasingly similar to low marsh (see Box below) and much less suitable for Saltmarsh Sparrow. Saltmarsh Sparrows generally do better in more natural and undisturbed marshes with extensive high marsh habitat that is not restricted by roads or other barriers (Correll et al. 2017), and those marshes are more resilient to sea level rise. Unfortunately, very few sites currently support these conditions; marshes with suitable breeding habitat now appear to be rare. Patches of high marsh nesting habitat suitable for Saltmarsh Sparrow are disappearing in some places or becoming smaller and more fragmented.

Although nest flooding is the primary limiting factor for Saltmarsh Sparrows across their breeding range, nest depredation was the greatest cause of nest loss in one study from southern New Jersey (Roberts et al. 2017), and predation risk is thought to increase from north to south (C. Elphick, pers. comm.). Given the well-documented changes in marsh vegetation structure and density (i.e., decreased canopy cover) in New Jersey (Joseph Smith, unpubl.) and elsewhere across the breeding range (Field et al. 2016), depredation rates may have increased over time as marsh degradation has increased.

The Saltmarsh Sparrow has been identified by state and federal agencies and non-governmental organizations as one of the highest conservation priorities in the Northeastern United States. Researchers, including some involved with the Saltmarsh Habitat and Avian Research Program (SHARP), have studied Saltmarsh Sparrows and other tidal marsh birds for decades. Based on SHARP surveys in 2011/2012, the global Saltmarsh Sparrow population was estimated at ~60,000 individuals, and has been declining at a rate of -9% per year since 1998. Projecting those declines through 2020, the population would be approximately 28,215 individuals, which represents an 87% decline from the 1998 population estimate of 212,000 individuals. The rapid population decline is attributed to low reproductive success throughout their range due to high rates of nest loss from flooding and nest depredation. Range wide, 48% of nests failed to produce a single nestling from 2011 to 2015 (Saltmarsh Sparrow Current Condition Report, USFWS).

Genetic Considerations

The Saltmarsh Sparrow isn't a single population with random mating across the breeding range; it has a hierarchical population structure, with regional groups or metapopulations where finer scale genetic differentiation occurs (Walsh et al. 2012; A. Kovach et al.; SHARP unpublished data). Range-wide, gene flow decreases with distance, so birds are genetically more similar to those in nearby than distant marshes. The spatial extent of gene flow is ~200 km, but most gene flow occurs relatively locally, due to this species' relatively high site fidelity and limited dispersal distances (Dequiznio 2001; Benvenuti et al. 2018; Greenlaw et al. 2018; SHARP unpublished data).

Defining genetically distinct population boundaries is challenging due to the continuous distribution of marshes along the coast. Nonetheless, researchers (Walsh et al. 2012; A. Kovach, SHARP unpublished data) have identified consistent patterns, including a north-south split at Cape Cod: Sparrows on the Cape (Wellfleet, Monomoy) and south are genetically distinct from those in the Great Marsh (MA/NH) north to Maine.

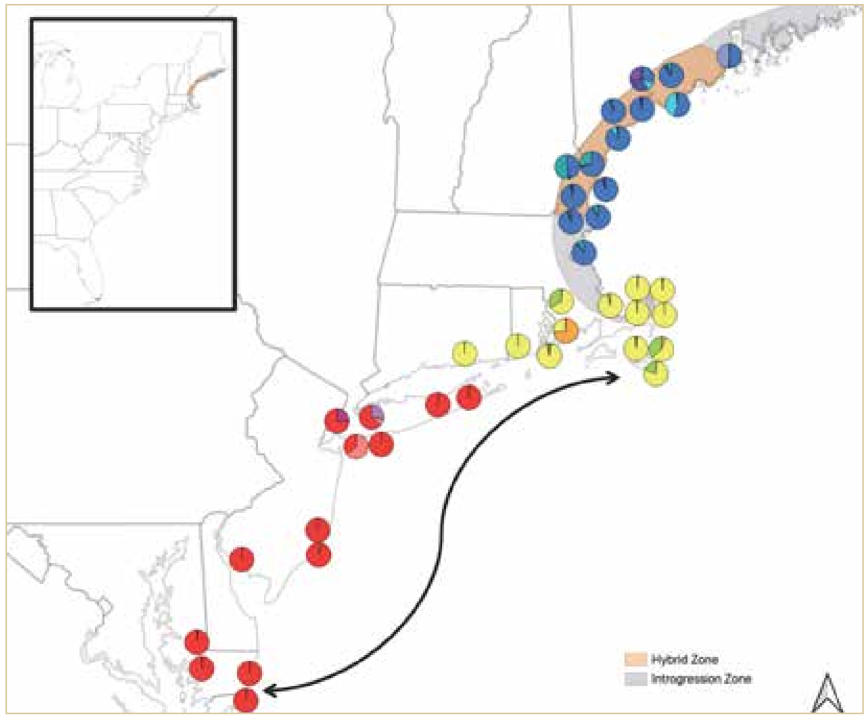


Figure 2. Genetic composition of each location is indicated by pie charts. Three broad-scale regional genetic groupings are indicated by predominantly blue, yellow and red pie chart location markers. Within each of these regions, finer scale (local) population structure is indicated by additional colors in the pie chart, meaning that those locations have distinct genetic signatures, and also share connectivity with other marshes in the region. The double-headed arrow indicates gene flow between the marshes in the Cape Cod/Nantucket, area and the Delmarva Peninsula. The hybrid zone with Nelson's Sparrow is indicated with peach shading, as the area where both species co-exist in sympatry, and the introgression zone (grey shading) indicates the area in which the genetic signal of hybridization extends through shared alleles between the two species.

In the north (blue circles in Figure 2), local structure is found in several of the upriver or fringe marshes, as well as those that have a relatively high proportion of—and interbreeding with—Nelson's Sparrow (*Ammospiza nelsoni*), including Weskeag, Maquoit Bay, Popham, Spurwink (Maine), and Great Bay (New Hampshire) marshes. Within the southern regions, at least two groups occur, with some gene flow among them. Some birds from southern marshes (New Jersey, Delaware and Maryland) are more related to birds in Cape Cod than to birds in New York. Some birds on the coast of Long Island, Connecticut, and Rhode Island are more related to birds in northern Massachusetts, New Hampshire, and Maine than to those on Cape Cod. So while the species' has a regional genetic structure, there is gene flow among groups and finer scale structure within each region. Some isolated, small, or fringe marshes exhibit a distinct genetic signal, due to genetic drift or higher local relatedness, including sites near Nantucket, Sachuest, Rhode Island, and in each of the New York City marshes. Genetic variation on a fine scale may be linked to habitat associations, with higher relatedness in birds using similar habitat types (Wang and Bradburd 2014). If so, sparrows may tend to disperse to sites with habitat conditions like their natal sites.

To ensure population redundancy, this plan calls for maintaining a similar distribution of Saltmarsh Sparrow within and across states as is found today, during both the breeding and non-breeding season.

Hybridization is not a Threat

Nelson's Sparrow and Saltmarsh Sparrow co-occur within a dynamic hybrid zone about 210 km long, between Thomaston, Maine and Essex, Massachusetts (Walsh et al. 2015, 2016a, 2016b, 2016c, 2017; Maxwell 2018). km). The extent to which each species' genes can be found in the other species extends

200 km north and south of the hybrid zone. The hybridization zone increased in size and its center shifted 60 km to the south between 1998 and 2013; over this time, the ratio of Nelson's Sparrow to Saltmarsh Sparrow increased at nearly a third of survey points, which could be due in part to the faster rate of decline in Saltmarsh Sparrows (Walsh et al. 2017). However, there is no clear evidence for genetic swamping; first-generation hybrids make up less than 10% of the population, and the majority of matings occur within species (Walsh et al. 2017). Therefore, species boundaries are likely to be maintained (Maxwell 2018).

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

Hybridization may have fitness consequences that are positive and negative. Hybrids (i.e., individuals with more Nelson's alleles) experienced reduced survival and nest success, but those impacts are masked by the strong effect of sea level rise and the overall high rate of nest flooding (Maxwell 2018). Hybridization may also increase adaptive capacity (Staudinger et al. 2013) by increasing genetic diversity and supporting ongoing evolutionary processes. Overall, potential negative consequences of hybridization are considered minimal compared to the imminent threats of sea level rise and habitat degradation that are driving ongoing population decline (Walsh et al. 2017; Maxwell 2018).

SCOPE AND CONTEXT

This plan provides implementation strategies to conserve the Saltmarsh Sparrow based on the best available science. It represents the input and consensus views of many experts and partners involved in Saltmarsh Sparrow and salt marsh habitat conservation. It addresses the full life-cycle conservation needs of the Saltmarsh Sparrow, throughout its geographic range. Short-, medium- and long-term strategies are included in this plan to encourage and guide immediate implementation needs and to anticipate and prepare for expected future conditions and needs. Action is required now and will continue to be needed to meet the short- and long-term conservation goals and objectives described in this plan. Collective progress will be regularly tracked and provide the basis for updating this plan periodically; an initial update is expected within two to three years to reflect the latest population status and management outcomes. Thereafter, goals and progress will be revisited at least once every five years.

Salt Marsh Bird Conservation Plan

Although designed to be used as a stand-alone document to guide Saltmarsh Sparrow conservation, this plan was developed within a broader conservation planning and implementation framework. The ACJV selected Saltmarsh Sparrow as one of three flagship species that provided the foundation for developing a comprehensive coastal wetland conservation plan. As part of that effort, a Salt Marsh Bird Conservation Plan (ACJV 2019) was developed for the Atlantic Flyway (Maine to Florida) to address the major threats facing a suite of highest-priority salt marsh bird species, including Saltmarsh Sparrow. State wildlife agencies and non-governmental organizations such as the National Audubon Society and American Bird Conservancy also have prioritized Saltmarsh Sparrow work as part of their conservation agenda. This Saltmarsh Sparrow Conservation Plan builds on the Salt Marsh Bird Conservation Plan by detailing how to implement its strategies to maximize benefits to the Saltmarsh Sparrow, and also includes additional strategies that are considered important to specifically enhance Saltmarsh Sparrow populations. Together, the two plans ensure that broader salt marsh conservation efforts are effective for highest-priority species such as Saltmarsh Sparrow.

Partners

Many different organizations, agencies, and partners are involved in Saltmarsh Sparrow conservation efforts, with a high degree of collaboration and coordination among them. A group of academic, governmental, and nonprofit experts who have worked on Saltmarsh Sparrow for more than a decade have formed SHARP. The ACJV has a Saltmarsh Sparrow Working Group which oversaw the development of this plan and includes individuals from the agencies and organizations described above. The U.S. Fish and Wildlife Service (USFWS) has a team coordinating its broad Coastal Resiliency effort, and a cross-programmatic team focused on Saltmarsh Sparrow, which operates within its broader At-Risk Species effort. The USFWS has developed a Current Conditions report for Saltmarsh Sparrow, as a precursor to its Species Status Assessment process. That report includes an exhaustive review of published and unpublished scientific literature covering all aspects of Saltmarsh Sparrow life history. Because this Saltmarsh Sparrow Conservation Plan draws heavily from that report, extensive literature citations are not included here; readers can refer to that report for a comprehensive and organized source of Saltmarsh Sparrow scientific literature.

An Adaptive Management Approach

Saltmarsh Sparrow populations are declining rapidly and managers have little understanding of which conservation and management actions will be most effective at reversing those declines. Success in achieving population objectives will hinge on partners' ability to begin implementation activities immediately, evaluate different approaches, and quickly learn how to carry out the most effective management practices in the shortest amount of time possible. To this end, ACJV partners want to implement Saltmarsh Sparrow conservation activities in an adaptive management framework, where implementation activities are carried out in a replicated manner, across different areas and conditions, and the outcomes of those efforts are rigorously monitored and evaluated. This information will be communicated to partners so that they can use it to develop and promote the most effective approaches (see Promising Management Actions in Need of Testing), and abandon those that are least effective.

Restoring or improving high marsh at sites currently unoccupied by Saltmarsh Sparrow entails little risk of failure, whereas deliberately changing conditions at occupied sites—especially those considered to be important—does involve risks. Changing conditions at occupied sites should be done only after careful consideration of the risks and tradeoffs between improving the Saltmarsh Sparrow population (including the lag time between implementing and achieving improved habitat) and long-term benefits to habitat quality or to the health and resiliency of the larger salt marsh ecosystem. New and innovative approaches need to be developed and tested at a fairly small scale first, and then applied to larger (and more) areas if they seem promising, including sites that currently support a healthy Saltmarsh Sparrow population.

Saltmarsh Sparrow. Ray Hennessy/rayhennessy.com

POPULATION GOAL

ACJV partners developed a phased breeding population goal for Saltmarsh Sparrow, based on the 2012 range-wide population estimate (Wiest et al. 2016, 2019). As it could take years for collective conservation efforts to succeed, the **first objective is to stabilize the population by or before 2031** when, if observed rates of decline continue, the population is predicted to decline to less than 10,000 individuals. Once the population is stabilized, the **ultimate goal is to restore it to at least 25,000 birds** (Fig. 3).

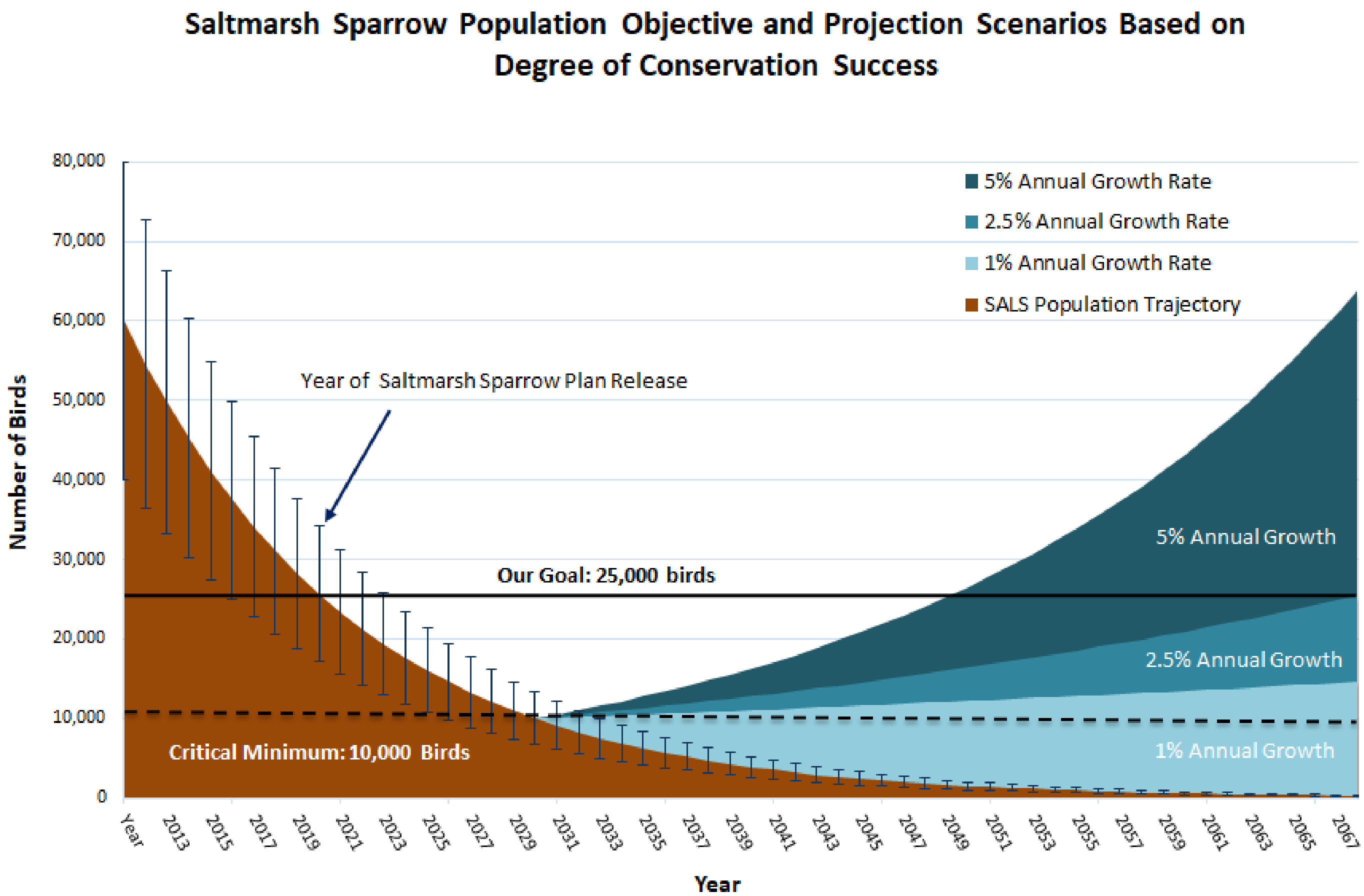


Figure 3. Population trajectories for Saltmarsh Sparrow based on observed (-9%) rate of decline (in brown on left). Population recovery, which depends on achieving positive population growth, is projected under three hypothetical scenarios (in blue on the right), starting in 2031, assuming constant and average annual future growth rates of 1%, 2.5%, and 5%. The long-term population goal is denoted as a solid line; the dashed line denotes a critical minimum level below which the population should not be allowed to fall.

The population goal of 25,000 individuals was based on a combination of ecological theory and empirical evidence. A population of 25,000 should allow sufficient resiliency to withstand stochastic disturbances, redundancy in its geographic distribution, and genetic diversity to adapt to changing environmental conditions over time, which are important factors preventing a species from becoming endangered or threatened (USFWS 2016).

Achieving this population goal will require significant investments in habitat restoration and enhancement, as well as land protection and management to enable successful marsh migration. Both short- and longterm habitat needs must be addressed to ensure that enough suitable habitat is available at any given time to support 25,000 birds. Recovering the population to that level will likely take decades; how long depends on future population growth rates. In this plan, population recovery is projected under three hypothetical scenarios, starting in 2031 (when the projected population decline reaches 10,000) and assuming 1%, 2.5%, and 5% average (and constant) annual growth rates in the future. Under these hypothetical growth rates, respective recovery times of 100, 40, or 20 years (from 2031) would be required to reach the population goal (Figure 2). All of these scenarios may be optimistic given the steep population decline observed in recent decades along with predicted habitat loss in coming decades. Implementing and monitoring the different management approaches recommended in this plan (see page 36) will provide greater understanding of and confidence in how various practices are likely to affect population growth.

State Population Goals

The population goal of 25,000 individuals was stepped down to state-specific population goals (Table 1) based on the proportion of the total population that each state supported in 2011/2012, multiplied by the overall population goal (i.e., 25,000). This approach emphasizes that each state's proportion of the total population should remain the same in the future as it was in 2012 (Table 1). The state population objectives implicitly assume that observed population declines will happen uniformly across all states or subregions. Maintaining the current spatial distribution of the Saltmarsh Sparrow population is also an explicit goal of the population objectives (see Genetic Considerations section).

Table 1. Saltmarsh Sparrow breeding population estimate (±95% confidence interval)*, and population goals, for each state in its breeding range.

State	2011/2012 Population Estimate	Confidence Interval	State's %**	Population Goal (Individual)
Maine	1,600	(± 1,200)	2.7%	668
New Hampshire	1,100	(± 1,700)	1.8%	459
Massachusetts	6,200	(± 2,700)	10.4%	2,588
Connecticut	1,600	(± 800)	2.7%	668
Rhode Island	900	(± 300)	1.5%	376
New York	5,300	(± 1,300)	8.7%	2,170
New Jersey	19,900	(± 13,600)	33.2%	8,306
Delaware	4,100	(± 4,400)	6.8%	1,711
Maryland	15,100	(±13,300)	25.2%	6,302
Virginia	4,200	(±2,600)	7.0%	1,753
Total	**60,000**			**25,000**

**Based on Weist et al. 2019.*
***State's % represents the total abundance in each state divided by the total population.*
Note: from Northern Massachusetts to Maine, reported Saltmarsh Sparrow abundance data have a higher degree of uncertainty than other areas, due to the way that Nelson's Sparrow, Saltmarsh Sparrow, and hybrid individuals were counted. In this hybrid zone, many "unidentified sharp-tailed sparrow" were observed but not included in Saltmarsh Sparrow abundance estimates. Corrected abundance estimates for those states need to be developed.

HABITAT GOALS

Quality Versus Acreage

The most important aspect of the habitat goals below is that the acreages represent the amount of ***high-quality*** high marsh habitat that is needed. High-quality habitat is defined as having suitable conditions to support stable or positive Saltmarsh Sparrow population growth on average, across the site. Observed population declines and supporting studies (Correll et al. (2017)) suggest that only a very small proportion of existing salt marsh habitat is currently in such condition. It is critical then that the minimum habitat goals are viewed as the number of acres of ***high-quality high marsh habitat that support population growth***, not just the number of high marsh acres on the landscape or in conservation ownership. For more information about high quality habitat, see What is Saltmarsh Sparrow Habitat section.

State Breeding Habitat Goals

For each state in the Saltmarsh Sparrow breeding range, the minimum acreage of high-quality high marsh necessary to support that state's share of the 25,000 bird population goal was estimated (Table 2), based on the predicted Saltmarsh Sparrow abundance in habitat patches in that state (Weist et al. 2019). Those estimates assume that if 25,000 birds were supported on ~80,000 acres in 2012, that same minimum acreage could be expected to support a future population of 25,000 individuals.

Table 2. Minimum breeding habitat acreage goal for Saltmarsh Sparrow for each state in its breeding range. The goal is meant to represent high-quality high marsh breeding habitat, which is defined as areas where populations are stable or growing. Current High Marsh represents the estimated acreage of high marsh (Correll et al. 2018), some of which is occupied by Saltmarsh Sparrow, that may potentially be restored, enhanced, and/or managed as high quality breeding habitat in the future. Each state's proportion of the global breeding population (State's %; see Table 1) is also included.

State	Minimum Habitat Goal (Acres)	Current High Marsh (Acres)*	State's % of Global Breeding Population**
Maine	2,511	12,123	2.7%
New Hampshire	2,316	3,678	1.8%
Massachusetts	7,596	24,051	10.4%
Connecticut	2,180	3,422	2.7%
Rhode Island	582	1,770	1.5%
New York	4,286	11,892	8.7%
New Jersey	21,398	103,130	33.2%
Delaware	2,838	24,441	6.8%
Maryland	24,783	57,654	25.2%
Virginia	11,115	13,517	7.0%
Total	**79,605**	**255,995**	

**Current high marsh acreage from Correll et al. 2018, based on remote-sensing data. These estimates do not reflect whether or what proportion of those acres are suitable for or occupied by Saltmarsh Sparrow, nor do they reflect high-quality habitat. Also, they do not reflect projected changes in high marsh habitat in future decades, due to sea level rise.*
***State's % represents the total Saltmarsh Sparrow population in each state divided by the total population, based on Weist et al. 2019.*

Given the dynamic nature of this ecosystem and the widespread degradation of high marsh habitat, considerably more than the minimum acreage estimated may need to be conserved to ensure that sufficient

Typical high marsh habitat at upland transition from New Jersey. Ray Heenessy/rayhennessy.com

high-quality high marsh acreage is consistently available to reach the population goal. Focused and successful management efforts will be necessary to reach and maintain densities of Saltmarsh Sparrows similar to past densities observed in each state. Strategies should include both improving the quality of existing salt marshes and protecting and managing buffers and marsh migration areas to ensure that habitat goals will continue to be met in the future.

Methodology for Calculating Minimum Habitat Objectives

Minimum habitat objectives were calculated for each state in the breeding range (Table 2) using the Saltmarsh Sparrow patch layer (Wiest et al. 2016, 2019), sorted by state, then by density (high to low). The predicted bird abundance by patch (estimated by multiplying patch size by predicted bird density in that patch) was tallied, starting with patches with the highest predicted densities, and adding in additional patches until the cumulative acreage of patches was sufficient to support that state's population goal. If the addition of a patch exceeded that state's population goal, that patch's size was prorated to count only the number of acres needed to reach the target population size.

Non-Breeding Habitat Goals

Because most Saltmarsh Sparrow research has focused on breeding habitat, which has been assumed to be limiting populations, very little is known about how much marsh habitat is needed to support a population of 25,000 birds during the non-breeding season. Past research (Borowske et al. 2018) indicated that Saltmarsh Sparrow populations were probably not limited by habitat quality or availability during the non-breeding season. That was based in part on the fact that there are more and larger salt marsh complexes in the winter range than in the breeding range and those marshes are generally less impacted and more intact relative to salt marshes in the northeast. Recent research in North Carolina has reported higher winter mortality than did earlier studies (R. Danner, pers. comm.), so additional surveys and research are needed to clarify habitat use and threats during the non-breeding season and to guide conservation efforts throughout the entire Saltmarsh Sparrow range and annual life-cycle.

Saltmarsh Sparrow survey in non-breeding habitat. SHARP

Given ongoing human development and sea level rise, there are considerable long-term threats to tidal marshes throughout the species' winter range. Further, although salt marsh acreage is extensive in the southeast, most complexes are dominated by low marsh. Saltmarsh Sparrows use low marsh for foraging but primarily rely upon high marsh habitat as well as the upland edge during winter for roosting and during extreme high water (e.g., spring tides).

Because low marsh is not currently limiting, non-breeding habitat goals have been set for states in the Saltmarsh Sparrow winter range based on maintaining high marsh and upland edge habitat (Table 3). The preliminary goal assumes that all ~560,000 acres of high marsh habitat that currently exists in the winter range (from North Carolina to Florida) may be needed to sustain the population at goal levels. Implementation activities should focus on the most resilient areas of high marsh (totalling 340,000 acres) as well as buffering uplands, which should be prioritized for land protection, improved marsh resiliency, and facilitating marsh migration. Non-breeding habitat goals are preliminary and conservative. A non-breeding population of 25,000 sparrows may not require more habitat in winter than does a breeding population of 25,000 sparrows. These goals can be modified and tailored to each state as more research is conducted to better understand Saltmarsh Sparrow distributions and habitat use in the winter.

Table 3. High marsh area (Allen 2019; SALCC) in southeastern states where Saltmarsh Sparrow spends the winter but does not breed. Priority high marsh acres are those considered to be above average in resiliency based on an assessment by The Nature Conservancy (Anderson and Barnett 2019).

State	High Marsh Acres	Priority High Marsh Acres
North Carolina	169,957	84,537
South Carolina	101,319	53,445
Georgia	101,575	77,843
Florida	192,992	124,512
Total	**565,843**	**340,337**

It's imperative to protect, restore, and enhance high marsh habitat to improve breeding conditions for the Saltmarsh Sparrow. Ray Hennessy/rayhennessy.com

WHAT IS SALTMARSH SPARROW HABITAT?

The habitat objectives in the Saltmarsh Sparrow Conservation Plan represent acres of "high quality" high marsh habitat, not just salt marsh or high marsh. High-quality habitat is defined as conditions that allow sufficient reproductive success to support a stable or growing Saltmarsh Sparrow population. Below we describe typical Saltmarsh Sparrow nesting and wintering habitat and conditions associated with high quality nesting habitat.

Nesting Habitat

Saltmarsh Sparrows typically nest on the higher-elevation, less-frequently flooded "high salt marsh" (NatureServe 2020) platform, characterized by a mix of *S. patens, D. spicata, J. gerardii*, and/or *S. alterniflora* grasses (present or co-dominant), with an extensive horizontal layer of dead vegetation (i.e., "thatch"). They also nest in high marsh dominated by *J. gerardii*, with or without thatch. Nests are often placed under the thatch layer, in areas of slightly higher elevation on the marsh platform, and in vegetation that is taller and more dense than average, such as near edges or water (e.g., a pool, ditch, vegetated panne, etc.). Less often, nests are within the marsh transition zone, at the upland edge of the marsh where shrubs like *B. halimifolia* or *I. frutescens* are present.

Nests are often placed under the thatch layer, in areas of slightly higher elevation on the marsh platform, and in vegetation that is taller and more dense than average, such as near edges or water. USFWS

Saltmarsh Sparrows may avoid extensive high marsh that lacks suitable habitat features, such as high marsh areas dominated by *J. roemerianus*. They also avoid areas within 50 m of tall objects such as tree lines and buildings, even when appropriate nesting vegetation is present (Marshall et al. 2020). Due to the ongoing degradation of many northeastern salt marshes over the past 30 years, Saltmarsh Sparrows now may nest more often in less-than-optimal conditions (see below).

Some proportion of Saltmarsh Sparrows nest in less typical conditions, such as areas dominated by tall form *S. alterniflora* without extensive thatch. In such areas, they nest in vegetation that is taller and more dense than average. Nests are also sometimes found on the high marsh platform in extensive areas dominated by short-form *S. alterniflora*, such as water-logged marshes, if there is suitable thatch. Those nests are often near a "panne" edge where vegetation is slightly taller.

High marsh extent and quality have been changing for decades. In many places, the high marsh platform has become wetter due to more frequent flooding and ponding, often causing a transition to conditions more similar to low salt marsh (NatureServe 2020), or even open water or mud flats. The process of high marsh degradation is associated with declines in both occupancy and nest success by Saltmarsh Sparrow. As degraded high marsh habitat becomes more common, Saltmarsh Sparrows may be forced to nest more often in less than optimal conditions, though they may have low or no reproductive success there.

High Quality Nesting Habitat

Breeding habitat quality is a function of flooding frequency. High marsh patches with the lowest flooding frequency provide the highest quality breeding habitat. Historically, these patches were usually flooded only once or twice each month—during the highest "spring" tides in the monthly lunar cycle, leaving a relatively safe window of at least 24 days with limited flooding. Infrequently flooded areas were often dominated by extensive and dense *S. patens* vegetation, with a deep, well-developed thatch layer; the presence of *J. gerardii* is also an indicator of low flooding rates. The highest quality high marsh habitat is now most often found in the least modified marshes, such as those without ditching or that are downstream, or free, of tidal restrictions like road crossings.

A note of caution: Vegetative composition may not be a reliable indicator of flooding frequency because it can take years of increased flooding before obvious vegetation changes. High marsh habitat that looks suitable in terms of plant species composition may be experiencing frequent flooding that prevents successful reproduction.

Wintering Habitat

In winter, Saltmarsh Sparrows forage on the ground and in vegetation in extensive *S. alterniflora*, sometimes in *J. roemerianus*, and along the interface of the two. They are often within a few hundred meters of a high tide roost site. When disturbed, or during high water events, they leave wetter, low marsh areas and roost primarily in tall vegetation (e.g., tall-form *S. alterniflora, J. roemerianus*) or on hummocks or higher-elevation areas (e.g., spoil banks, dune scrub, or berms) dominated by *Juncus, B. frutescens*, or a mix of other plants. They tend to use areas of higher elevation within the marsh interior rather than upland edges along the landward side of the marsh that are typically dominated by drier grass species, *Myrica cerifera*, *B. halimifolia*, or *B. angustifolia* shrubs. During the highest tides, they may be forced to use landward edges if their preferred high tide roosts are flooded. From North Carolina to Florida, short form *S. alterniflora* is the most commonly used habitat, patches of *J. roemerianus* are used occasionally but large monocultures of *J. roemerianus* are avoided.

High tide supratidal habitat Fort Fisher/Bald Head Island State Natural Area. Marae Lindquist

SPATIAL CONSIDERATIONS

Conserving Genetic Diversity

Although some states have a relatively small proportion of the total Saltmarsh Sparrow population, they may play a disproportionate role in preserving genetic diversity. Mike Kirpatrick

The goal of this plan is to preserve the current distribution of the Saltmarsh Sparrow population across the entire breeding range, including populations on small and fringe marshes. That goal is reflected in the state-specific population and habitat objectives. Although it has not been quantified, there is evidence of some range contraction at both the northern and southern limits of the breeding range (Saltmarsh Sparrow Current Condition Report, USFWS, 2020). Furthermore, breeding individuals are not evenly distributed across the entire range, with approximately 78% of the population breeding in marshes of the mid-Atlantic states. Although some states have a relatively small proportion of the total Saltmarsh Sparrow population, they may play a disproportionate role in preserving genetic diversity (Walsh et al. 2012) and are making an important contribution to the global population. Even small or fringe marshes may harbor unique genetic diversity or have relatively high productivity (e.g., due to reduced nest flooding) that contributes disproportionately to population gene flow, while large, well-connected marshes have the largest populations and sources of dispersal.

Maintaining populations throughout the range maximizes the conservation of genetic diversity and facilitates local, stepping-stone dispersal required to prevent population isolation. Conserving the species' genetic variation is important to: 1) provide evolutionary potential to adjust to environmental change; 2) increase resilience to environmental disturbances such as hurricanes, disease or oil spills; and 3) preserve important local adaptations. These advantages are especially important for specialist species like Saltmarsh Sparrow with narrow niches, which may have lower genetic diversity than generalists. Maximizing adaptive capacity may be critical for keeping up with sea level rise (Staudinger et al. 2013), the species' greatest threat. Representation of different habitat types and conditions and the degree of population redundancy will be essential to reducing the Saltmarsh Sparrow's risk of extinction.

A Shifting Mosaic

Given the dynamic nature of coastal marshes and the effects of sea level rise, the same, fixed set of sites are not expected to continuously provide the habitat needed to meet population goals. Rather, habitat goals are expected to be met through conserving a shifting mosaic of salt marsh habitat patches which, at any given point in time, provide the adequate quantity and quality of habitat needed to support the population goal. In some areas, high marsh habitat suitable for Saltmarsh Sparrows is expected to be lost (i.e., converted to low marsh or open water) over the coming decade(s). In other areas marshes are expected to migrate inland, resulting in new habitat becoming suitable for Saltmarsh Sparrow. To reach the population goal, partners must ensure that enough high-quality high marsh habitat is kept in a resilient state, such as through restoration or enhancement efforts, or successfully allowed to migrate into upland areas to offset the amount of acreage that becomes unsuitable for Saltmarsh Sparrows.

Threats to Saltmarsh Sparrow populations are briefly described below. Many of these threats are interrelated; for example, the degree of historic modifications to salt marshes can determine how resilient marshes are to the threat of sea level rise. An assessment of major threats formed the basis of the Implementation Strategies below. More detailed information, including the threat ranking process, criteria, and factor scores, are provided in the Salt Marsh Bird Conservation Plan.

NEST FLOODING & HABITAT LOSS FROM 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 the main driver of Saltmarsh Sparrow population declines. Sea level rise causes higher tidal amplitude and results in repeated nest flooding throughout the breeding season, increasing nest failure rates for Saltmarsh Sparrows. 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. The East coast of the U.S. is experiencing much higher rates of sea level rise than the global average; from 1970-2009 the area between Boston, Massachusetts and Virginia has experienced rates of sea level rise 2 to 4 times the global average. This area encompasses nearly all of the Saltmarsh Sparrow breeding range. If this trend continues, it would translate to 0.45 m of sea level rise by 2050 under the best-case scenario or 1.05–1.40 m sea level rise by 2050 under the 'worst case' scenario.

Most models (Spenser et al. 2016)predict major changes in the distribution and abundance of tidal marshes in future decades, with large (90%) losses of tidal marsh (Crosby et al. 2016) expected by the end of the century. The high marsh habitat needed by Saltmarsh Sparrow is much less resilient to sea level rise (Gonneea et al. 2019), compared to low marsh (Kirwan et al. 2016), and is expected to decline across the Saltmarsh Sparrow range, even in places where low marsh is able to keep up with rising seas. This trend is exacerbated in the mid-Atlantic, where much of the coastal plain is experiencing subsidence due to isostatic rebound from the end of the ice age (Sella et al. 2007).Further, astronomical patterns (i.e., the relative position and tilt of the sun, moon, and earth) cause predictable changes in tide dynamics over time. Known as the metonic cycle, tides change over a 19-year period which affect Saltmarsh Sparrow nest success in positive or negative ways. The tidal amplitude has been relatively low from 2015 to 2024, but is expected to increase from 2025 to 2034, which will make management for Saltmarsh Sparrow even more challenging.

HISTORIC MODIFICATIONS TO SALT MARSHES

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 crops and then for many other forms of development such as housing and transportation. These alterations have affected Saltmarsh Sparrow habitat and populations directly and indirectly. Draining and filling have eliminated 37% of salt marshes in New England (Bromberg and Bertness 2005) and even higher proportions (70-80%) around urban areas like Boston and New York, representing tens of thousands of acres lost. Tidal flow has been restricted in many remaining salt marshes, particularly in the northeast, usually due to roads and rail infrastructure, which fragment or border many tidal marshes, or from low dikes or banks built to prevent flooding or improve agricultural production.

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/USFWS

Historic modifications within salt marshes exacerbate the profoundly negative effects of sea level rise on Saltmarsh Sparrow populations. For example, legacy agricultural dikes or berms increase ponding in upper portions of salt marshes, where trapped standing water leads to reduced plant growth and a conversion of high marsh to more salt-tolerant vegetation and open pools. Where there is considerable development and impervious surfaces adjacent to salt marshes, runoff and freshwater inputs to the marsh increase, which also contributes to more ponding and degradation in some areas.

TIDAL RESTRICTIONS

Saltmarsh Sparrow population declines were not observed in salt marshes without tidal restrictions (Correll et al. 2017), presumably because restricting tidal flow prevents or limits sediment supply to salt marshes which is key to marsh accretion. Areas with severely restricted tidal flow often experience significant subsidence of the marsh platform due to oxygenation of marsh soils and higher rates of plant decomposition. Restoring healthy marshes in such areas is more challenging and can take longer because tidal flow may need to be gradually reintroduced to allow vegetation growth and accretion and prevent inundation and large areas of open water. Some marshes upstream of tidal restrictions are reported to have high Saltmarsh Sparrow breeding productivity, but the short-term benefits to the sparrow population likely come at the cost of long-term health and resiliency of those marshes.

DITCHES

Approximately 90% of salt marshes from Maine to Virginia have been extensively ditched, first for salt marsh haying, then in an attempt to control mosquito populations. Ditches were dug at much higher densities than tidal channels, and eventually replaced the tidal channel morphology. Denser ditches reduced tidal velocity and resulted 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 and pool formation (Vincent et al. 2013), 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 (Schepers et al. 2016).

EXACERBATING SEA LEVEL RISE

Rising seas are increasingly flooding higher-elevation portions of the marsh, where relict agricultural ditches and dikes can impound and/or delay the exit of tidewater. Today, the platform in many historically modified salt marshes has subsided and may be more than a meter below sea level in some areas (Weinstein and Weishar 2002). Subsidence is most problematic in portions of the coastal plain that are still sinking due to glacial isostatic adjustment (Sella et al. 2007). 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. In these areas, additional sediment inputs may be needed to maintain or create a high marsh platform.

LAND USE INCOMPATIBLE WITH MARSH MIGRATION (INCLUDING NEW RESIDENTIAL DEVELOPMENT AND SHORELINE HARDENING)

The ability to accommodate inland migration of tidal marshes is probably the single most important factor (Schuerch et al. 2018) that determines whether or not tidal marshes will be lost (Spencer et al. 2016) due to sea level rise. The loss of existing salt marshes could be offset, in part, by inland migration of salt marshes into adjacent uplands or freshwater wetlands—a process that is likely to develop slowly over decades.

Residential development, along with hardened shorelines is a major threat to salt marsh habitat. Chesapeake Bay Program

Marsh migration is already happening in some areas but is generally blocked or impaired in areas with human development. From Massachusetts to Florida, over 40% of coastal land with an elevation of 1m or less is currently developed and almost 60% is expected to be developed in the future. Coastal landowners often protect their property from storm or tidal flooding by 'hardening' their shorelines through berms, walls, or other barriers to tidal flow. Hardened structures are in place on 14% of the entire U.S. coastline and affect more than 50% of the shoreline in more developed areas (Gittman et al. 2015). Increased shoreline hardening can result in increased water depths and wave energy in the intertidal zone, eroding and degrading remaining areas of natural, unprotected shoreline, and deprive inland areas from sediment supply necessary to help marshes keep up with sea level rise (Schuerch et al. 2018). In some places this has left little or no vegetated marsh on the seaward side of barriers and effectively blocks the inland migration of tidal wetlands.

As discussed in the Salt Marsh Bird Conservation Plan, buildings and other development adjacent to salt marshes negatively affects habitat quality and resiliency in several ways. Noise, disturbance, and human-subsidized predator populations reduce ecosystem integrity, and impervious surfaces increase run-off and flooding.

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 uses earthen embankments that 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. Historical impacts from transportation infrastructure on salt marsh birds are considerable and new transportation infrastructure continues to encroach upon and degrade marsh ecosystems, such as through the spread of the invasive species along transportation corridors (Hansen and Clevenger 2005). For example, in the northeast and mid-Atlantic, invasive *Phragmites australis* now dominates many areas that were formerly salt marshes.

REDUCED SEDIMENT SUPPLY

Natural sediment deposits from a winter storm in the Great Marsh, Massachusetts. Aimee Weldon/USFWS

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 and allow 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 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 (Schepers et al. 2016). Much of the area in the Saltmarsh Sparrow range does not have sufficient sediment supply to keep up with sea level rise (Kirwan et al. 2010). Although some scientists have argued that sediment accretion will allow many tidal marshes to keep up—even with accelerated levels of sea level rise—low marsh has much greater capacity (Kirwan et al. 2016) to do so than does high marsh (Morris et al. 2013). Therefore, most experts expect sharp declines in the high marsh habitat that Saltmarsh Sparrow require, given future sea level rise and an insufficient supply of sediment.

In many areas, sediment supply has been reduced or blocked from entering marshes due to human activities and infrastructure, such as roads that restrict tidal flow, sea walls, development or paving of dune areas that prevents overwash, and regular dredging of navigational channels. The construction of dams on coastal river systems was widespread from colonial times until the late 20th century. Removing upstream dams and other hardened structures that block sediment could provide an important source of nourishment to some salt marshes, which may be in need of such inputs to keep up with sea level rise.

However, it is important to understand the magnitude and importance of upstream or landward sediment sources—and the likelihood that they will end up in a particular marsh—before undertaking projects such as dam or barrier removal. Many salt marshes used by Saltmarsh Sparrow are in locations with geomorphic settings where sediment supply comes mainly from marine sources. Where salt marshes are thought to depend on riverine or upland systems for their sediment supply, land managers should coordinate barrier removal efforts with other partners conducting such work for purposes such as aquatic connectivity or flood abatement to help prioritize work that benefits multiple values. Shoreline hardening can also disrupt and prevent normal sediment dynamics; vertical and hard structures often have the opposite effect on sediment than does a more natural shoreline with a flatter, vegetated interface. Rather than reducing wave velocity and capturing sediment, vertical structures can cause scouring and removal of existing substrate.

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 as South Carolina (Ward & Jacono 2009). *Phragmites* quickly forms a tall, dense, monoculture, which excludes most other plant species and dramatically lowers the habitat value for Saltmarsh Sparrow. Perennial pepperweed (*Lepidium latifolium*) is another salt-tolerant species that has invaded several northeastern states, including some sites with large and healthy Saltmarsh Sparrow populations, and has the potential to invade all East Coast salt marshes (Reynolds and Boyer 2010).

NEST PREDATORS

Although nest flooding is an important cause of nest mortality in Saltmarsh Sparrow populations, nest mortality due to depredation is also significant (Greenberg et al. 2006). In fact, in some places nest depredation can be the single most important factor (DiQuinzio et al. 2002; Roberts et al. 2017) affecting Saltmarsh Sparrow productivity. There are currently no studies identifying the species of nest predators that have the greatest influence on Saltmarsh Sparrows, and they may vary by state or region. In some areas, birds such as grackles, night herons, and crows are thought to be important; in other places, it may be mid-sized mammals (e.g., raccoon and fox). In urban marshes, non-native rats and house cats may be most significant, especially where their populations are subsidized by human activities (e.g., garbage, agriculture, pet food). Snakes are major nest predators of other sparrow species in the southern U.S., and several species are found in salt marshes.

Small mammals like raccoons are an important cause of nest mortality in Saltmarsh Saprrow populations. Barb & Dean Ross/ Creative Commons

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. Saltmarsh Sparrows also face a trade-off between nest flooding and depredation (Greenberg et al. 2006; Benvenuti et al. 2018), which may be additive or compounding. Nests that do not fail due to flooding are often located higher in the vegetation and may be more susceptible to depredation. After nests fail due to flooding, subsequent nests are usually constructed higher in vegetation, where they are more vulnerable to predators (Benvenuti et al. 2018).

PRESCRIBED FIRE

Prescribed fire is used for salt marsh management, particularly in the southeast, where it is used to control encroachment by woody and/or invasive plants that can degrade habitat quality. Fires are a natural disturbance in salt marshes and one from which they can sometimes recover 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, and the plant community can take decades to recover. Therefore, burning has to be done carefully to avoid conflicts and negative impacts on Saltmarsh Sparrow habitat, such as burning too often or too infrequently, at the wrong time of year, or with improper water levels. Use of prescribed fire to control *Phragmites* stands can also be problematic, as burning stimulates its rhizome production and adds nutrients to the estuarine system, which benefits *Phragmites* and promotes its spread. As an intermediate step between two successive herbicide treatments, however, burning can be effective at removing above-ground biomass of *Phragmites* and encouraging establishment by native plants.

OIL SPILLS

Although uncommon, oil spills are a constant potential threat to Saltmarsh Sparrow. An 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 Saltmarsh Sparrow and greatly increase extinction risk. A spill affecting large areas of the southeastern U.S. could affect migratory and/or wintering birds. It is important that priority marshes are integrated into spill response plans. Relative to other threats to Saltmarsh Sparrow, however, oil spills were not viewed as a high-priority threat to address in this plan.

THREATS DURING WINTER

Winter food availability has been shown to limit the population sizes of related species of birds using tidal marsh, through local movements and mortality (Danner et al. 2013). Therefore, winter food availability and habitat extent and quality may also limit Saltmarsh Sparrow populations. Saltmarsh Sparrow prefer high marsh habitats in winter just as they do in summer. Higher-elevation marshes, dominated by short-form *Spartina alterniflora, S. patens,* and *Juncus*, make up a small fraction of southeastern salt marshes, and are at the greatest risk of loss or degradation due to sea level rise. Recent research indicates that mortality in winter may be higher than during the breeding season (R. Danner, pers. comm.) but earlier research found high adult survival in both summer and winter (Borowske et al. 2018).

OTHER STRESSORS & POTENTIAL THREATS

The goal of this conservation plan is to address the most critical threats limiting Saltmarsh Sparrow populations. This plan does not discuss and address every potential threat to the species (e.g., disease or ingestion of contaminants), although the USFWS's Current Conditions report for Saltmarsh Sparrow does consider numerous additional threats with potential to affect Saltmarsh Sparrow. That analysis and literature review found no compelling evidence of major threats or limiting factors beyond those addressed in this plan. Pesticides and other contaminants are still considered a potential threat (Winder and Emslie 2012; Weston et al. 2015), but one that is not currently considered as critical as the threats addressed in this plan.

Salt marsh habitat in Essex, Massachusetts. Cheryl Bagshaw

IMPLEMENTATION STRATEGIES

The goal of this plan is to improve, create, and maintain sufficient nesting and wintering habitat to support a healthy Saltmarsh Sparrow population, with an eye on both short- and long-term habitat needs. Halting the Saltmarsh Sparrow population decline and sustaining and recovering its population in the future will require considerable effort by partners to protect, restore and enhance existing habitat patches, the larger salt marsh ecosystem, inland marsh migration corridors, and a mosaic of sites that are expected to provide or buffer high marsh habitat in the future. A multi-pronged conservation approach must be pursued to:

- Improve breeding conditions on existing salt marshes used by Saltmarsh Sparrow;
- Maintain the integrity and prevent further degradation of salt marshes that are currently important for Saltmarsh Sparrow; and
- Ensure that suitable marshes are allowed to develop in the future through inland migration to offset the predicted loss of marshes inundated by sea level rise.

Given the species' rapid population decline, there is a clear need to increase the amount of high-quality habitat, where Saltmarsh Sparrows can successfully reproduce. Most of the implementation strategies suggested in this plan are expected to have the concomitant benefit of improving habitat quality for Saltmarsh Sparrow and the health and resilience of the salt marsh ecosystem.

To achieve the population and habitat goals set forth in this plan, partners must invest in a comprehensive set of conservation strategies that address the major threats to Saltmarsh Sparrow. If successfully implemented, these strategies are expected to halt population declines and allow populations to rebuild despite ongoing sea level rise.

The Saltmarsh Sparrow Conservation Plan was designed to build on and complement the Salt Marsh Bird Conservation Plan, which included two major approaches: strategies to protect and restore salt marsh habitat (in existing marshes and the marsh migration zone), and outreach/engagement strategies to enlist the key partners needed to significantly advance conservation of salt marsh habitats. The seven strategies in the Salt Marsh Bird Conservation Plan that are most relevant to Saltmarsh Sparrow conservation are:

- Restore and Enhance Degraded Salt Marsh
- Protect Marsh Migration Zones (via acquisition/easements)
- Build Marsh Resilience through Dredged Material
- Facilitate Marsh Migration
- Integrate Salt Marsh Conservation into Natural Resources Conservation Service (NRCS) Farm Bill Programs
- Engage Transportation Agencies to Improve Coastal Infrastructure
- Engage/Improve Local Land-Use Planning Process

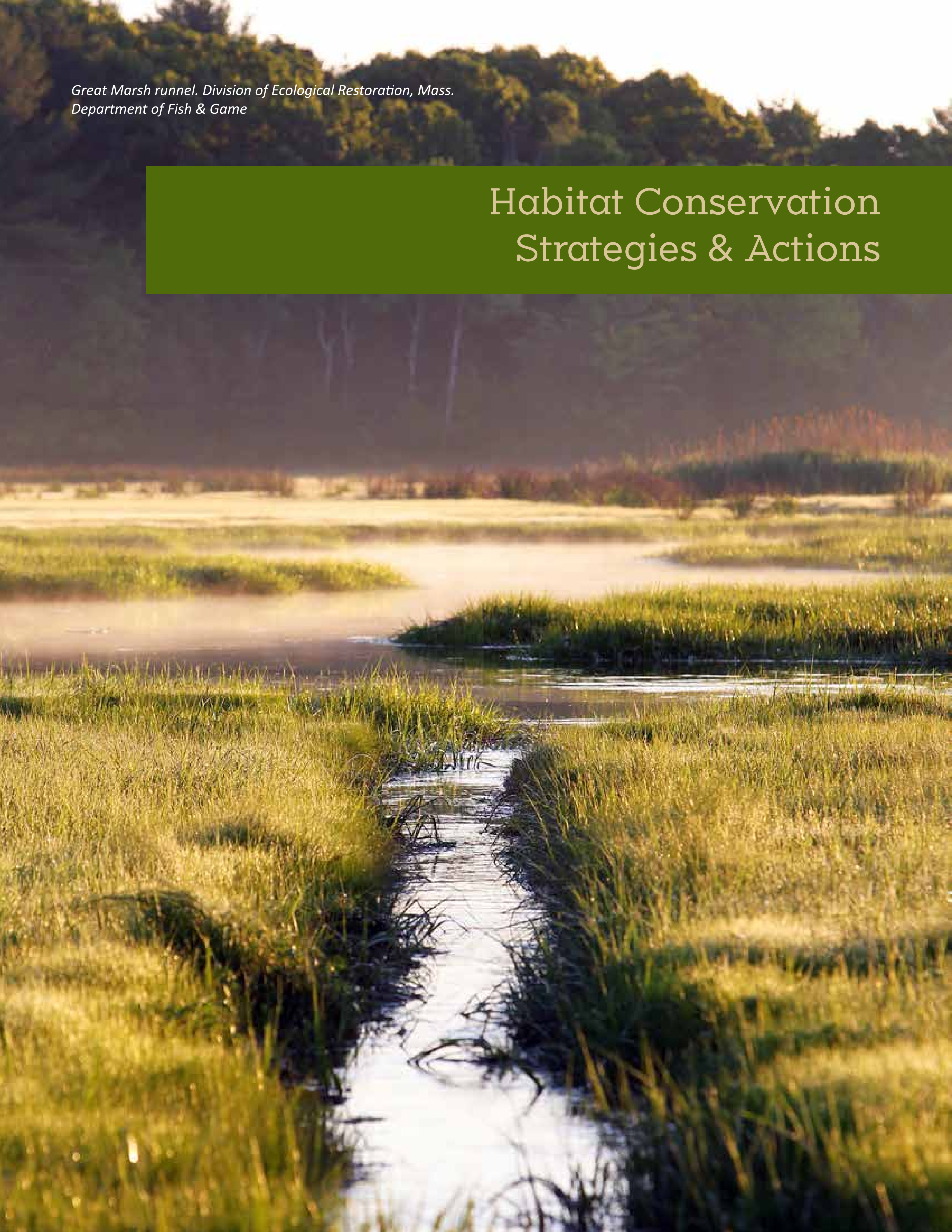
Five additional strategies were developed for this Saltmarsh Sparrow Conservation Plan, four of which fall under a third category of implementation activities, enhancing Saltmarsh Sparrow populations:

- Create/enhance microhabitats
- Tide gate manipulation
- Predator management
- Individual nest protection

A fifth strategy focuses on addressing Saltmarsh Sparrow conservation needs during the non-breeding season .

All twelve of these strategies are described in detail below.

Habitat Conservation Strategies & Actions



Great Marsh runnel. Division of Ecological Restoration, Mass. Department of Fish & Game

STRATEGIES TO PROTECT & RESTORE SALT MARSH

Reaching the ultimate goal of stabilizing and reversing Saltmarsh Sparrow population declines will require protecting, restoring, and enhancing a sufficient amount of salt marsh with high-quality high marsh habitat characteristics over short (<5 years), medium (5-10 years), and longer (> 10 years) time scales. The most immediate need is to implement a variety of promising management strategies to restore degraded habitats, improve ecosystem resilience, and create or enhance habitat conditions that benefit Saltmarsh Sparrow breeding productivity. Because each marsh is unique, selecting the best strategy will require evaluating marsh structure and function in the context of both short- and long-term benefits to Saltmarsh Sparrow populations and the long-term resiliency of the larger salt marsh ecosystem. While a given action may benefit both, some options may result in a trade-off between them. To avoid unintended consequences, partners should pilot test each strategy on a small scale (i.e., on small sites or small portions of larger sites), across many different marshes, and scale those efforts up to more and larger areas of salt marsh if results are positive.

Although restoration is the most urgent need to prevent population collapse, land protection is a critical tool that will allow partners to safeguard the marshes of the future. To help offset salt marsh loss due to sea level rise, upland buffers and inland migration corridors must be protected from development and active management may be required to facilitate marsh migration in those areas. Because a high proportion of salt marshes are already owned by conservation entities, and wetlands have statutory protections limiting adjacent development, land protection efforts can focus on buffering uplands and undeveloped marsh migration corridors expected to be most resilient to sea level rise. High priority marsh migration zones in the northeast and southeast have been identified and mapped by The Nature Conservancy; these data are provided on the Saltmarsh Sparrow Habitat Prioritization Tool.

Finally, nonbreeding season habitat must also be conserved. Although there is relatively little information about marsh use by Saltmarsh Sparrows during winter, sea level rise is projected to limit availability of high marsh habitat in all parts of the Atlantic Coast in the near- to mid-term. Because Saltmarsh Sparrows seem to depend on high marsh habitat on both the breeding and the wintering grounds, a sufficient quantity and quality of high marsh habitat must be available throughout its range, to support the target population, and ensure that winter habitat doesn't become a limiting factor in the future.

The strategies and actions listed below include a combination of land protection and habitat restoration needed to provide sufficient high-quality Saltmarsh Sparrow habitat over the long term. These include a suite of promising management actions that should be implemented and evaluated at multiple sites in an adaptive management framework to allow managers to understand which are most effective in various marsh settings. For more information about how these strategies were developed (e.g., the underlying logic models, or "results chains") see the Salt Marsh Bird Conservation Plan (page 76). Each of that plan's strategies has been modified somewhat to reflect how it can be implemented to maximize benefits to Saltmarsh Sparrow. Actions and objectives not expected to benefit Saltmarsh Sparrow were not included in this plan.

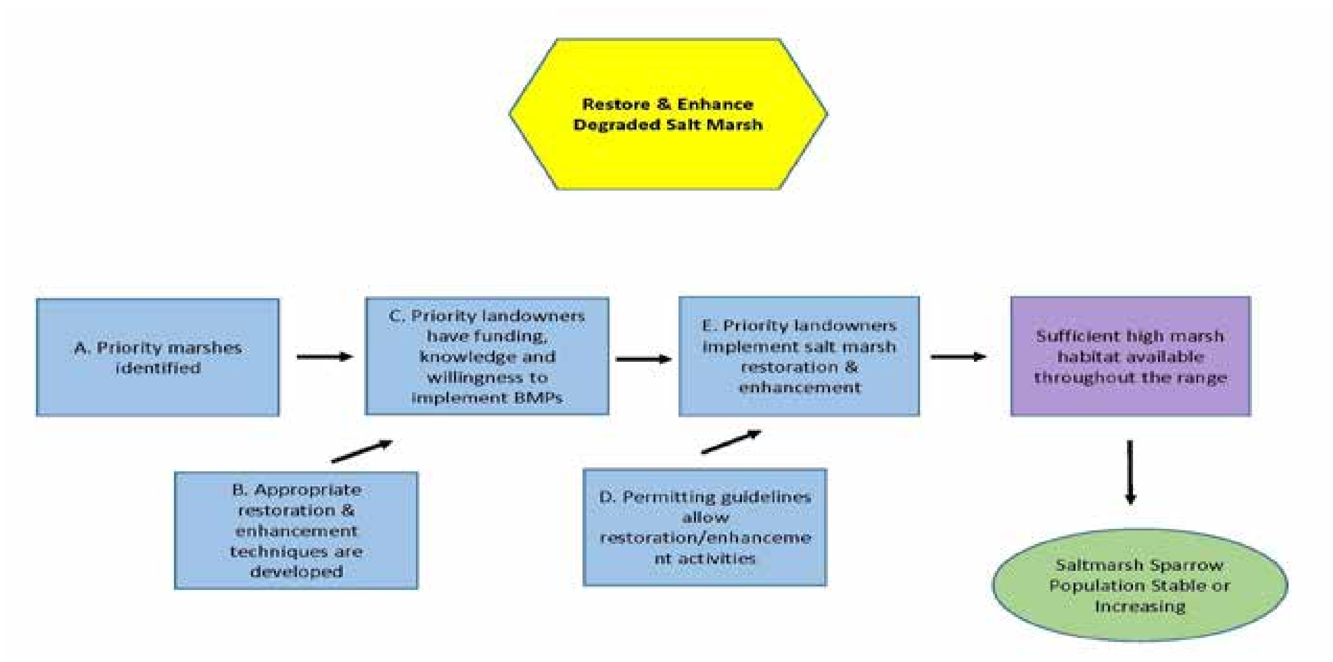
Saltmarsh Sparrow Habitat Prioritization Tool

To identify the most effective places to do Saltmarsh Sparrow conservation at the state and regional levels, the ACJV Saltmarsh Sparrow Working Group developed a simple habitat prioritization tool. The tool uses remotely-sensed and regional data layers to rank marsh patches in the breeding range based on a variety of positive (e.g., high marsh area, resiliency of surrounding landscape) and negative (e.g., probability of inundation by sea level rise, degree that marsh is tidally restricted) factors that experts selected as important characteristics of good Saltmarsh Sparrow habitat. The tool prioritizes more than 9,000 patches in rank order, by region and by state, and provides a starting point for land managers interested in identifying potentially important habitat patches for Saltmarsh Sparrows in their area. It also includes maps of marsh migration zones identified as above average in resiliency by The Nature Conservancy (Anderson and Barnett 2017).
See acjv.org/saltmarsh-sparrow-2/ for more information.

STRATEGY: RESTORE AND ENHANCE DEGRADED SALT MARSH

In recent decades, high marsh has been transitioning to low marsh as sea level rises and flooding rates have increased throughout the Saltmarsh Sparrow range. This climate-driven change is exacerbated by the legacy of historic marsh modifications (e.g., roads, berms, ditches, Open Marsh Water Management (OMWM) [Riepe 2010]) that often accelerates the conversion to wetter habitats. Restoring and enhancing the functionality and resilience of salt marshes is a critical need that must be addressed to stabilize and then increase the population trend for Saltmarsh Sparrow. However, there are relatively few examples of restoration or management practices that are known to effectively improve marsh resiliency over the short-, medium-, or long-term, and none that have yet demonstrated a reduction in Saltmarsh Sparrow nest flooding. Every marsh has unique hydrology, sediment dynamics, and history of modifications that may dictate which strategies are likely to be most successful. Restoration activities could also take years to fully implement and mature before high-quality Saltmarsh Sparrow habitat is achieved. Therefore, partners must quickly develop tools to identify the best places to work and the most effective conservation practices to apply in each priority area through pilot testing in an adaptive management framework. The strategy and five objectives below were established to achieve this goal.

Strategy Logic



Strategy Description

This strategy relies upon partners to identify and prioritize which marshes to target for restoration or enhancement (A), based on an understanding of their current condition, the stressors that need to be addressed to improve habitat quality, and any limitations or opportunities (e.g., availability of local dredged sediment supply) unique to each site. Currently, there is somewhat limited knowledge about which restoration and enhancement techniques will be most appropriate and effective under different conditions; so these techniques must be developed (B) and evaluated using an adaptive management framework. When conservation partners understand what restoration is needed where, they must secure the funding for delivery (C), including landowner incentives needed, and work with regulatory agencies to ensure that the work will be permitted (D). Then, restoration and enhancement can be implemented at high priority sites and where valuable opportunities arise (E). That restoration work will improve habitat quality (e.g., reduce nest flooding), which will result in a stable or growing Saltmarsh Sparrow population.

Objective 1a: By 2020, create and make available a map of priority marshes for Saltmarsh Sparrow and indicate where management is needed to improve habitat conditions (e.g., nest success) or maintain marsh resiliency (i.e., prevent habitat degradation or loss).

Objective 1b: By 2020, create and make available an updated map of invasive species (e.g., *Phragmites* and Pepperweed) patches to inform management action.

Objective 2: By 2020, begin to implement a series of restoration and enhancement actions needed to conserve Saltmarsh Sparrow across replicated sites, which can be evaluated in an adaptive management framework to support the development of Best Management Practices (BMPs). See page 36 for more information on design considerations.

Some actions have been shown to be successful on a small scale but need to be tested on a scale large enough to be meaningful to Saltmarsh Sparrow; others have never been tested but seem promising to salt marsh experts. All actions must be tested in as many marshes and as many states as possible to quickly learn which are most effective to enable partners to refine and improve implementation efforts. The efficacy of each action likely will depend on site-specific factors like geomorphology, sediment supply, nature and degree of marsh degradation, and availability of dredged material.

Objective 3: Within one year of identifying priority marshes, communicate to landowners, including agencies and NGOs, the restoration/enhancement actions that are most promising for at least 50% of priority marshes.

Activity: Develop/publish guide that indicates most appropriate and promising restoration and enhancement actions to increase Saltmarsh Sparrow nesting success 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: Reach out to regulators to streamline regulatory approval of proposed restoration.
Activity: Offer landowners incentives for conservation action on their property.

Creating shallow channels, or "runnels," can reduce ponding and help restore natural hydrology in marsh systems with impaired drainage. Tanner Steves

Objective 4: Within 5 years of plan completion, create state or regional working groups focused on 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 the most promising techniques, share valuable lessons learned, and stimulate additional work in at least five high priority landscapes.

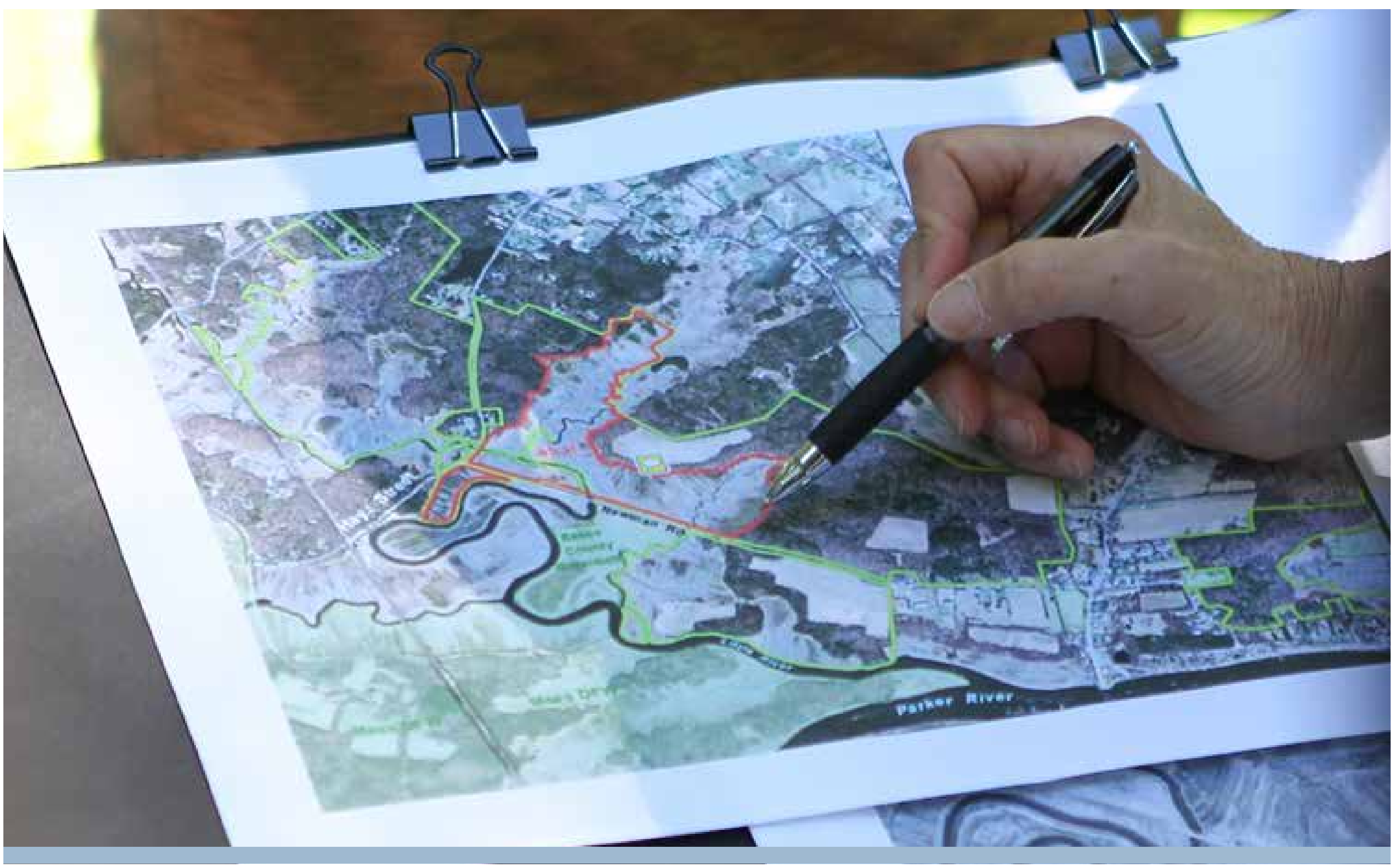
Activity: Use the publicly accessible ACJV Tracking Tool to house information on restoration projects throughout the ACJV.

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:

- Saltmarsh Sparrow nest densities and/or productivity is equal or similar to high-quality reference sites; and
- Saltmarsh Sparrows are breeding successfully on sites where they were absent; or
- Site has above-average value as non-breeding habitat for Saltmarsh Sparrow.

Activity: ACJV States, federal agencies, and conservation organizations include salt marsh restoration in their annual plans.

Activity: Private landowners in priority areas voluntarily enroll in cost-share programs for salt marsh restoration to benefit Saltmarsh Sparrow.



Identifying important marshes will help prioritize conservation efforts. Division of Ecological Restoration, MA Department of Fish & Game

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

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

What is needed to improve habitat differs by site, including how—and how much—its hydrology, topography, and/or elevation was altered by historic marsh modifications or other impacts. Depending on the site, one or more of the following actions is likely to improve habitat quality for Saltmarsh Sparrow, with additional details provided below:

- Remove tidal restrictions to restore tidal flow.
- Improve hydrology by remediating ditches, trunks, and dikes.
- Create runnels to improve drainage.
- Apply sediment to increase marsh elevation.
- Use living shorelines to reduce marsh loss or fragmentation.
- Use prescribed fire to improve habitat quality.
- Strategically control invasive plants.
- Strategically remove dams to improve downstream sediment flow.

Tools have been and continue to be developed to assess high marsh health and resiliency, indicate good candidate sites for restoration, and guide which techniques (e.g., digging runnels or providing additional sediment) are likely to be needed (Raposa et al. 2016; Ganju et al. 2017; Wasson et al. 2019). Restoration is likely to be most effective when carried out at sites where conditions such as sediment rates, tidal amplitude, erosion, and relative sea level rise indicate that the site is relatively resilient and likely to be around for decades to come. See Box 2, on page 52 for more about evaluating promising management actions.

Remove Tidal Restrictions to Restore Tidal Flow

Where tidal flow has been restricted, it limits or prevents salt marsh formation or processes. Salt marsh extent, integrity, and resilience can be restored or improved by removing or enlarging the restriction (e.g., replacing culverts with an open span or larger box culvert). However, many past efforts to restore tidal flow have resulted primarily in low marsh that did not benefit Saltmarsh Sparrow (Elphick et al. 2015). Therefore, preference should be given to sites with sufficient elevation to provide high marsh habitat after tidal flow is restored and should be planned carefully to avoid inundating areas where the marsh platform has been lowered. Tidal flow may need to be reintroduced gradually to provide an optimal depth for marsh grass production and accretion to avoid creating extensive areas of open water. Although restoring tidal flow can provide both short-term (e.g., increasing salinity to reduce *Phragmites*) and long-term (e.g., increasing sediment supply and marsh migration) benefits to marsh resiliency, careful consideration must be given to avoid unintended conversion of high marsh areas to low marsh (Hinkle & Mitsch 2005). See Box 2, below, for design considerations and more about evaluating promising management actions.

Improve Hydrology by Remediating Ditches, Trunks, and Dikes

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. Ditches, dikes, historic water control structures, and a legacy of Open Marsh Water Management (Riepe 2010) all can impede hydrology and degrade salt marshes, especially when compounded by 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 repeatedly cutting and raking salt hay into selected ditches

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

(Burdick et al. 2019) to trap sediment. This can increase sheetflow of tidal water across the marsh, which increases sediment capture and accretion of the marsh platform. Trunks or water control structures and dikes can be removed or breached to allow tidal flow, or replaced with tide gates to facilitate gradual reintroduction of tidal flow over time, which may be necessary to restore areas that have experienced subsidence.

Create Runnels to Improve Drainage

Where tidal marshes have impoundments from historic dikes or other infrastructure, or are frequently or excessively flooded due to impeded drainage, marsh 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 Sediment to Increase Marsh Elevation

Applying supplemental sediment, such as a thin layer of dredged material (e.g., spraying a slurry of water and sediment) to the marsh surface can increase or maintain the elevation of the marsh platform (Raposa et al. 2020). 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. 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). Practitioners have suggested that accretion rates may be improved by providing additional sediment into marshes in multiple ways, beyond spraying dredged material, such as by adding sediment slurry directly into tidal creeks. Providing supplemental sediment after a tidal restriction is removed could also help address the challenge of 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.

Thin layer deposition helps to raise marsh elevation and mitigate impacts of sea level rise. Dave Harp

Use Living Shorelines to Reduce Marsh Loss or Fragmentation

In some areas, erosion from waves or currents reduces the size and integrity of large salt marshes—including important high marshes—and fragments large marsh complexes into smaller, less resilient patches, accelerating the conversion of high marsh to low marsh and causing widespread marsh loss. Various approaches known as living shorelines (Davis et al. 2015), which include creating oyster reefs or rock sills that provide fish habitat, can reduce erosion and provide long-term benefits to the integrity of the salt marsh ecosystem. To benefit Saltmarsh Sparrow, living shorelines would need to target areas where substantial or high-quality high marsh habitat is at risk, because this practice has the potential to disrupt sediment dynamics. In some places, erosion of the marsh edge is thought to be the primary means of transporting sediment onto the high marsh platform and facilitating marsh migration into adjacent uplands. In other places, living shorelines have been effective at reducing erosion, capturing sediment, and increasing marsh extent (Davis et al. 2015).

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

Use Prescribed Fire to Improve Habitat Quality

Prescribed fire is used to control woody encroachment or invasive species to improve habitat quality, particularly from Maryland south. Prescribed fire can improve marsh resiliency (Cahoon et al. 2010) and benefit salt marsh birds (Kern and Shriver 2014), but those benefits may depend on seasonal timing, frequency, and intensity of burns. Although fires are a natural disturbance in salt marshes and one from which they can recover relatively quickly, salt marshes are not generally recognized as fire-dependent systems. Burning must be done carefully and according to BMPs, at the optimal time of year to obtain desired results. Sites that are known to be important should be partially burned over multiple years, to maintain some habitat in all years. Managers will also need to consider potential tradeoffs between short-term impacts that affect habitat availability (i.e., burned areas being unavailable as habitat) and increased nest depredation rates (Almario et al. 2009).

Strategically Control Invasive Plants

Invasive non-native plants (e.g., *Phragmites australis* or Perennial Pepperweed, *Lepedium latifoloium*) can dominate salt marsh habitat and prevent colonization of native marsh grasses in transition zones where marshes are migrating into upland areas (Reynolds and Boyer 2010). Invasive *Phragmites australis* covers approximately 256 square km of tidal marsh area from Maine to Virginia—nearly 10% of the total coastal marsh area (Correll et al. 2019). *Phragmites* control may be a necessary approach to habitat management and conservation where it is likely to result in quality high marsh habitat; however, such control should be done strategically.

Perennial Pepperweed is an invasive plant that is relatively new to the East Coast but poses a threat to salt marshes. Initially colonizing the upland marsh interface (i.e., the Iva zone), once established it can tolerate high salinity and frequent flooding. Untreated patches can cover entire marsh areas within 5-10 years, and spread 0.25 - 1 mile per year in tidal waters.

Strategic Control of *Phragmites australis*

Effective *Phragmites* control is often difficult, costly, and requires ongoing resource investments. Its use should always be carefully evaluated against other management options that may provide a better return on investment. Because *Phragmites* is relatively intolerant of salt water, it often can be effectively reduced or eliminated if full tidal flow is restored to tidally restricted areas. However, many tidally restricted areas may have experienced substantial subsidence over time (Portnoy and Giblin 1997); if so, immediately restoring tidal flow may result in open water, mud flats, or low marsh, as opposed to high marsh that would benefit Saltmarsh Sparrow. Therefore, restoring tidal flow should only be done to control *Phragmites* if site conditions indicate that some higher-elevation high marsh habitat is likely to result (Elphick et al. 2015).

Marsh migration zones are some of the best places to conduct strategic *Phragmites* control. Once established in these areas, *Phragmites* can dominate large areas and prevent the establishment and success of native salt marsh plants, preventing or limiting transgression of marsh into upland areas (Smith 2013). Control should focus on those areas that have above average resiliency according to the Saltmarsh Sparrow Habitat Prioritization Tool.

Phragmites can dominate marsh transition zones and prevent colonization of native marsh grasses. Chris Elphick

RESTORATION AND ENHANCEMENT: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

The species is now established on the North Shore of Massachusetts and colonizing Maine, New Hampshire, Connecticut, Rhode Island, and New York. Watershed-level treatment has effectively contained its spread and eradicated it from Great Marsh, Massachusetts. Hand-pulling by volunteers is effective and has the added benefit of effectively engaging the local community in salt marsh conservation. Early detection in newly colonized areas is crucial to preventing its spread. This species can also colonize roadsides so collaboration with local, state, and federal transportation agencies is important to address this threat.

Strategically Remove Dams to Improve Downstream Sediment Flow

In some areas, rivers are a major source of sediment that sustains the resiliency of downstream marshes. Therefore, strategic removal of certain dams in coastal rivers could increase sediment supply to priority marshes, which may be necessary to ensure that marsh accretion can keep pace with sea level rise. Although dozens of dam removals have occurred in recent years, there are few examples demonstrating direct benefits to salt marshes. This could be due to lack of research or because the focus of most dam removals has been on fish passage. Many such projects also have specifically avoided the removal of dams that would increase sediment loads which are often considered to reduce water quality for priority aquatic species (e.g., mussels).

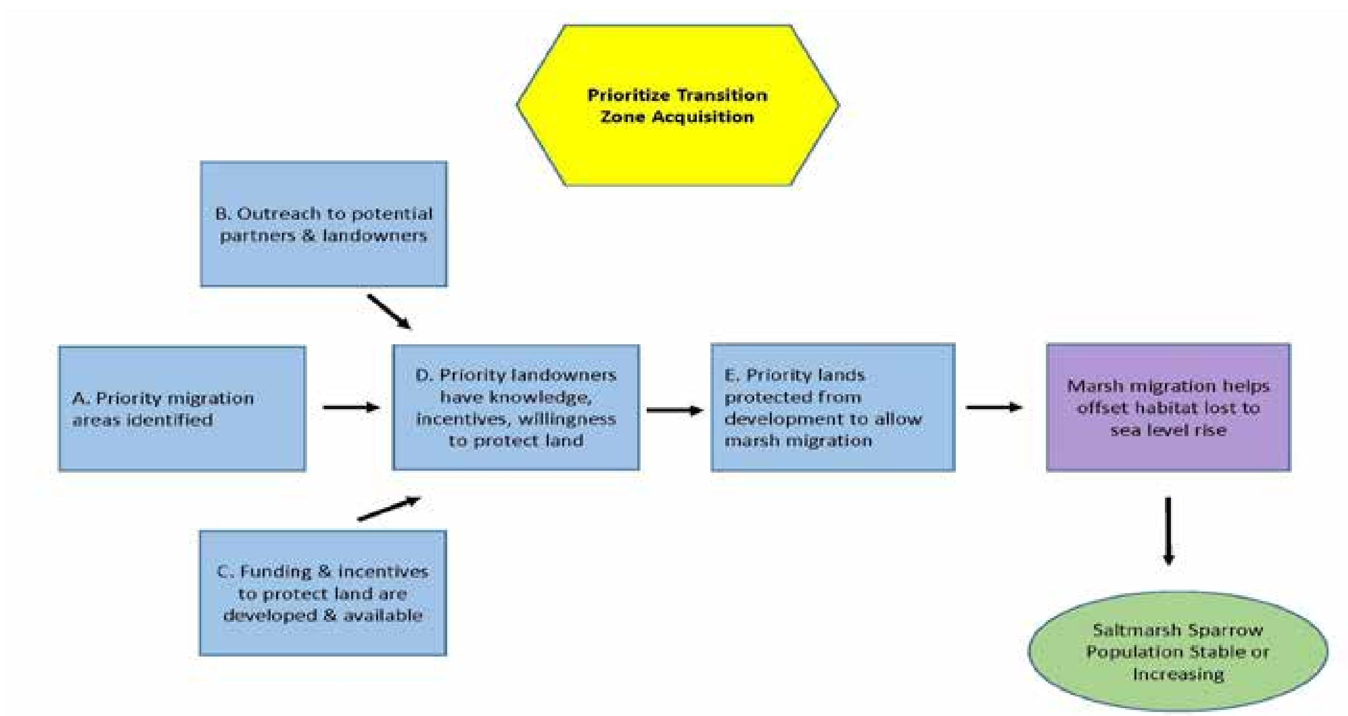
Rivers are a major source of sediment. Removing barriers like this one on the Goff Mill Brook in Maine allows sediment to flow into the Kennebunk River Estuary. The Wells Reserve

STRATEGY: PROTECT MARSH MIGRATION ZONES

There is both a short- and long-term need for land protection to conserve salt marsh habitat. Upland areas immediately adjacent to important salt marsh habitat patches are a priority for short-term protection, as buffers are important to maintain habitat quality (e.g., reduce disturbance, runoff, etc.) and marsh resiliency, and allow marshes to migrate inland in the future. Because a high proportion of salt marshes are already under conservation ownership and usually protected by statute, it is also important to invest in long-term land protection that is focused on inland marsh migration corridors, to ensure that areas most suitable for migration remain undeveloped.

Regional (Craft et al 2009) and global assessments of salt marsh loss due to sea level rise (McFadden et al. 2007) 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. However, this figure does not distinguish lower- from higher-elevation marsh and the overall percentage of high marsh replaced will likely be much lower. The process of marsh migration will take decades to achieve and may be hampered by the increasing rate of sea level rise, ongoing development, invasive species, or other challenges. Therefore, partners must act soon and maintain land protection efforts over time, to ensure that a sufficient quantity and quality of new high marsh habitat exists in the future to offset expected habitat losses. Given predicted future development, opportunities to protect large, unfragmented areas for marsh migration will become increasingly rare. Protection should focus on those areas most capable of supporting marsh migration and most likely to become large saltmarshes in the future. The priority marsh migration zones identified and mapped by The Nature Conservancy (Anderson and Barnett 2017) provide a roadmap to prioritize land protection under one- to six-foot sea level rise scenarios.

Strategy Logic



Strategy Description

Maintaining a sufficient supply of high-quality high marsh nesting and wintering habitat is necessary to stabilize and sustain (or recover) Saltmarsh Sparrow populations. This strategy involves prioritizing marsh migration areas (A), outreach to inform partners and landowners about the importance of these areas (B), and ensuring that there is sufficient funding for landowner incentives and to acquire priority areas in full fee or via conservation easements (C). Outreach and engagement with landowners in priority areas must be sufficient for many to be willing to sell or encumber their land (D), so that it is not developed or hardened and is available for marsh migration (E), to help offset salt marsh habitat loss due to sea level rise.

High quality salt marsh habitat is critical for Saltmarsh Sparrow population growth. Ray Hennessy/rayhennessy.com

> ***Objective 1***: By 2020, identify priority Saltmarsh Sparrow patches and adjacent lands suitable for marsh migration from Maine to Virginia, which are needed to meet Saltmarsh Sparrow population goals based on predicted future habitat loss.

> ***Objective 2a***: By 2020, identify funding sources to pursue to protect prioritized marsh migration habitat, in fee or easement, to meet Saltmarsh Sparrow 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.

Given the relatively continuous distribution of salt marshes along the coast, and the ability of Saltmarsh Sparrows to find available high-quality habitats, it was not considered important that marsh migration corridors be adjacent to areas that are currently important to Saltmarsh Sparrow populations. Although the process of marsh migration is expected to take decades, experts expect that Saltmarsh Sparrows will find and colonize it as it becomes available.

Buffer zone protection of areas adjacent to high quality Saltmarsh Sparrow habitat should also be prioritized. This reduces threats to salt marsh integrity including predators, disturbance, and flooding from impervious surfaces. Sites adjacent to high-quality high marsh that are known to be important or predicted to remain resilient should be priorities for protection.

STRATEGY: BUILD MARSH RESILIENCE THROUGH DREDGED MATERIAL

Low-pressure equipment, specially designed for work on soft ground like marshes and wetlands, was used to carefully place dredged soil on top of a marsh in Rhode Island. NOAA

The process of adding sediment to raise the elevation of the tidal marsh platform to maintain the plant community relative to sea level (Raposa et al. 2020) is called thin-layer deposition (TLD). TLD emulates the natural process of storm-driven deposits of large volumes (1 - 50 cm) of sediment on the marsh platform, with existing applications typically in the 10-20 cm range. Although sand, soil (e.g., from nearby berms), or other quarried material can all be used, most applications in tidal marshes have used dredged sediment from marine systems. The U.S. Army Corps of Engineers (USACE) regulates and coordinates dredging and maintenance of ~25,000 miles of harbors and navigational channels across the U.S. The 200 to 300 hundred million cubic yards of sediment dredged each year is a valuable resource that could be used to nourish beaches or raise the elevation of salt marsh platforms to increase resiliency to sea level rise or marsh subsidence. Some dredging occurs outside of federal navigation maintenance and may be led by entities other than USACE, such as state, local, and private water-dependent businesses, which presents additional opportunities to obtain dredged material. See Raposa et al. 2020 for concerns and considerations related to different source materials.

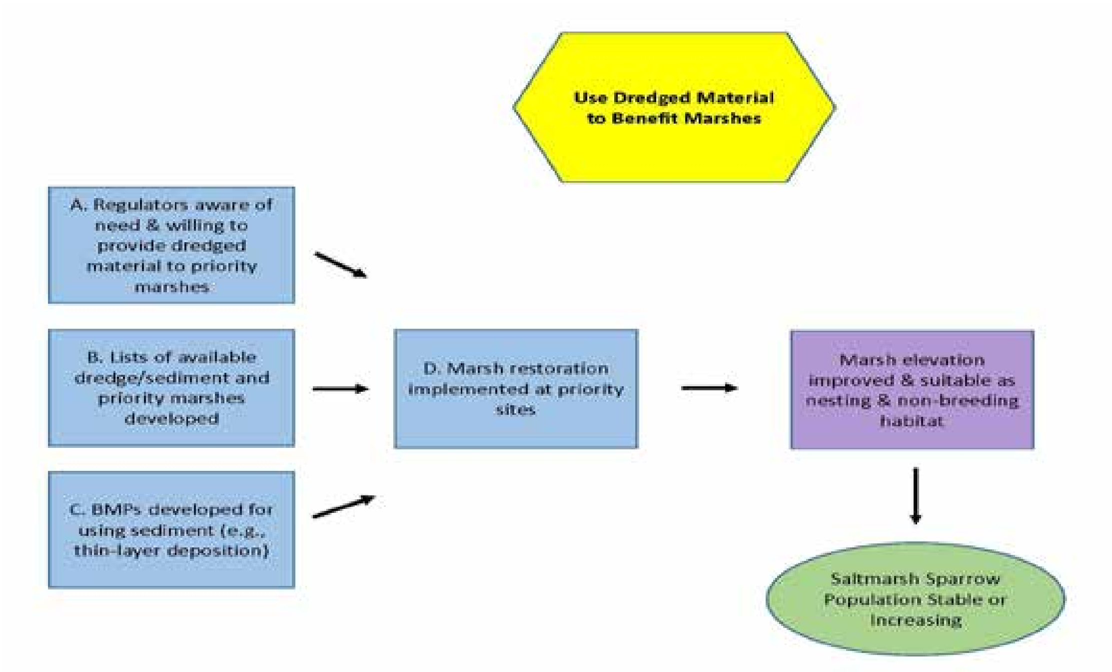
The USACE has the authority to use dredge material in environmentally beneficial ways (EPA 2020); however, more education on these new opportunities is needed, and new partnerships must be developed to implement projects that take full advantage of the beneficial use policy. Most dredge material originates from maintenance of existing federal navigation projects. Beneficial use opportunities near such dredging operations can be accomplished using federal operation and maintenance funding and 100% of the costs can be 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 entities. Partner leadership on beneficial use projects typically comes from economic development (e.g., ports) or environmental (e.g., non-profits, state agencies) communities or both.

The USACE has a pilot program and periodically requests proposals for beneficial use of dredge material projects that 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 for construction or fill material; civic improvement objectives; and other uses that produce public economic or environmental benefits.

See the box on page 35 regarding considerations for beneficial use of dredge.

Strategy Logic



Strategy Description

Using dredged material to restore, enhance, and/or sustain priority salt marshes requires that regulatory agencies, such as the USACE, be aware of the conservation needs and benefits and willing to make dredged material available for marsh conservation efforts (A). A practical step in this process is to develop and maintain publicly accessible lists or databases showing where dredge material may be available and where sediment is desired by conservation partners (B). BMPs need to be developed so that partners and practitioners understand the most effective ways to deposit sediment such as dredged material (C), and can implement marsh restoration efforts (D) using dredge or other sediment that is available. If marsh platform elevation and suitable high marsh habitat conditions can be improved and sustained in the breeding and non-breeding range, even in the face of future sea level rise, Saltmarsh Sparrow populations can be stabilized or recovered.

The following objectives will be necessary to ensure effective use of dredged material by partners:

> ***Objective 1***: By 2021, identify and map the sites where dredging activity is happening in proximity to priority Saltmarsh Sparrow habitat patches.
>
> > <u>Activity</u>: Assess elevation and potential for successful application of dredge at priority marshes in close proximity to dredge operations.
>
> ***Objective 2***: Within one year of identifying prioritized marshes near dredging, engage key partners (e.g., USACE, National Oceanographic and Atmospheric Administration (NOAA), Department of Transportation (DOT)/Port Authority and state Coastal Zone Management (CZM) offices) to ensure that regulators are aware of the priority salt marsh areas and consider thin-layer deposition as an option for disposal of dredge material.
>
> > <u>Activity</u>: Work with USACE at state and regional levels 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 thin-layer deposition to benefit Saltmarsh Sparrow.

Activity: Synthesize information from existing thin-layer deposition projects on how to apply dredge material to benefit Saltmarsh Sparrow.
Activity: Develop protocols 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 (NROC 2017) being used to improve the resiliency of salt marshes (see recent synthesis by Raposa et al. 2020), direct benefits to Saltmarsh Sparrow have not yet been observed due to the relatively recent implementation and small scale of existing projects. Where it is cost-effective, TLD is considered to be an important approach to maintaining coastal resiliency. Managers should be explicit about the goals of TLD projects, whether the purpose is to increase resiliency of the marsh (e.g., prevent, reduce, or eliminate drowning or waterlogging) or increase high marsh area. Although it may be possible to effectively use sediment to increase the area and/or resiliency of higher-elevation portions of the marsh and thus increase Saltmarsh Sparrow breeding success, placing sediment that is too thick has some risk of failure. Natural storm-driven deposits of sediment may provide a natural template for TLD. Such events are relatively uncommon, but when they occur they can provide large areas with relatively large amounts of sediment, which are rapidly revegetated (N. Pau, pers. comm.). Research and monitoring of such events can inform the design and implementation of TLD as a management tool

Steps for Considering Beneficial Use Options for New and Maintenance Dredging Projects: A General Approach*

- Initiate a collaborative effort involving USACE, Environmental Protection Agency, ports, federal/state/local agencies, environmental 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 the beneficial use project.
- Develop Project Cooperation Agreement with local sponsor.
- Design and implement the project.

The National Estuarine Research Reserve System has also developed resources and guidance on thin-layer sediment placement as a strategy to enhance tidal marsh resilience, including case studies, a literature review, guidance on the permitting process, and recommendations for monitoring indicators. https://www.nerra.org/reserves/science-tools/tlp/

**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*

Testing Promising Management Actions: Design Considerations

Determining the effectiveness of the promising management actions (listed on pages 27 & 40) in this plan requires adopting an adaptive management framework, with implementation efforts monitored and evaluated to determine the optimal conditions, efficacy, and relative costs of each. Confidence in those inferences will increase if 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 may be implemented by different partners, but ideally their efforts would be at least loosely coordinated and follow the same standardized monitoring protocols, such as those developed by SHARP; results should be available in a common database. In the Northeast, a central 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 them (tidalmarshbirds.org).

Note: the ACJV has developed an online tracking tool that catalogues protection, restoration, and enhancement efforts throughout the Saltmarsh Sparrow range since 2016.

STRATEGY: FACILITATE MARSH MIGRATION

Phragmites overtakes dead and dying loblolly pines at Blackwater National Wildlife Refuge where sea level rise has led to the conversion of forested land to marsh in the Chesapeake Bay region. Will Parson/Chesapeake Bay Program

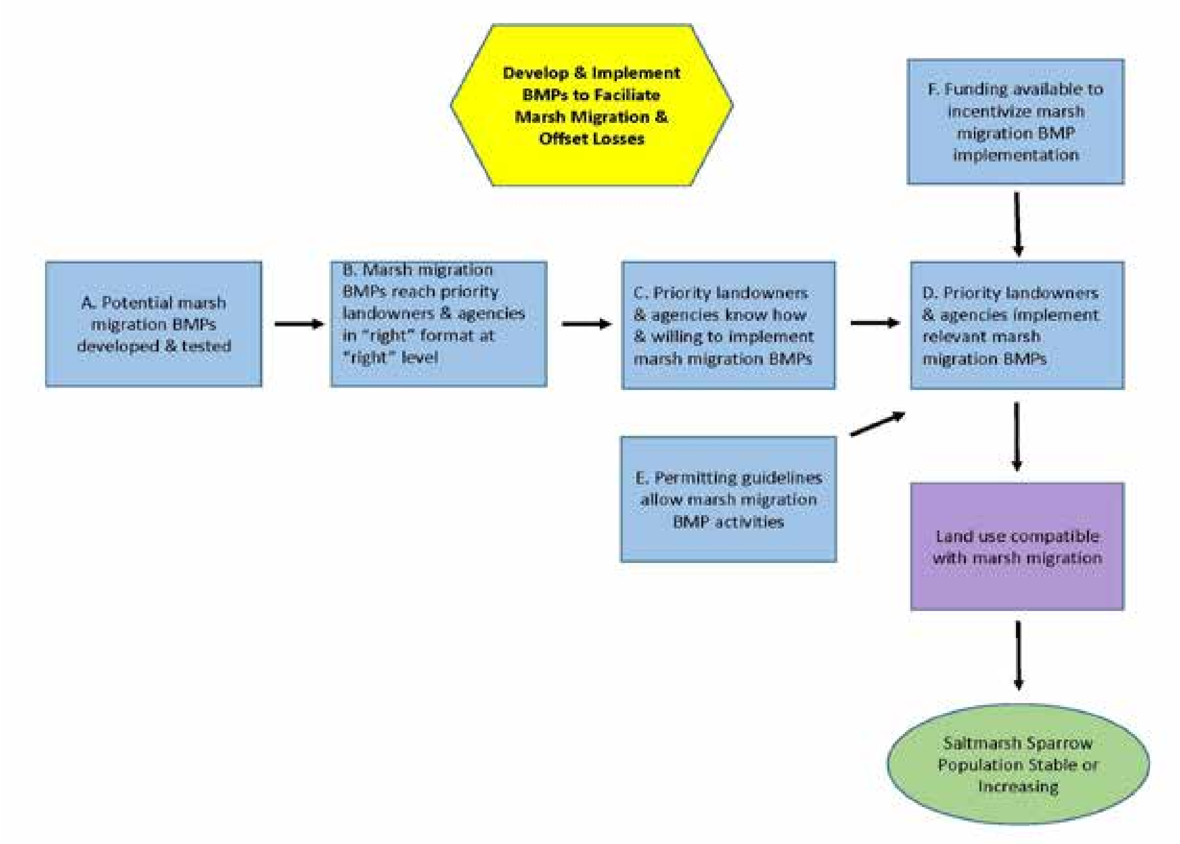
Protecting land in the marsh migration zone may not be sufficient to ensure the migration of enough marsh of the appropriate quality, needed by Saltmarsh Sparrow populations. Partners must also determine whether and how the marsh migration process can be facilitated by active management, to ensure that adequate habitat of suitable quality exists when it is needed.

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 (Field et al. 2016) presumably because of steeper slopes, like those in New England, lower rates of saltwater intrusion, or the occurrence of *Phragmites* (Smith 2013). Even where saltwater intrusion is occurring, uplands do not always convert to high marsh suitable for Saltmarsh Sparrow. Ghost forests of dead and dying trees persist for many years after high marsh vegetation has colonized the ground layer; because Saltmarsh Sparrows prefer large, open areas and avoid areas within 50 m of tall objects such as trees (Marshall et al. 2020), migrating marshes may not be usable habitat until and unless trees and snags are removed. Transitional zones are particularly vulnerable to *Phragmites* invasion (Smith 2013) because of their tendency to have lower salinity and partial shade; facilitating marsh migration may require dealing with or removing such invasives. In areas that have experienced subsidence or where hydrology has been modified, transition zones may become waterlogged and ultimately convert to open water (Schepers et al. 2016) instead of high marsh (Voss et al. 2012) .

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. More work must be done to understand how to facilitate this process where possible (Anisfeld et al. 2017) and to develop and implement BMPs for facilitation, to ensure that new marsh habitat includes adequate high marsh.

Facilitation techniques could include removing dead or dying trees to increase light penetration into forest understories or *Phragmites* control 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, the time scale required for the necessary plant communities to form, and the ability of Saltmarsh Sparrow to find and use new habitats, there is a pressing need to rapidly begin implementing a series of replicated pilot projects throughout the breeeding range to develop effective management methods that facilitate marsh migration. Implementation efforts should be evaluated in an adaptive management framework to enable robust assessment and rapid adoption of the most effective approaches.

Strategy Logic



Strategy Description

Underpinning this strategy is the need to develop and test BMPs for landowners and managers (A), in a practical format that they understand and find useful (B) so that they understand how to and are willing (C) to implement relevant BMPs that facilitate marsh migration in their area (D) in a cost effective way. Partners must work with regulatory agencies to ensure that BMPs will be allowed and/or permitted (E), and they must raise or allocate sufficient funding to implement the BMPs (F) and landowner incentives needed to ensure that sufficient high-quality high marsh habitat is allowed to migrate inland and offset losses due to sea level rise.

The following objectives will be necessary to achieve the goals of this strategy:

Objective 1a: 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 of properties 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 and state agencies, and conservation organizations include facilitated marsh migration in their annual plans.

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

To maximize benefits, partners should focus on landscapes that have relatively high potential for successful marsh migration into adjacent areas, such as:

- Above-average predicted marsh migration zones;
- Low extent and/or threat of development in migration zone;
- Already transitioning (e.g. developing ghost forests, crops affected by inundation); and
- Existing marsh with high probability of inundation by sea level rise.

Former loblolly pine habitat transitioning into native salt marsh habitat. Craig Watson/USFWS

FACILITATE MARSH MIGRATION PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

AT A GLANCE: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING FACILITATE 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.
- Contour (or terrace) adjacent slopes.
- Remove barriers impeding marsh migration.
- Transition fresh or brackish impoundments to salt marsh.
- Convert agricultural/open areas to marsh habitat.
- Extend tidal creeks in transition areas to reduce ponding.

See Box 2, on page 52 for more about evaluating promising management actions.

Remove Snags in "Ghost Forests"

In many areas of the Southeast and Mid-Atlantic, "ghost forests" have formed where rising seas and saltwater intrusion damages forested uplands. The remaining snags may deter Saltmarsh Sparrow colonization or use and/or increase nest predation rates by providing perches for avian predators. A recent study (Marshall et al. 2020) 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, suggesting 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 (Lerner et al. 2013).

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.

Contour (or Terrace) Adjacent Slopes

In some upland areas adjacent to salt marshes, which have a sufficient slope, it is likely that a relatively narrow, fringing marsh will migrate upslope over time. Because marsh width affects the ability to attenuate wave energy (Moller and Spencer 2002), narrow marshes may be more susceptible to erosion. Narrow marshes

Low lying agricultural fields such as this one, in Wicomico County, Maryland, can suffer from saltwater intrusion. By grading and creating channels, the lowest portions can be restored to tidal wetlands, which improves the resilience and productivity of higher portions. Tim McCabe/USDA NRCS

FACILITATE MARSH MIGRATION
PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

also have limited potential for accretion, or vertical marsh development, which is critical (Cahoon et al. 2018) for keeping pace with sea level rise. Accretion is driven by sediment supply (Ganju et al. 2017) and accumulation of organic matter—both above and below ground. Although sediment availability varies across sites, vegetation characteristics (e.g., density, growth rates) strongly influence both sediment capture and biomass production (Schile et al. 2014). Therefore, larger and wider marsh platforms are likely to have higher accretion rates and better prevent erosion (Shepard et al. 2011). Managers can grade or contour the upland slopes adjacent to salt marshes to create larger, wider platforms for migrating marshes rather than a continuous slope with a narrow fringing marsh. A broad, flat terrace (or a series of terrace steps) would result in a larger marsh platform as seas rise, which would be less prone to erosion and better able to buffer adjacent areas (e.g., agriculture fields) from saltwater intrusion. Because larger marsh areas have a greater capacity to trap sediment and accumulate biomass, they would be more likely to keep up with sea level rise. This terracing approach shifts marsh migration from a continuous process to a series of static periods, and has the potential to provide greater benefits for adjacent land uses, bird habitat quality, and marsh resiliency.

Restoration of low-elevation farmland to tidal marsh (i.e.,"managed realignment") can improve coastal resilience, provide valuable habitat for fish and wildlife, and offers many other public benefits. Vieira de Silva et al. (2014), used by permission of Elsevier

Remove Barriers Impeding Marsh Migration

Structures or topography that impede tidal hydrology (e.g., low berms, dikes, or undersized culverts) or the upland elevational continuum (e.g., sea walls or other shoreline hardening) have the potential to prevent or limit inland migration of tidal marshes. Removing or remediating the barrier allows for future marsh migration and may contribute to restoration or improvement of present salt marsh habitat. Barriers often impede hydrology, and are breached or removed for the purpose of restoring tidal flow, which is discussed on page 36, above.

Transition Fresh or Brackish Impoundments to Salt Marsh

Freshwater or brackish marshes, particularly managed wetlands or impoundments, that are adjacent to tidal areas can be restored or managed to facilitate their transition to salt marsh. Throughout the twentieth century, dikes or levees were constructed at many wildlife management areas or wildlife

FACILITATE MARSH MIGRATION
PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

refuges near the coast to create freshwater or brackish impoundments near or in tidal marshes. Water control structures enabled flooding and draining areas to create productive feeding and roosting habitat for migratory birds, particularly waterfowl (Strader and Stinson 2005). Water levels were managed to promote plants such as smartweed, millet, and redroot, which are nutritious and support diverse populations of invertebrates. As sea level has risen, maintaining coastal freshwater impoundments has become increasingly difficult and expensive and there has been greater consideration and interest in restoring or transitioning them to tidal marsh (Kane 2011). Many places in Europe where defenses against waves and tidal flow are now seen as unsustainable or impractical are being considered for "managed retreat" (Townend and Pethick 2002) or "managed realignment" (Boorman and Hazelden 2017).

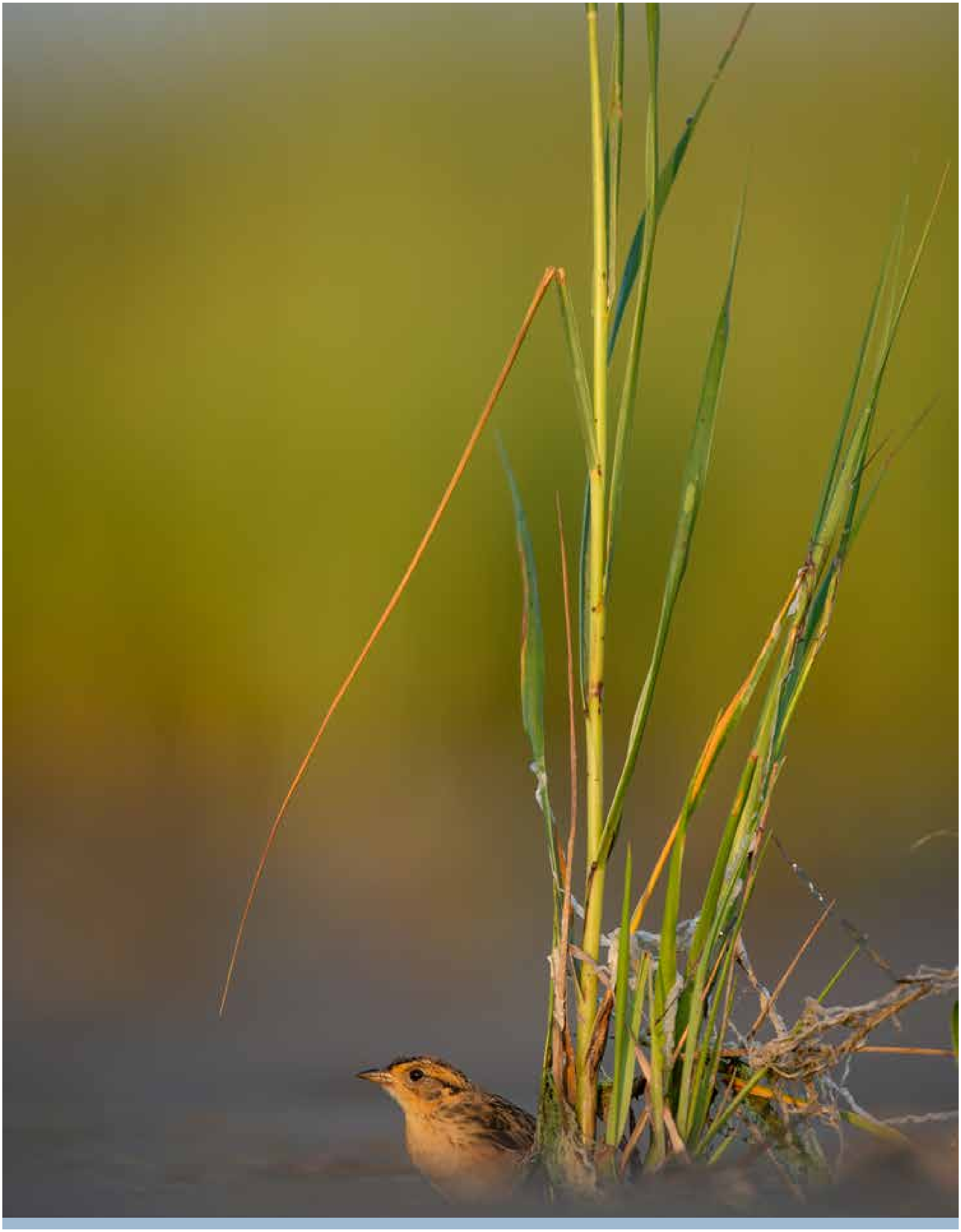
Convert agricultural/open areas to marsh habitat

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 fields adjacent to existing salt marshes. Such areas present opportunities as salinity and elevation conditions are already conducive to support marsh grass development, provided that invasive *Phragmites* is controlled. Improving the hydrology of such sites to facilitate tidal inundation may accelerate the marsh migration process and these open areas may also be occupied by Saltmarsh Sparrow faster than areas with ghost forests, which may have very slow rates of avian colonization (Taillie et al. 2019).

Extend tidal creeks in transition areas to reduce ponding

In former forested uplands, saltwater intrusion can jeopardize the persistence of newly established high marsh through root ball shrinkage and ground surface collapse associated with tree mortality. This results in shallow basin topography that becomes waterlogged where basins are isolated from the tidal creek network, leading to interior erosion of the high marsh vegetation (Lerner et al. 2013).

Audubon Maryland-DC has piloted the extension of tidal creeks into ponded areas to drain surface water and reinvigorate marsh vegetation at Farm Creek Marsh in Maryland. Dave Curson



Facilitating marsh migration will enable future habitat for Saltmarsh Sparrows, and is needed to to offset habitat loss due to sea level rise. Ray Hennessy/rayhennessy.com

Outreach & Engagement Strategies & Actions

Planting marsh grasses at Barren Island off the coast of Dorchester County, Maryland. Alicia Pimental/Chesapeake Bay Program

STRATEGIES FOR OUTREACH & ENGAGEMENT

Outreach and engagement with a host of stakeholders is necessary to overcome many significant barriers to successful implementation of Saltmarsh Sparrow conservation. Ongoing threats from development and transportation infrastructure must be reduced or reversed by improving land-use planning and transportation policies and practices. Priority landowners must be engaged to implement practices that benefit Saltmarsh Sparrow. Outreach and engagement with key agency partners, such as the U.S. Department of Agriculture (USDA) NRCS, USFWS National Wildlife Refuge System, DOT at all levels (federal, state, county, and local), USACE, and Federal Emergency Management Agency (FEMA), will be critical to achieving the objectives laid out in this plan. Likewise, partners must increase engagement with agencies such as the NOAA, state CZM offices, the National Estuarine Research Reserve 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.

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

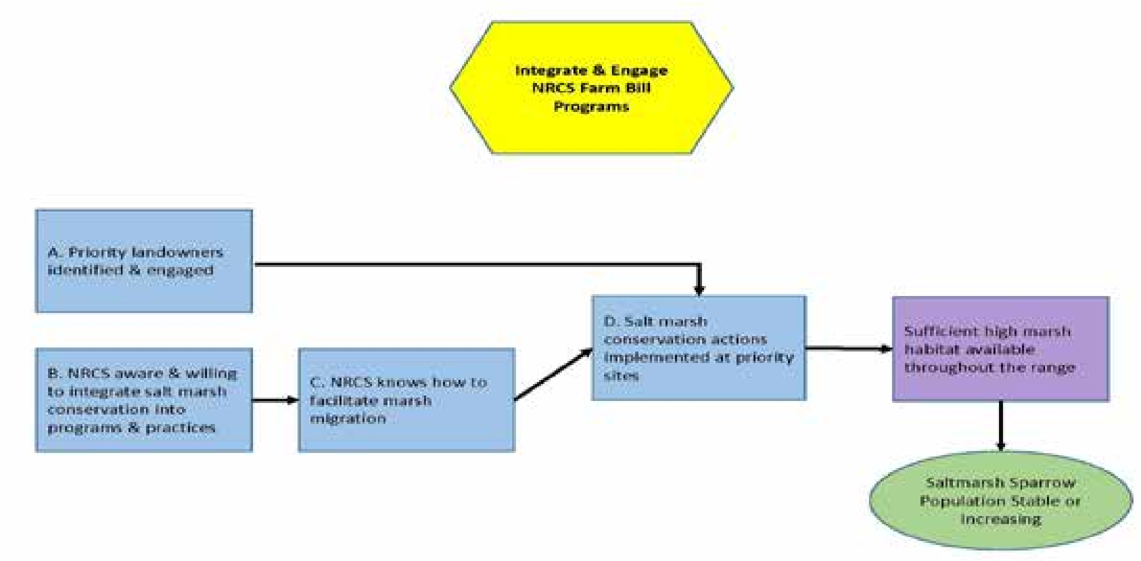
High priority Saltmarsh Sparrow habitat patches, marsh migration zones, and upland buffers occur on tens of thousands of acres of privately owned land. These lands require substantial financial resources for protection, restoration, enhancement, and/or management to create and maintain the quantity and quality of salt marsh habitats needed to reach Saltmarsh Sparrow 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 Farm Bill programs cover both conservation easements and restoration activities on lands with a history of agriculture. Many salt marshes and adjacent areas have a long history of agricultural use for salt hay farming, grazing, and crop production. These areas are therefore eligible for easement enrollment and financial assistance offered through Farm Bill programs. The Wetland Reserve Easement program, for example, can protect wetlands and some associated uplands from development via conservation easements, and pay the full cost of salt marsh restoration activities.

NRCS Conservation easement on private property in Princess Anne County, Maryland. Natural Resources Conservation Service

Many Farm Bill conservation programs have great potential to benefit salt marshes, which is limited only by partners' awareness and capacity to engage with NRCS. Effectively leveraging some of the many millions of dollars of Farm Bill funding for salt marsh conservation projects will require additional partner and staff capacity. NRCS program staff often do not have the capacity to develop new outreach efforts or tailor their programs to every conservation threat, such as the relatively novel threat of sea level rise on Saltmarsh Sparrow 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 and improve the resiliency of existing Saltmarsh Sparrow 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 Saltmarsh Sparrow populations, discuss the immediate need for salt marsh habitat conservation, and work with each office to develop effective practices and programs to address salt marsh conservation in their areas. In particular, NRCS and landowners need tools to better evaluate options and encourage efforts 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 develop and conduct outreach efforts, and incentive programs to attract landowners of high priority salt marsh habitat or in marsh migration zones.

Strategy Logic



Strategy Description

This strategy involves identifying and engaging priority landowners (A) in areas adjacent to existing salt marshes and in priority marsh migration zones. NRCS offices at all levels must be engaged so that they understand the conservation needs and are willing to work with partners to ensure that Farm Bill programs and practices conserve salt marshes (B). This includes an awareness and understanding of BMPs to facilitate marsh migration (C), so that the most effective conservation approaches can be implemented at priority sites (D), including land protection in marsh migration zones and buffers; salt marsh restoration degraded by agricultural activities; and facilitating marsh migration into inland areas. This will help ensure that sufficient high quality high marsh breeding and non-breeding habitat is available in the future to stabilize and recover Saltmarsh Sparrow populations.

The following objectives will be necessary to effectively leverage this tremendous resource for Saltmarsh Sparrow habitat conservation:

Objective 1: By 2022, ensure that all coastal state NRCS programs have been engaged by partners and recognize the important role that Farm Bill programs can play in Saltmarsh Sparrow 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 Saltmarsh Sparrow conservation, and discuss the shared goals, opportunities, and specific roles for Farm Bill programs in Saltmarsh Sparrow conservation.

Objective 2: By 2025, ensure that all state NRCS offices have developed a portfolio of practices and scoring criteria to address conservation of key salt marsh habitat patches and marsh migration corridors as part of effectively designed landowner incentive programs.

Objective 3: By 2026, 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 Saltmarsh Sparrow through existing (e.g., Regional Conservation Partnership Program) or future (e.g,. Working Lands for Wildlife) program opportunities.

Activity: Secure resources or commitments for designing incentive programs and outreach capacity to engage private landowners and facilitate enrollment in Farm Bill programs, in more than half of the states in the Saltmarsh Sparrow range (i.e., Maine to Virginia).

To maximize benefit to Saltmarsh Sparrow partners should focus on those areas that:

- are relatively important to Saltmarsh Sparrow currently;
- have a history of agricultural modifications, which restoration could address; and
- are currently agricultural areas, with high potential as a marsh migration corridor.

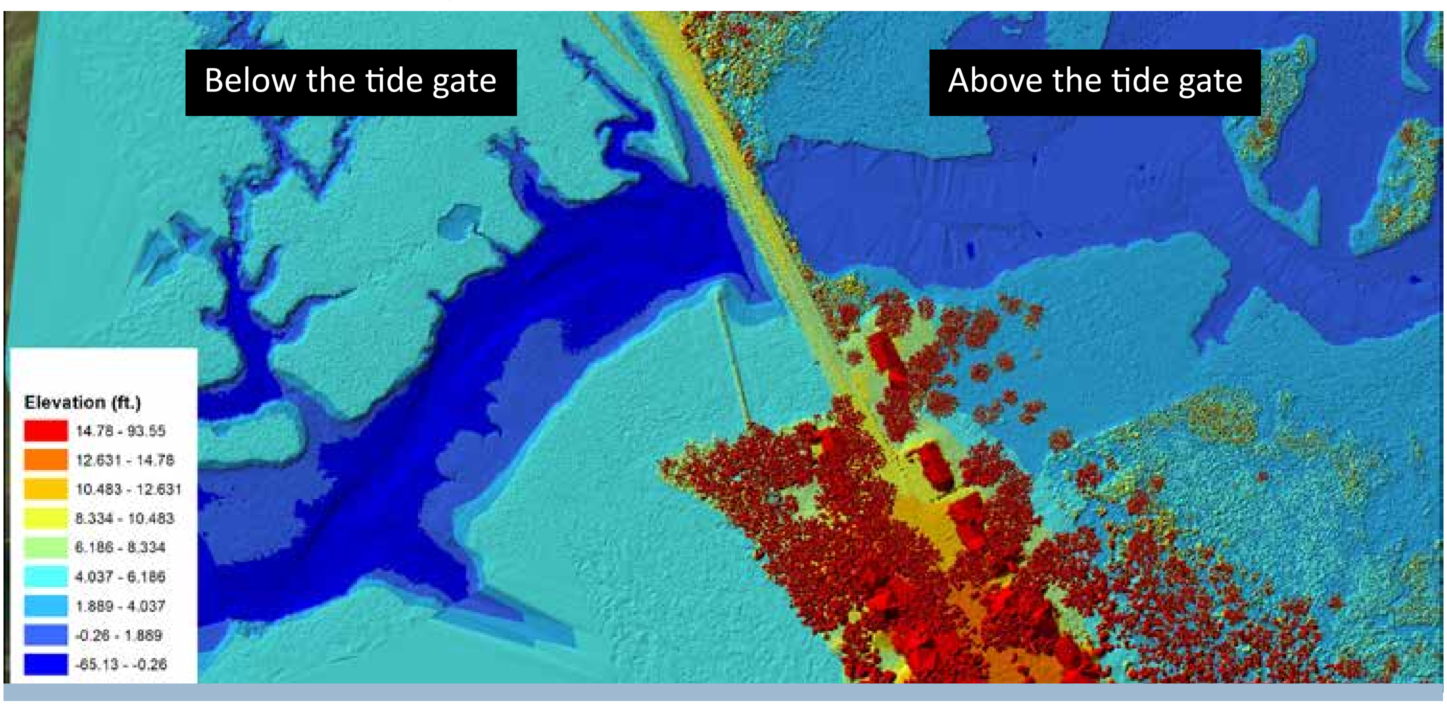
Creating living shorelines in the Chesapeake Bay Watershed. Bob Nichols/Natural Resources Conservation Service

STRATEGY: ENGAGE TRANSPORTATION AGENCIES TO IMPROVE INFRASTRUCTURE

Transportation infrastructure, such as roads, railways, and bridges, has historically been and continues to be a major source of tidal wetland loss and degradation. The construction of roadways and train tracks often involves earthen embankments that function as dikes, which can dramatically affect wetland hydrology. Roads also facilitate the spread of invasive species that are detrimental to salt marshes. DOT staff at the local, state, and federal levels (e.g., Federal Highway Administration (FHA), Federal Railroad Administration, Federal Aviation Administration) must be engaged in implementation efforts to ensure that existing and future transportation infrastructure is compatible with Saltmarsh Sparrow conservation goals.

The goal is to have "marsh smart" transportation infrastructure in all tidal marsh 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. Marsh smart practices must be incorporated into the design and construction of all new transportation infrastructure as soon as possible, as well as major repairs or updates that can improve old or existing infrastructure in tidal areas. Appropriate planning can also ensure that new infrastructure avoids sensitive areas so as to not fragment or degrade tidal marshes or marsh processes.

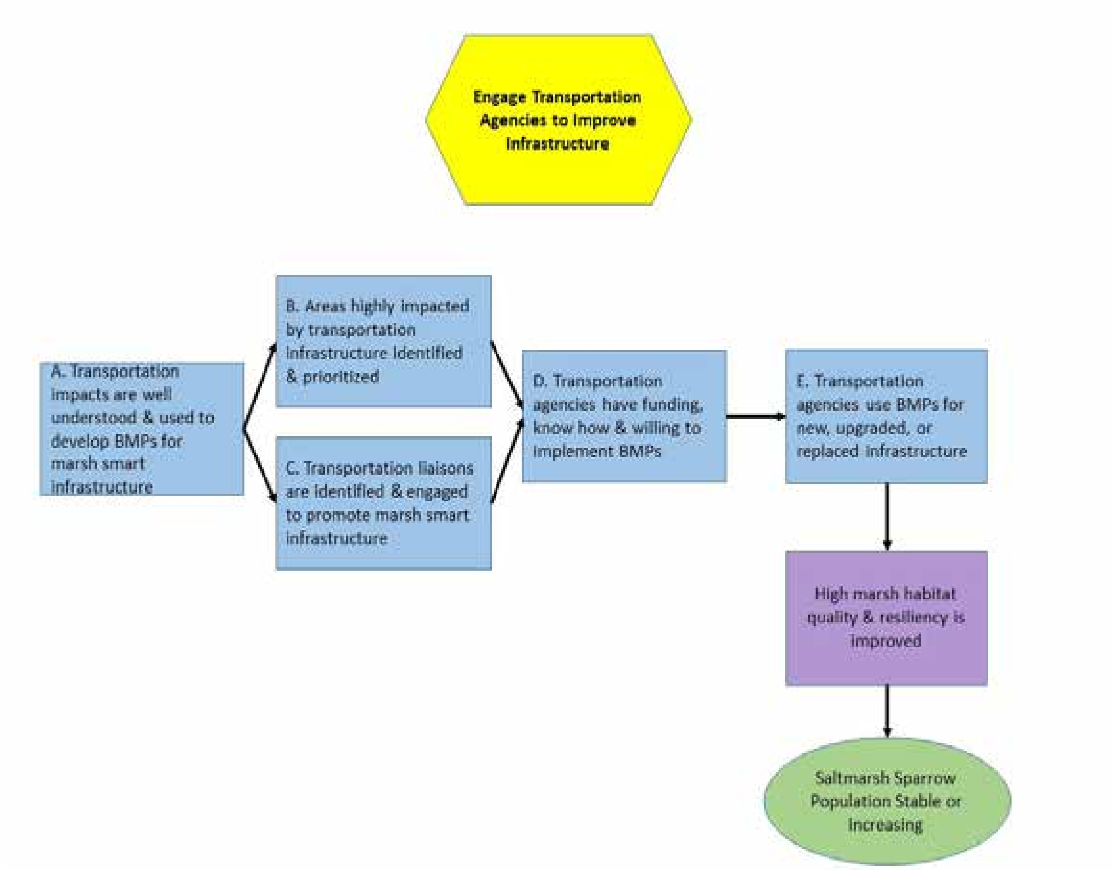
Fortunately, there is great potential to find common ground with DOT agencies and design projects that meet conservation and transportation needs. Transportation infrastructure is threatened by sea level rise (Almeida and Mostafavi, 2016) just as tidal marsh habitats are. Roads and bridges are becoming flooded and damaged more frequently and severely and maintenance costs are increasing rapidly in some tidal areas. Climate change is projected to increase the annual costs of keeping roads in service by $785 million by 2050 (Chinowski et al. 2013). Many examples of marsh smart transportation (Almeida and Mostafavi, 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 Many of the potential fixes will benefit the functionality and increase the resilience of both transportation infrastructure and salt marsh ecosystems.



LiDAR image showing marsh elevation on either side of a tidal restriction (in yellow). Restricting tidal flow and sediment inputs can lead to several feet of subsidence and over time, high marsh loss or degradation. Although nests above a restriction may benefit from dampened tidal flooding, they may be more susceptible to flooding due to rain events that cannot drain rapidly. USFWS

The DOT's FHA 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 provides important guidance to partners to make transportation infrastructure more compatible with salt marsh conservation. Nature-based solutions such as created marshes have been effective at protecting some coastal transportation infrastructure for decades, providing increased habitat value in the process.

Strategy Logic



Strategy Description

Underpinning this strategy is a sufficient understanding of how transportation infrastructure affects salt marsh structure and function, and the development of BMPs to promote the installation, replacement, and improvement of transportation infrastructure (A) to ensure that it is marsh smart and results in improved high marsh habitat quality, compared to past practices. Partners need to identify and prioritize sites where the transportation infrastructure, if remediated or addressed, can have the greatest benefit to Saltmarsh Sparrows (B). Existing, and perhaps additional transportation liaisons, with the capacity to promote marsh smart infrastructure, need to be identified and engaged (C). Outreach efforts must ensure that transportation agencies and/or conservation partners have sufficient knowledge, willingness, and funding to implement BMPs (D), so that future infrastructure, upgrades, and replacements at key sites can be marsh smart (E). This will help ensure that sufficient high quality high marsh breeding and non-breeding habitat is available in the future, to stabilize and recover Saltmarsh Sparrow populations.

Objective 1: By 2022, identify and map existing roads and bridges of greatest concern for priority Saltmarsh Sparrow habitats.

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 Saltmarsh Sparrow conservation related to transportation infrastructure, that can be conveyed to DOT.

Objective 2: By 2022, work with relevant DOT agencies, federal landowners, and other regulatory agencies to synthesize and distribute existing marsh smart transportation guidelines that 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: Provide state and federal DOT staff in each state or subregion with a presentation of guidelines and/or other outreach materials and discuss the impacts of transportation infrastructure on Saltmarsh Sparrow and the specific role of transportation agencies in addressing conservation needs.

"Marsh smart" practices are those that support healthy tidal marsh structure and function such as replacing undersized culverts. Wells National Estuarine Research Reserve

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

Transportation infrastructure is not considered as big of a threat in the more extensive salt marsh patches in the southern portion of the Saltmarsh Sparrow breeding range, which hosts the bulk of the Saltmarsh Sparrow populations. In some areas that are locally important for Saltmarsh Sparrow, such as in New England, road-related issues and repairs arise frequently due to damages from coastal flooding. Each road repair represents an opportunity to improve tidal flow and/or resiliency and could have important implications for Saltmarsh Sparrows.

STRATEGY: ENGAGE/IMPROVE LOCAL LAND-USE PLANNING PROCESS

County planners meets with partners to conduct a structured decision making workshop to help identify habitat and working landscapes that are most important to protect and restore on the Delmarva Peninsula. Genevieve LaRouche/USFWS

Municipalities and organized governments at the local, regional, and state levels all play a major role in tidal marsh conservation. Local governments typically determine zoning, which dictates what kind of development is allowed where. They also own and manage many roads and culverts that may be negatively affecting particular salt marshes. All levels of government, including local, state, and federal, also regulate other activities that impact wetlands in positive or negative ways. Government agencies often determine and facilitate appropriate conservation activities and engage directly in conservation efforts. They are major partners in wetland conservation as they can initiate, facilitate, regulate, and prohibit conservation work by other partners. Local and state governments need to fully understand the economic benefits and societal importance of salt marshes, and the range of options for nature-based solutions to challenging issues they face. When they do, they are more likely to consider the ramifications of predicted sea level rise and the relative costs and benefits of short-term fixes versus longer-term solutions that involve improving coastal resiliency.

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 that cause short-term damage can ultimately result in improved long-term function. For instance thin-layer deposition may harm some vegetation but improves long-term resiliency. Often, however, these novel projects encounter challenges during the permit process (Ulibarri et al. 2017), causing delays, inefficiencies, or outright denials that drive up costs and impede project benefits.

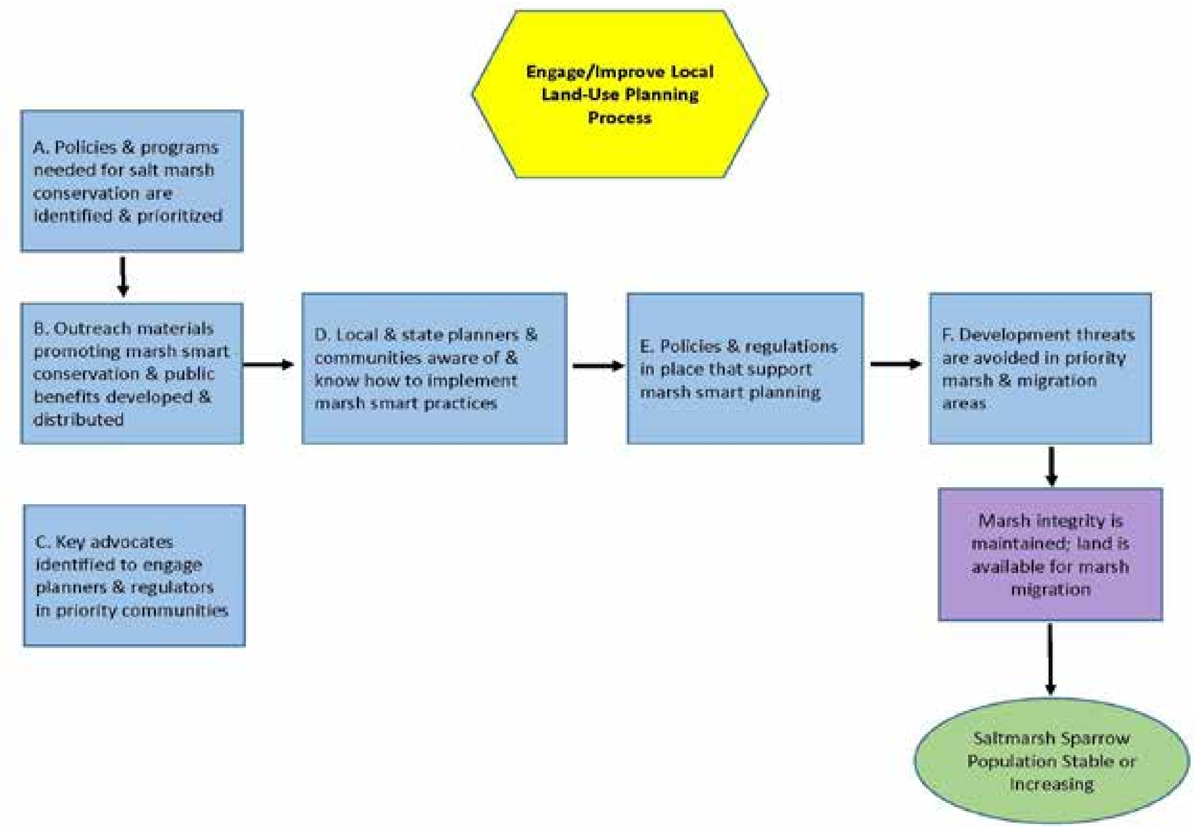
Wetland protection policies should not serve as a barrier to conserving wetlands facing new and existential threats. Projects that include collaboration—meeting early and often with regulators—tend to move more efficiently through the permitting process (Ulibarri et al. 2017). As a longer term goal, 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 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 from permitting if they follow established guidelines and notify regulators. This can begin with federal 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 Saltmarsh Sparrow 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.

Strategy Logic



Strategy Description

Improving local land-use planning and minimizing regulatory obstacles to salt marsh conservation involves first identifying and prioritizing the policies and programs that are most important for salt marsh conservation partners (A), then developing outreach materials and efforts to promote marsh smart conservation actions and policies (B), and identifying partners in priority communities who can be advocates to engage planners and regulators (C). If state and local community planners are aware of and know how to implement marsh smart policies and practices, then (D) policies and regulations can be put in place (E) that support healthy and resilient salt marsh ecosystems and discourage or prohibit practices that are detrimental to them (e.g., encouraging living shorelines instead of armoring). Policies and regulations that minimize development and degradation in key salt marsh and marsh migration areas (F) will sustain marsh integrity, and help maintain sufficient high-quality high marsh to support a stable or growing Saltmarsh Sparrow population.

The following objectives are needed to achieve regulatory and land-use planning goals:

> ***Objective 1a***: By 2021, identify wetland laws or policies in each state that are creating barriers to Saltmarsh Sparrow 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 2. Engage permitting authorities to understand the impacts of proposed activities to marsh processes at larger scales and the extent of research and monitoring needed to successfully permit projects.

Activity: Develop a report summarizing ideal nest conditions and recommended management actions for Saltmarsh Sparrow

Activity: Reach out to 100% of permitting authorities in priority areas by phone or in person to discuss Saltmarsh Sparrow-related implementation.

Objective 3a: 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 Saltmarsh Sparrow conservation.

Objective 3b: 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 Saltmarsh Sparrow.

Activity: Develop and provide materials that promote Saltmarsh Sparrow 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 4: 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.

Activity: Develop and provide materials that describe suitable Saltmarsh Sparrow habitat and how to create that habitat.

Sea level rise is impacting both human and animal communities on Maryland's Lower Eastern Shore. By building marsh elevation through the application of dredge materials, we can restore habitat for Saltmarsh Sparrow and support the sustainability of isolated coastal communities. Gwen Brewer

Enhance Saltmarsh Sparrow Populations Strategies & Actions

Saltmarsh Sparrow nestlings. Suzanne Paton/USFWS

STRATEGIES TO IMPROVE POPULATIONS

In addition to the seven strategies above, from the Salt Marsh Bird Conservation Plan (ACJV 2019), the ACJV Saltmarsh Sparrow Working Group developed five additional strategies specific to Saltmarsh Sparrow conservation needs.

- Where appropriate, use self-regulated tide gates to dampen extreme tides or storm surge during breeding to improve nest success.
- Create areas of increased elevation (i.e., microtopography) to provide areas on the marsh platform that may offer flood-free nesting habitat.
- Control predators, especially where most nests are lost to depredation.
- Develop techniques that can be used to protect individual nests if needed.
- Address knowledge gaps needed to guide conservation during the non-breeding season (i.e., the winter range).

The first four strategies relate to enhancing or sustaining Saltmarsh Sparrow breeding populations; the fifth focuses on understanding the relative importance of conservation needs during the non-breeding season.

Although these are considered to be the most important and widely-applicable strategies to enhance the global Saltmarsh Sparrow population, additional approaches that may be useful in certain situations should also be explored and evaluated. For example, given the apparent avoidance by Saltmarsh Sparrow of habitat within 50 m of tall objects such as trees (Marshall et al. 2020), small patches of high marsh surrounded by mature forest may benefit from tree removal around the perimeter. A more open buffer of grass or shrubs may increase the occupancy and/or density at small salt marsh patches, assuming it doesn't increase levels of human disturbance (e.g., car traffic).

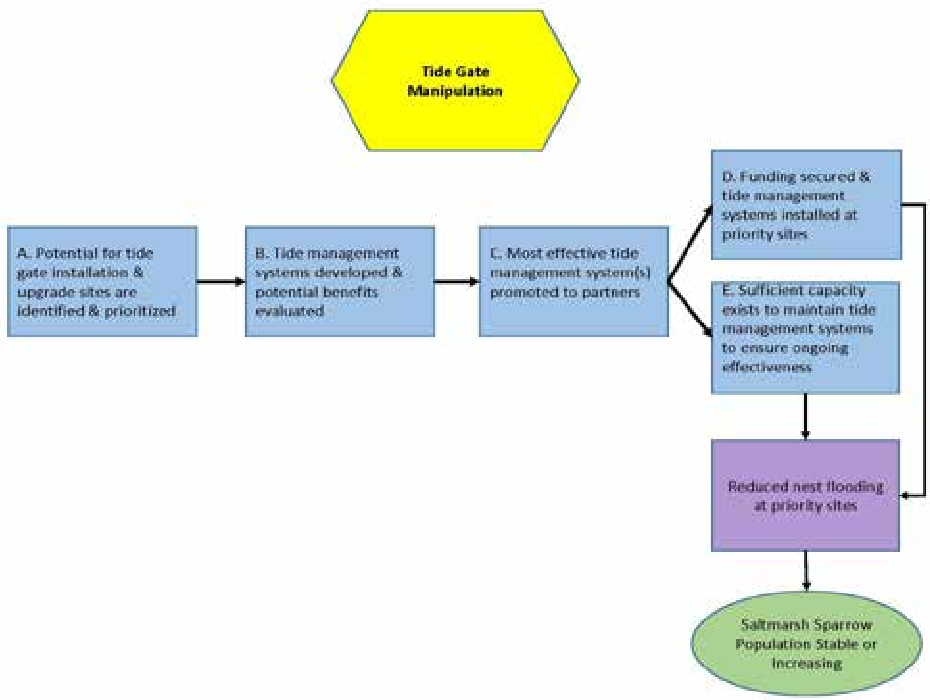
STRATEGY: TIDE GATE MANIPULATION

In much of the Saltmarsh Sparrow breeding range, most nest losses are due to flooding from spring tides, king tides, storm surge, and unusually intense rain events that occur during the nesting season. Nest losses could be reduced, or possibly eliminated, if the tidal amplitude at a site could be kept within a certain range, and excessive flooding could be prevented (i.e., tides don't exceed average nest height) in high marsh nesting areas throughout the breeding season. One way to manage tidal amplitude in areas that have previously been diked, or have existing tidal restrictions, is to strategically install and manage tide gates. Self-regulating tide gates are designed to allow managers to maintain a specific tidal amplitude upstream of the gate, and prevent or dampen storm surge or extreme tides from reaching those areas. Self-regulating tide gates are most often installed in diked salt marshes that are close to human development, to prevent property damage from flooding. Installing self-regulated tide gates in diked marshes can provide an opportunity to manage tidal flow specifically to benefit Saltmarsh Sparrow breeding populations by minimizing nest flooding upstream of the tide gates. Similar protection from flooding can also be obtained without self-regulating tide gates in some cases. If tidal flow is being restored or improved by expanding an opening (e.g., a culvert, bridge, or tide gate) in a dike or levee, it can be designed in such a way to accommodate normal daily tidal flow (i.e., the average tidal prism) but insufficient to allow extreme tides or any flooding that exceeds the normal range, which would prevent or dampen flooding of nests above the restriction. When planning and designing projects to improve or restore tidal flow to a marsh that is diked or otherwise tidally-restricted, managers should consider possible opportunities to reduce nest flooding upstream, and balance them with other (possibly contradictory) factors, such as accommodating future sea level rise, and properly draining marsh flooding from heavy rains or upland runoff.

Using self-regulating tide gates to improve reproductive success at particular sites may provide an important stop gap measure that helps to sustain populations in the short term, and "buy time" while other, longer-term management practices are being put in place and/or maturing into favorable conditions elsewhere. However, it is important to note that preventing full tidal flow to any portion of a salt marsh over long periods of time may limit the supply of sediment to parts of the marsh, which may be needed for long-term resiliency. If tide gates are managed to benefit Saltmarsh Sparrows, tides should be dampened only during the breeding season (May to August) to minimize negative long-term impacts to the salt marsh. If tide gates can remain open (and allow full tidal flow) throughout the rest of the year, accretion and natural processes would be normal most of the time, and may not significantly reduce the annual sediment supply or the rate of migration of marshes into adjacent uplands.

NOTE: This strategy is not suggesting that new berms or water control structures be constructed in unrestricted tidal marshes. Rather, it is intended for salt marshes that have existing or remnant infrastructure that could be modified with self-regulating tide gates or other methods to reduce nest flooding. Where implemented, tide gate modifications will require ongoing monitoring and adjustments. Taking a "set it and forget it" approach is strongly discouraged because many tide gates require regular and active management in order to avoid unintended and adverse effects on salt marshes or Saltmarsh Sparrow populations. For example, gates may need to be opened to deal with large rainfall events or storm surges that could result in trapped floodwaters above the restriction, which could inundate nests.

Strategy Logic



Strategy Description

This strategy involves partners evaluating and prioritizing sites with tidal restrictions for potential tide gate management or upgrades that could benefit breeding Saltmarsh Sparrow (A); if sufficient population benefits are possible, appropriate tide management systems are developed, used, and evaluated at a set of sites (B) to understand the magnitude of benefits. The most beneficial management approaches are promoted to partners (C) who then must raise or allocate sufficient funding to put tide management systems in place at high priority sites (D). Because tide management systems require ongoing maintenance and management, and can negatively affect habitat conditions at sites that are not appropriately managed, it is essential for partners to maintain sufficient capacity to ensure that they are continuously and effectively managed (E) to benefit marsh resiliency and avian productivity, by allowing full tidal flow throughout most of the year, but reducing nest flooding during the breeding season.

Objective 1: By 2020, evaluate the potential benefits, identify potential sites, and prioritize sites for tide gate modification.

Activity: Evaluate potential Saltmarsh Sparrow population benefits from tide gates (Spring 2020).

Activity: Prioritize identified sites based on potential Saltmarsh Sparrow benefits, land ownership, and capacity for ongoing management, by December, 2020.

Activity: Identify landowner(s) and potential partners for implementation at each identified site, by December 2021.

Water control structure from Prime Hook National Wildlife Refuge helps to manage flooding of saltmarsh habitat important for sparrows. USFWS

If Objective 1 results in a clear benefit to sparrow populations, then the inventory of sites with existing infrastructure in place would be used for the following subsequent objectives and activities:

Objective 2: Develop and evaluate tide management systems by 2024.

Activity: Install/modify/upgrade tide management system (e.g., self-regulating tide gates) in appropriate places, at a minimum of 5 sites/treatment/region.

Activity: Assess effectiveness of tide management systems; develop monitoring protocol and determine a threshold or desirable population response (e.g., stable or growing population).

Activity: Develop BMPs and guidance document for land managers.

The goal of implementing each tide gate management action at five sites per region is based on the desire to have a sufficiently robust experimental design to evaluate the efficacy of management. More than five replicates is preferred, but may be unrealistic in the short-term. That number is not based on a power analysis, as data on the variability among sites are lacking.

Objective 3: Within one year of determining the most effective tide management system(s), promote effective systems to partners.

Activity: Conduct outreach to owners/managers of all priority breeding sites.

Objective 4: Identify and promote funding sources to implement tide management systems.

Objective 5: Ensure that tide management systems are installed and managed to support stable or increasing Saltmarsh Sparrow population at 50% of prioritized sites (or acres), or that support 25% of the global Saltmarsh Sparrow population by 2027.

Activity: Distribute guidance (e.g., BMPs) to partners on tide management system considerations for installation and ongoing management by 2024.

Objective 6: Ensure sufficient capacity to manage all existing tide management systems to ensure regular and ongoing effectiveness and 10-yr monitoring of accretion rates behind tide gates.

Activity: Compile an inventory of sites with tide management system(s) in place, which require ongoing management.

New research from the University of Connecticut can help managers identify the most important places to consider tide gate manipulation to have the greatest population impact on Saltmarsh Sparrow.

Note: This strategy may not provide long-term benefits at all sites; for example, the height of the dike infrastructure may not be high enough to prevent it from being overtopped in the future as sea level rises.

Self-regulating tide gates were installed during restoration efforts at Galilee Salt Marsh, Rhode Island. Waterman Valve LLC/ watermanusa.com

STRATEGY: PREDATOR MANAGEMENT

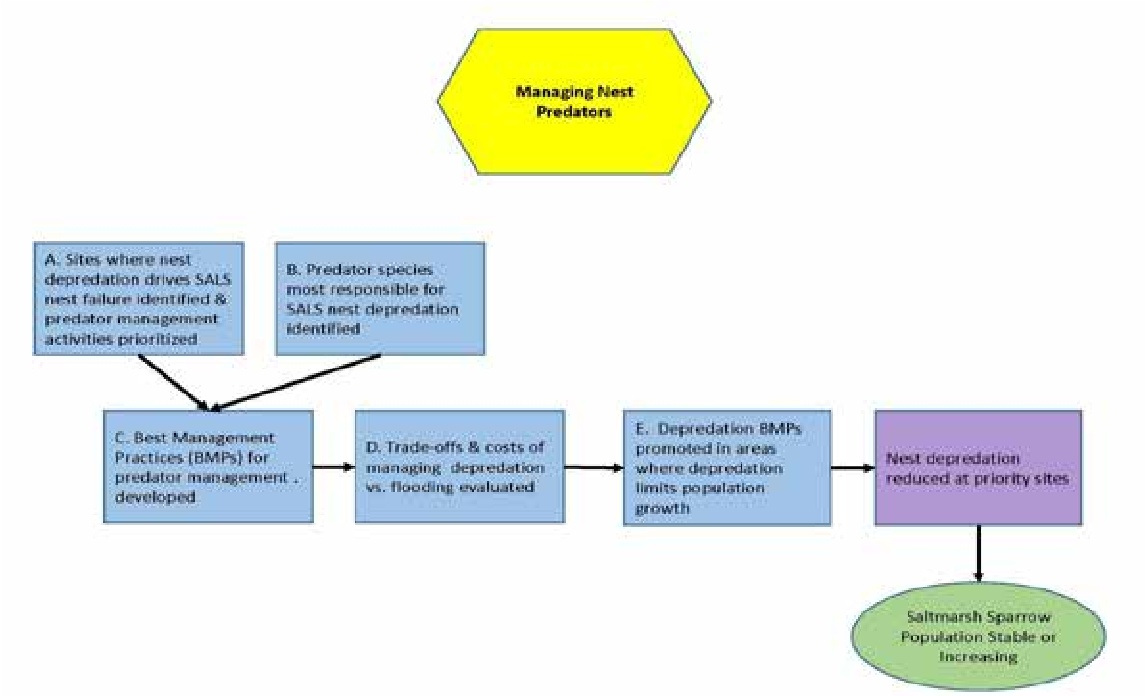
Although nest flooding is the main cause of nest mortality in the northern half of the Saltmarsh Sparrow range, nest depredation rates increase as you move south. Nest losses from flooding and depredation represent trade-offs in Saltmarsh Sparrow life history (Greenberg et al. 2006; Benvenuti et al. 2018). However, the relationship between these two selective pressures, and how it varies in space and time, is not clear. Nests that do not fail due to flooding may ultimately fail due to depredation, and vice versa; the impacts of flooding and depredation may be additive or compensatory. In New Jersey (Roberts et al. 2017), at the southernmost demographic sites studied by SHARP, nest depredation is the main cause of Saltmarsh Sparrow nest failure. Although nest mortality by native predators is a natural aspect of salt marsh bird ecology, it may require management attention if it is contributing to the species' steep decline. In places where most nests are lost to predators, reducing depredation rates may be an effective way to help stabilize or sustain Saltmarsh Sparrow populations, especially in marshes that support high densities or large numbers of birds.

Predators are the primary source of nest losses in some areas, such as Southern New Jersey. Robert Colona

Non-lethal practices such as fencing off marshes or using nest-exclosures may be the most practical approach to protecting nests from predators. Large (i.e., 4.5 - 6m) diameter exclosures significantly reduced Seaside Sparrow nest depredation rates (Post and Greenlaw 1989), and similar exclosures (i.e., 4.6m diameter fences) are being used successfully for Florida Grasshopper Sparrows (Ragheb et al 2019). A protocol has been developed in Florida (Ragheb et al 2019; J. Oteyza, in review) detailing how to install nest exclosures that prevent most nest predation by snakes and mammals.

Developing successful predator management strategies requires an understanding of which predator species are having the greatest impact in a given area. Exclosures of nests or nesting areas may be the most efficient and effective approach for some predators. Eliminating anything that attracts or encourages predators (e.g., food or shelter) may also help. In some situations, lethal or non-lethal predator removal may be necessary. Whatever the strategy, predator management efforts should always be evaluated to determine effectiveness and unintended consequences. For example, nest exclosures that deter mammals may attract or provide perches for crows or other avian predators. Demonstrating an understanding of predator dynamics and tradeoffs may also be required to obtain permits necessary for management while assessing the magnitude of predator reduction benefits will help evaluate the degree to which those benefits are offset by nest flooding. Finally, because predator management is often controversial, public concerns should be considered and addressed through proactive communication strategies to minimize potential conflicts.

Strategy Logic



Strategy Description

This strategy involves identifying a set of sites where nest depredation limits Saltmarsh Sparrow productivity and implementing appropriate predator management at those sites (A). Management must be done adaptively, with monitoring and evaluation to determine which predator species are responsible (B), facilitate development of BMPs for predator management (C), and identify the trade-offs and cost-benefits for management that addresses nest depredation versus flooding (D). Based on these evaluations, BMPs can be appropriately promoted (E) and implemented to increase productivity in high priority areas.

Objective 1: Identify the subset of sites where nest depredation is the main cause of Saltmarsh Sparrow nest failure, to prioritize predator management, by 2022.

Activity: Initiate nest monitoring on at least four sites (one per state) in northern NJ, MD, DE, VA for at least three years to document causes of nest failure and understand the magnitude of nest predation rates over time and the degree to which nests would flood if not depredated.

Objective 2: Address knowledge gaps related to nest depredation at Forsythe NWR by 2024, including identifying the predator community and which predator species are most important in terms of their responsibility for depredating Saltmarsh Sparrow nests.

Activity: Identify predator species responsible for nest depredation in southern NJ, using nest cameras or other techniques.

Activity: Expand research as needed to other areas with high depredation rates.

Depredation rates can be highly variable across years and sites, so depredation must be studied at multiple locations over several years to understand typical patterns and conditions.

Objective 3: Develop BMPs for predator management, including the most effective control methods that are informed by an understanding of predator population dynamics and possible thresholds (i.e., how many predators need to be removed to see benefit), by 2024.

Activity: Initiate at least three predator management techniques in places where predation is identified as an important driver of nest failure (see Objective 1) by 2021 and evaluate effectiveness over a three-year period, including:

- Exclosures;
- Predator removal (e.g., targeted trapping); and
- Removal of attractants (e.g., trash, bait boxes, perches, cat feeding stations, etc.)

Activity: Evaluate whether/how human activities (e.g., creating trails or inadvertently leaving scents attractive to predators) during predator management may contribute to nest predation rates.
Activity: Develop a process (e.g., Structured Decision Making) to determine if a site is a good candidate to initiate predator management, and develop criteria for initiating implementation.
Activity: Analyze/compile results into accessible BMP document (e.g., white paper).

Objective 4: By 2024, evaluate large areas being managed to reduce depredation and improve shorebird productivity to determine whether those efforts increase Saltmarsh Sparrow productivity as well.
Activity: Establish Saltmarsh Sparrow demographic monitoring plots in treated and nearby control sites where available.

Objective 5: Determine the trade-offs between nest depredation and nest flooding rates and the relative costs of different management techniques to address them, to determine whether predator management is worthwhile in the context of population level impacts.

Objective 6: Based on outcomes of Objective 5, promote BMP implementation by engaging partners managing 50% of areas where predation limits populations, by 2026.
Activity: Conduct outreach on predator management BMPs.

An important knowledge gap related to this strategy is whether, in areas with high depredation rates, nests that do not fail due to depredation would fail anyway due to nest flooding. It may be possible to explore this using existing SHARP data (e.g., to see when in the nesting cycle nest depredation occurred), but ultimately it will require demographic research coupled with predator management efforts.

Recent efforts to develop comprehensive shorebird predation management BMPs (https://atlanticflywayshorebirds.org/documents/Guidance_BMP_coordinated_predator_mngt_FINAL.pdf) could be useful for Saltmarsh Sparrow conservation efforts. Decision support tools (e.g., PiperEx) have also been developed to guide managers considering predator exclosures to benefit shorebirds. Predator management to benefit shorebirds could reduce sparrow nest depredation rates or provide cost-savings if the predator management approach benefits both shorebirds and sparrows. However, it is unclear whether key predators of shorebirds and sparrows overlap or if predator exclusion for beach-nesting shorebirds might actually displace predators to salt marshes. Area-wide predator management efforts targeting shorebirds, which is underway on Virginia's barrier islands, may be most likely to benefit Saltmarsh Sparrow populations. Other efforts to reduce or control predator activities (e.g., predator removal at airports) may provide useful insights about the scale of management required to benefit Saltmarsh Sparrow conservation.

It is important to evaluate the outcome of predator management by comparing treated and control sites, across a range of conditions. It is possible that nest flooding will cancel any benefits from reducing nest depredation rates. Evaluations of predator management should be implemented immediately on sites where nest depredation is known to be a limiting factor for Saltmarsh Sparrow productivity (e.g., Forsythe NWR in New Jersey). This could allow partners to accomplish multiple objectives simultaneously, such as learning where predation is a limiting factor in the southern half of the breeding range (Objective 1), how widespread a problem predation is (Objective 2) and evaluating the effectiveness of management actions at multiple sites (Objective 3).

STRATEGY: CREATING/IMPROVING MICROHABITATS

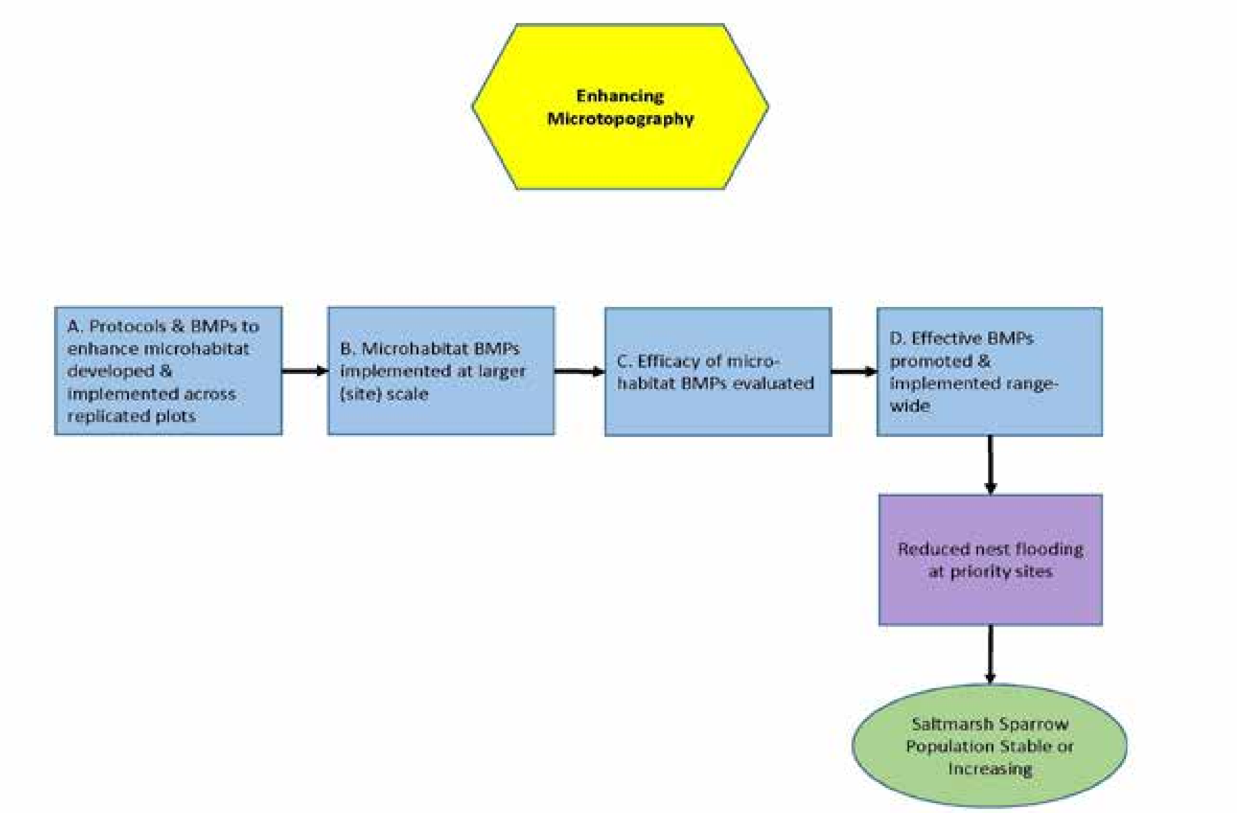
This strategy is focused on improving Saltmarsh Sparrow breeding productivity by creating or enhancing "microhabitats"—small patches or "islands" of higher elevation that experience less flooding from extreme tides, storm surge, and unusual rain events -- and thereby increase nest success. The goal is to create patches of salt marsh with elevation and vegetative conditions (e.g., presence of thatch) that are suitable for Saltmarsh Sparrow and where flooding is infrequent (e.g., only 1-3 days per month). In some marshes, such patches would only need to be a few inches higher than the surrounding high marsh platform. The effective size of such patches is yet to be determined but may vary from several square meters to patches of 1-2 acres depending on site conditions and approach taken.

Microtopography could be created or improved by depositing sediment or other material (e.g., local sand, organic waste, or salt marsh hay) on small portions of a site to create patches of higher elevation. Microtopography improvements could be made by various means, such as artificial floating islands, spreading material from relict berms, or depositing sediment, etc. Partners have begun a pilot test to see if raised "marsh mattresses" (<10 cm thick) made of coconut coir fiber or synthetic material can be placed and planted on the marsh platform to create areas less prone to flooding.

It is important that any microhabitat patches created do not act as berms and impede tidal flow. Their elevation and hydrology should be carefully designed to prevent creation of dams that impede drainage of flood waters. Long or linear features should be oriented parallel (not perpendicular) to sheet flow. Managers will need to understand the elevational range in the local marsh that supports native high marsh plants and create microtopography within that same range. If successful Saltmarsh Sparrow nest locations are known, they can provide a target elevation. There are many cases of Saltmarsh Sparrow nesting on berms and remnants of past management (e.g., fence lines, road crossings), so newly created areas could replicate similar conditions, so long as they do not impair natural hydrology. Understanding marsh hydrology is central to the success of this strategy and should be evaluated prior to designing the final management approach.
This strategy overlaps with the Increase Use of Dredged Material strategy but differs both in scale and purpose. Beneficial use of dredge focuses on restoring an entire site or large portions of a site through relatively homogenous sediment deposition to increase its resiliency. The microtopography approach increases elevation in a heterogeneous way for the purpose of providing more successful nesting sites in a faster or less expensive way. This approach may not be effective at increasing overall site resiliency. This strategy could be done in concert with others above, including engaging NRCS to provide assistance in creating/improving microtopography in salt marshes adjacent to agricultural lands.

A pilot test to create microtopography in high marsh habitats uses "marsh mattresses" planted (on one half) with Spartina grasses. The mat on the left is made from plastic (PET); the mat on the right is made from coconut fiber (coir). Forsythe NWR. Vinny Turner

Strategy Logic



Strategy Description

This strategy involves developing and implementing various approaches to create microhabitat conditions at small-scales across replicated sites (A), develop BMPs to promote the most effective approaches so that they are implemented at larger scales (B) and further evaluated to understand whether and how they are used by and benefit Saltmarsh Sparrow (C). BMPs that are demonstrated to be effective at improving high-quality high marsh habitat conditions need to be promoted and implemented range-wide (D) to reduce nest flooding at priority sites and contribute to a stable or growing Saltmarsh Sparrow population.

Objective 1: By 2021, begin pilot projects to develop viable approaches to create microhabitat through design and implementation of at least 10 replicates of each promising approach (e.g., sediment mounds, floating islands, natural and/or synthetic marsh mats) with at least three in each broad region (i.e., New England, NY/NJ, Delmarva/Chesapeake).

Activity: Develop installation protocols, design guidance, and evaluation protocols for each promising approach, specifying:

- Materials needed;
- Size of area treated;
- Soil characteristics (e.g., depth, grain size, organic to inorganic content);
- Vegetation planting (i.e., species, density, timing, technique);
- Placement location (e.g., in or at edge of low/high marsh, in pannes);
- Techniques (e.g., anchoring or attempting to stabilize/sustain mounds);
- Costs of material/labor; and
- Considerations and cautions (e.g., avoiding upland edges, trees).

The goal is to find methods that work, provide partners with successful examples, share lessons learned, and encourage consistent use of treatment and monitoring protocols to facilitate robust evaluations of research trials. As with other management strategies in this plan, all pilot projects should enable comparisons between treated and control sites, collect baseline data prior to treatment, involve replicates of treatments, and use the same monitoring protocols to allow pooling of data.

Placing peat on top of an existing marsh creates improved microhabitat conditions and may reduce flooding of Saltmarsh Sparrow nests. Wells National Estuarine Research Reserve

Objective 2. By 2022, begin evaluating microtopography plots and/or floating islands at larger scales to determine the efficacy of different techniques as they relate to:

- Suitable conditions for nesting (e.g., sufficient thatch or structure to attract nesting females);
- Use by nesting Saltmarsh Sparrow;
- Reduction in nest flooding;
- Risk of predation; and
- Other risks or benefits to birds or marsh processes.

Activity: Monitor outcomes using existing vegetation protocols and develop new protocols to evaluate adequacy of conditions and other risks/benefits to marsh and Saltmarsh Sparrow.

Note: Existing SHARP protocols may be sufficient for monitoring vegetation but refinement of SHARP protocols may be needed for measurements of elevation and flooding dynamics.

Objective 3. Implement recommended BMPs for creating improved microhabitat at the "site scale" (e.g., 25 acres), and evaluate its use by Saltmarsh Sparrow and effectiveness at improving productivity by 2022.

Activity: Implement replicated set of sites managed to improve microhabitat.

Activity: Monitor outcomes of microhabitat management, comparing differences of treated sites from baseline conditions and controls, to determine if Saltmarsh Sparrow use treated sites and if their productivity is greater at managed sites.

Activity: Ensure that projects are being tracked in the ACJV tracking database.

Objective 4. If microhabitat management improves Saltmarsh Sparrow productivity, implement practices at range-wide scale by 2025.

Activity: Determine criteria for which sites would be the best candidates for microhabitat management.

Activity: Develop site prioritization.

STRATEGY: INDIVIDUAL NEST PROTECTION


Protecting individual nests from flooding has been suggested as a way to slow Saltmarsh Sparrow population declines or prevent local extinction, albeit, one of last resort. Rhonda Smith/USFWS

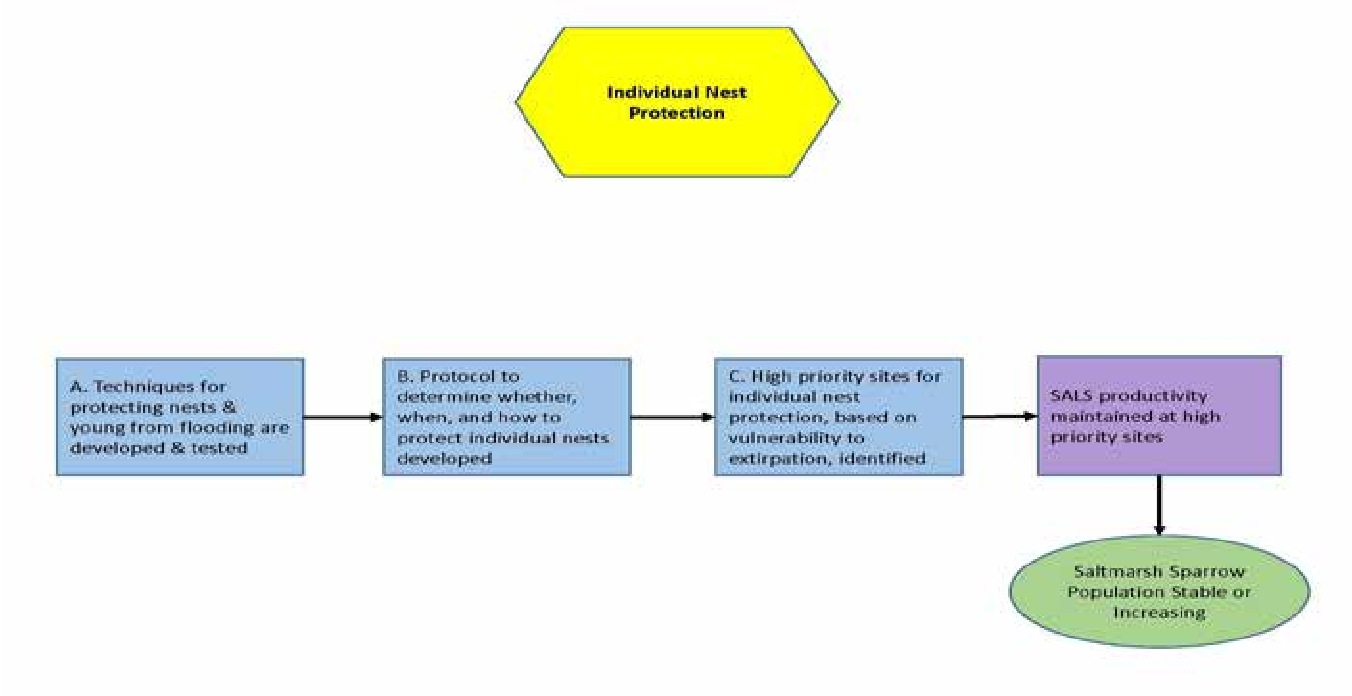
Protecting individual nests from flooding has been suggested as a way to slow Saltmarsh Sparrow population declines or prevent local extinction, albeit, one of last resort. It is generally wiser and more cost-effective to invest in large-scale measures that prevent population declines, rather than small-scale, intensive measures to save individual birds. Although saving individual nests in the field is less intensive and expensive than a captive breeding program, implementation of either approach is warranted only when the global population (or key local populations) are at imminent risk of extinction. However, there is widespread agreement among partners that it is prudent to start developing and refining methods to do so while Saltmarsh Sparrow populations are still comparatively robust. Developing and evaluating these techniques is much harder and the negative consequences of mistakes or failures more grave when populations reach emergency status. State and federal permits will be required to implement this strategy and permit considerations should be included in project work plans, budgets, and timelines.

Techniques for saving individual nests could include placing eggs or chicks in a bag or cage nearby on a temporary basis (e.g., a few hours) until flooding abates; placing a structure next to the nests to facilitate young birds climbing up to avoid flooding; elevating nests to proactively avoid flooding; or otherwise protecting them from flooding with inflatable dams (e.g., water-filled bladders), sand bags, or other temporary barriers. Florida Grasshopper Sparrow nests have been lifted to protect them from flooding and the Florida Fish and Wildlife Conservation Commission and the USFWS have developed a similar protocol that can be tested for Saltmarsh Sparrow. Water-filled flood barriers have been used to protect individual homes from flooding and could potentially be employed to protect small habitat patches with a high density of Saltmarsh Sparrow nests. It may be more effective to protect larger habitat patches that contain multiple nests to avoid the risk of predators cueing in on individually protected nests.

Captive breeding of Saltmarsh Sparrow could be informed by ongoing efforts involving other, similar species, such as Florida Grasshopper Sparrow or Coastal Plain Swamp Sparrow. However, Saltmarsh Sparrow has a different breeding system that makes them challenging to breed in captivity. Therefore, for this to be a recovery option, it is important to figure out how to undertake captive breeding now while Saltmarsh Sparrow populations are still relatively robust and any mistakes will not endanger the few remaining individuals.

There are parallels between this approach and the above Predator Management Strategy, which may involve installing fences or predator exclosures to reduce predation at individual nests. If Saltmarsh Sparrow populations reach very low levels, predator management may happen in conjunction with protecting nests from flooding where both actions would be effective. However, sites currently facing high losses from predation versus flooding appear to be different (e.g., southern vs. northern portion of Saltmarsh Sparrow breeding range, respectively) though it is unclear whether or to what degree nest losses from predation and flooding are compensatory or additive.

Strategy Logic



Strategy Description

This strategy involves developing and testing techniques that are effective at protecting eggs or chicks from flooding (A), developing protocols that determine whether, when, and how to protect individual nests from flooding (B), and identifying high priority sites that are candidates for this technique (C). Following the guidance developed, partners will have the ability to maintain Saltmarsh Sparrow productivity at sites at high risk of extirpation, which contributes to a stable or increasing population and ensures both occupancy of and gene flow among sites throughout the breeding range.

Objective 1: By 2023, develop and test approaches that successfully protect nests from flooding. Determine what materials and designs are most effective at protecting nests or groups of nests.

Activity: Implement pilot tests and/or replicated experiments to determine best approach(es) at multiple sites throughout flood-prone areas.

Areas facing localized extinctions may want to implement this strategy sooner than other areas. Individual nest protection could also be used to mitigate potential negative effects of an intensive restoration at a site, by reducing or preventing the displacement of birds nesting in the affected area, which might otherwise result in a local extinction.

Objective 2: By 2025, develop a guidance document and/or protocol to determine whether or when sites should be managed to protect individual nests from flooding, and how to do so.

Activity: Develop consensus threshold/criteria regarding whether, when, and/or where to implement nest protection; develop a BMP document and make it available to partners.

Objective 3: By 2025, Identify the highest-priority sites to protect from flooding.

Activity: Develop consensus map (or list of sites) identifying areas at greatest risk of nest flooding and most important to maintain for population dynamics, to determine candidate sites for individual nest protection efforts.

Developing and testing techniques that are effective at protecting eggs or chicks from flooding could be a way to maintain Saltmarsh Sparrow productivity at sites at high risk of extirpation David Eisenhauer/USFWS

Non-breeding Season Habitat Conservation Strategies & Actions

Non-breeding Saltmarsh Sparrow habitat in South Carolina.
Craig Watson/USFWS

STRATEGIES IN NON-BREEDING HABITAT

Recent research has underscored the importance of high marsh habitat for Saltmarsh Sparrow during winter. In North Carolina, sparrows are found in patches of short-form *Spartina alterniflora* and *Juncus*, which makes up a small portion of regularly flooded salt marshes there. Although Saltmarsh Sparrows forage in both low and high salt marsh habitats, they concentrate in high marsh habitat during high tides and are further restricted to the highest-elevation patches during spring tide events (R. Danner, pers. comm.; A. Given, pers. comm.). Previous research shows low overwinter mortality (Borowske et al. 2018), but preliminary results from recent banding and telemetry work suggests variable and high mortality rates during winter at other sites (R. Danner, pers. comm.). Although most experts agree that low breeding productivity is driving Saltmarsh Sparrow declines, the wintering grounds also face threats, and conservation efforts are needed to ensure that wintering habitat loss does not become a limiting factor affecting Saltmarsh Sparrow population dynamics.

STRATEGY: ADDRESSING NON-BREEDING SEASON NEEDS

Winter food availability has been shown to limit the population size of other sparrow species (e.g., Swamp Sparrow, *Melospiza georgiana*) through local movements and mortality (Danner et al. 2013). This suggests that increased habitat extent or quality (i.e., food availability) could allow higher overall abundances and survival of Saltmarsh Sparrow, though it is unclear if winter habitat (whether high tide roosts or low tide foraging habitats) is limiting Saltmarsh Sparrow population growth.

Radio telemetry tower at sunset at Bald Head State Natural Area. Marae Lindquist

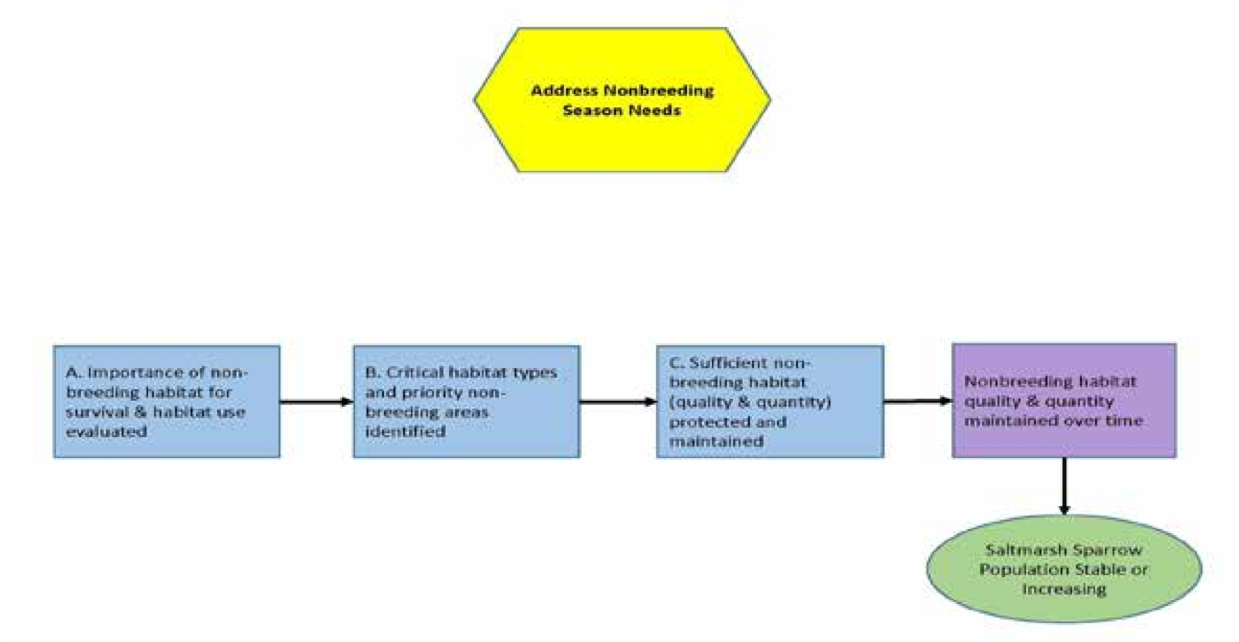
Conservation needs identified for the non-breeding season include:

- Research to address important knowledge gaps; and
- Proactive conservation of existing high marsh habitats.

Partners need to determine how much winter habitat is needed to support 25,000 Saltmarsh Sparrows. Developing state-specific habitat or population goals for the wintering area (Virginia to Florida) will require studies that determine the importance of different habitat types for non-breeding birds (e.g., their dependence on high marsh), and the importance of different geographic areas during winter. However, partners do not need to wait for these research needs to be addressed before implementing proactive conservation measures to benefit Saltmarsh Sparrow populations during winter. Most of the strategies in this plan that apply to breeding habitat can also be considered important for conservation of winter habitat. This includes restoring or enhancing high marsh habitats, beneficial use of dredge material, protecting adjacent buffers and inland migration zones, facilitating marsh migration, and outreach and engagement with key partner agencies (e.g., NRCS, USACE, DOT, etc.) to advance salt marsh conservation goals.

Because the exact habitat needs of wintering Saltmarsh Sparrows are unknown, partners chose to be conservative in their approach to setting habitat objectives and set a goal of maintaining all of the existing high marsh acreage (Table 3) with a focus on prioritizing those that are identified to be of above average resiliency for protection.

Strategy Logic



Strategy Description

This strategy involves research and monitoring to evaluate Saltmarsh Sparrow habitat use and availability and survival during the non-breeding season (A), to identify critical habitat types and areas that are most important during winter (B), so that partners can effectively protect sufficient habitat during the non-breeding season (C) and maintain sufficient habitat in the future to support a stable or growing Saltmarsh Sparrow population.

Objective 1: By 2025, evaluate the importance of wintering grounds to survival and habitat use of Saltmarsh Sparrow in at least 10 sites from Virginia to Florida over three years.

Activity: Assess movement and mortality through telemetry and mark/recapture studies to determine specific habitat use and identify important sub-habitat types to conserve.

Objective 2: Maintain habitat quality and quantity that is equal to or greater than what is currently available.

Activity: By 2025, produce a prioritized map of high-quality non-breeding habitat for Saltmarsh Sparrow.

Activity: Identify marsh migration corridors, using state acquisition priorities or The Nature Conservancy (TNC) data layers, to target for protection to offset expected losses of salt marsh habitat due to sea level rise.

Activity: Ensure that all agencies and organizations are aware of the need to conserve non-breeding Saltmarsh Sparrow habitat.

Activity: Incorporate Saltmarsh Sparrow non-breeding habitat into all relevant agency and organization planning documents.

Protection and restoration should target and prioritize important, extensive habitat areas and sub-habitat types identified in Objective 1. Partners should emphasize high marsh habitat and the upland edge in salt marsh conservation implementation efforts in the non-breeding range. Restoration activities should consider marsh structure and emphasize high marsh habitat (e.g., filling in ditches from upland edges or managing deer/horses/feral pigs to avoid degradation of narrow high marsh zones).

MONITORING & EVALUATING SUCCESS

The success of this plan depends on the ability of partners to track collective progress towards plan objectives and determine whether their efforts are improving Saltmarsh Sparrow populations. Monitoring and evaluation efforts are central to an adaptive management approach for evaluating the management strategies in this plan and should not be considered an optional element, done only if funding is available. Implementation activities outlined in this plan should be carried out and then the performance of each approach assessed to allow for course corrections. Ultimately, the goal is to understand the effects of various management actions on Saltmarsh Sparrow populations. Ongoing investments in research and population monitoring are therefore critical to conservation success, and, most critically, to helping determine whether conservation efforts are increasing reproductive success - or survival during the non-breeding season - to improve the overall population trend.

Achieving success will require both large-scale monitoring, to understand population change, and an ability to evaluate management actions at individual sites. If a set of sites is managed specifically to improve Saltmarsh Sparrow productivity, and there is evidence of positive population growth at those sites, similar results would be expected for other sites managed similarly. However, that assumption needs to be tested, especially if the approach is implemented at additional areas with different conditions. The combination of large-scale and site-level monitoring through an adaptive management approach will allow partners 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 and grow declining Saltmarsh Sparrow populations by providing a sufficient quantity and quality of habitat to achieve a population of at least 25,000 birds and sustain it into the future. To determine if that goal has been achieved requires periodically measuring Saltmarsh Sparrow population size and trends at a regional level. Existing national survey efforts (e.g., Breeding Bird Survey, Christmas Bird Count) do not adequately sample Saltmarsh Sparrow, so comprehensive regional surveys are needed, which specifically target this species.

To determine the success of this plan we need to monitor the Saltmarsh Sparrow population at sites where implementation occurs and also at a large (range-wide) spatial scale. SHARP

Breeding Season Surveys

The SHARP and USFWS Salt Marsh Integrity (SMI) monitoring programs established standardized breeding marsh bird monitoring protocols (Weist et al. 2016) and collectively sampled more than 3,000 locations for Saltmarsh Sparrows and other salt marsh breeding birds in the Northeast Region. SHARP surveys from Maine to Virginia in 2011 and 2012 provided a global population estimate and, when compared to historical data, indicated a -9% annual rate of decline. It is important to follow up on that effort with another comprehensive regional survey by 2021/2022 to estimate the population change and trend. The Salt Marsh Bird Conservation Plan (ACJV 2019) called for a comprehensive regional survey of Saltmarsh Sparrow at least once every five years. Surveys done by SHARP in 2011 and 2012 provided breeding population estimates.

Sampling Considerations

Most tidal 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 (Wiest 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

Regional surveys should generally be conducted two years in a row, every five years. Statistical power may be reduced at subregional (e.g., state) or site scales unless sampling covers several years. For example, to estimate breeding Saltmarsh Sparrow trends in coastal Connecticut, experts recommend selecting 12 hexagons in the state and surveying multiple sites and survey points in each hexagon, twice per season, biennially, for eight to ten years. This recommendation is based on a regional power analysis of a similar sampling framework with 76 point counts in Delaware, with a power greater than 0.80 to detect a 5% annual decline in Saltmarsh Sparrow abundance.

Non-Breeding Season Surveys

Although some researchers are studying Saltmarsh Sparrow distribution and densities during the non-breeding season, there is no standardized or regional assessment of Saltmarsh Sparrow outside of the breeding season. A comprehensive Saltmarsh Sparrow survey during the non-breeding season is needed to understand which areas and habitat types are most important during migration and winter. To determine priority areas, non-breeding surveys need to be carried out over multiple seasons, years, and states, as the importance of a given area may vary by season or year.

In Georgia, non-breeding monitoring includes dragging a line at low tide to flush birds into a nearby net. Tim Keyes/Georgia DNR

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 Saltmarsh Sparrow with visual transect surveys and area searches by dragging ropes.

Non-Breeding Season Demographics

Additional research is needed to determine if and how mortality in winter limits Saltmarsh Sparrow populations. Borowske et al. (2018) found a low level of mortality in winter, but preliminary estimates from Danner et al. (2020, unpublished) indicated higher mortality rates, perhaps suggesting variation in mortality across space or time. It is also unclear whether winter mortality is related to habitat quality or availability. Regarding winter habitat availability, Saltmarsh Sparrow have high fidelity to high tide roosting and low tide foraging locations (Winder et al. 2012; Danner et al. unpublished), suggesting that both are important.

EVALUATING MANAGEMENT ACTIONS

This plan emphasizes the critical need to evaluate promising management actions to determine whether and how they are contributing to Saltmarsh Sparrow population stability or growth. This is especially important given the novel nature of many of the implementation actions suggested and the desire for an adaptive management framework for implementation. For each management approach, it is important to determine whether it works as expected, under what conditions it is successful or not, and how it affects population dynamics. Evaluations of management require site-level monitoring, ideally across an array of several managed sites, which serve as experimental replicates.

Recommending specific management actions should hinge on clear evidence that the intervention will improve productivity of Saltmarsh Sparrows. SHARP

Conducting an evaluation of all restoration or management efforts is strongly recommended. If Saltmarsh Sparrow are not present prior to the management action, occupancy may be a suitable indicator of success. If Saltmarsh Sparrow are present, changes in abundance, density, or productivity should be evaluated. Ultimately, recommending specific management actions should hinge on clear evidence that the intervention will improve productivity of Saltmarsh Sparrows.

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 two-three years.

Abundance, Density or Occupancy?

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 (>10) or have abundances high enough to provide sufficient statistical power to detect meaningful differences. Therefore, it is more practical to estimate sparrow or nest densities or measure nest productivity at a site and track these over time or in response to management changes. If the site is not occupied by Saltmarsh Sparrow prior to restoration or management, occupancy is a simple metric that may be sufficient to adequately assess restoration success.

Monitoring Demographics

Nest productivity is the most appropriate indicator of habitat quality. Understanding how conservation actions affect population growth ultimately requires some measure of reproductive success at managed or restored sites. Because demographic data collection (e.g., nest searching, mist-netting) is intensive and expensive, a clear sense of how management affects population growth may be possible only for a small sample of managed sites. Those results could be extrapolated to all sites managed similarly across a region.
A recent study by SHARP (Field 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) for Saltmarsh Sparrow. Based on these findings, it is recommended that 10 to 15 sites are established, where comprehensive demographic data are collected every year, to provide an understanding of inter-annual variation and survival. This could not be achieved 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 researchers are 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. Sparrow populations appear to be more affected by reproduction than by annual survival so this approach assesses breeding productivity but does not provide estimates of annual survival as would more intensive demographic studies. Even this rapid demographic sampling requires at least a week of work by a small crew of trained individuals, which is well beyond the capacity of many land managers working at a particular site. However, conservation partners must prioritize evaluations of breeding success to understand if management actions are working, and decide which management approaches are worth additional—or major—investments.

In comparison to nesting productivity, occupancy rates or nest density are relatively poor indicators of breeding habitat quality. However, both variables could be important in certain situations, especially if monitored over time at many sites. If either variable were trending upwards or downwards across many sites in a given region, it would reflect an expanding or contracting population, which would indicate population change.

MONITORING VEGETATION

Marsh monitoring. Andrew Neal Ferguson/Save the Bay

Vegetation data should be collected on any sites where bird surveys are being carried out. Monitoring vegetation can help detect marsh changes over time, which is critical to understanding the effectiveness of restoration and management actions. Vegetation data collected in the absence of avian productivity data may provide insufficient, or even misleading, information as factors, such as sea level rise may impact reproductive success and population dynamics more quickly than they affect habitat structure. Therefore, habitat that appears to be high-quality high marsh based on the presence of appropriate vegetation may actually be a population sink due to increased nest flooding rates. 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.

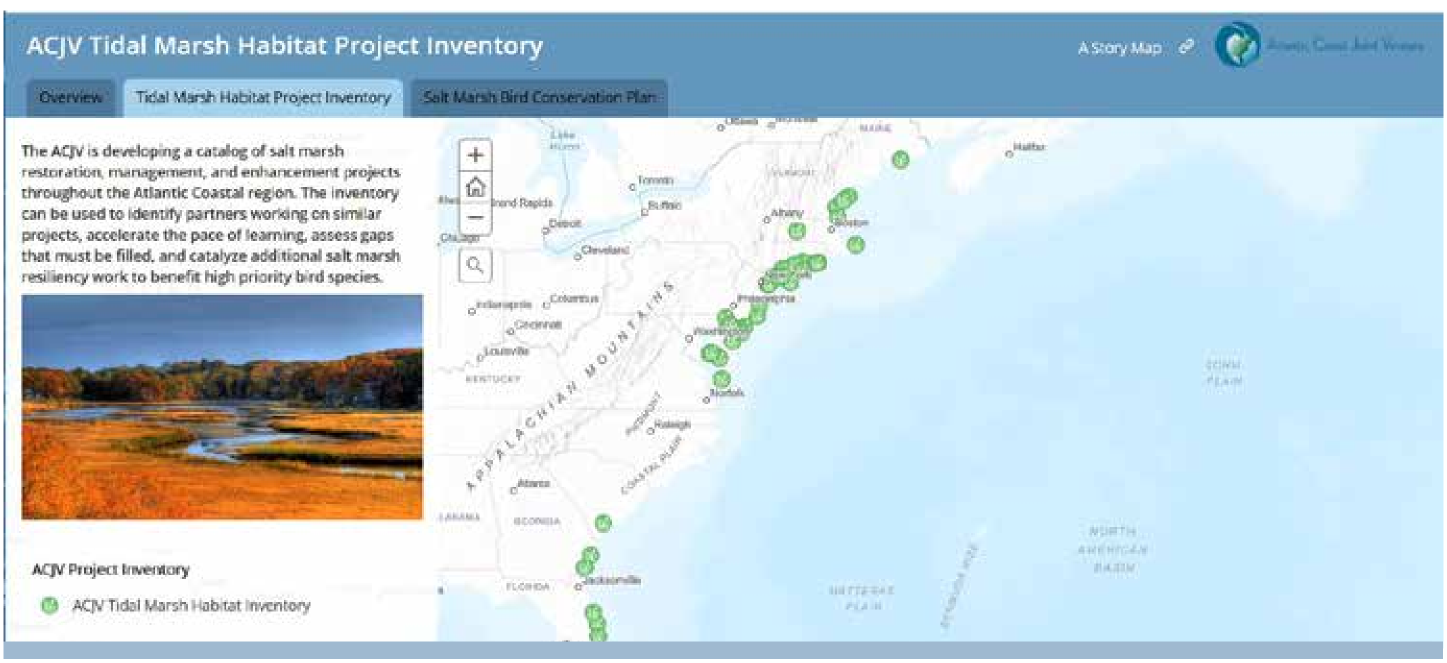
In addition to vegetation data, there are several other variables that could provide important insights into the structure and function of salt marsh ecosystems if they are measured. Such variables include open water to vegetated marsh ratio, the nature and degree of historic modifications, sedimentation 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.

PROTOCOLS

The SHARP protocol, which is also used to monitor 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 understanding of population trends along with avian and vegetation response 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. Protocols need to be developed for non-breeding surveys of Saltmarsh Sparrow. It may be useful to compare SHARP protocols with those of NERR researchers to understand similarities and differences in approaches related to key variables such as thatch, marsh platform inundation (i.e., frequency and magnitude), and using point intercepts versus percent cover, among others.

CONSERVATION ACTION TRACKING

This plan describes many different objectives and activities among 11 major conservation strategies. These objectives include science, management, outreach, and engagement activities, and rely upon a diverse partnership working in a coordinated fashion to advance Saltmarsh Sparrow conservation throughout the Atlantic Coast. A centralized and publicly accessible tracking tool will be necessary 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 track performance and assess progress overall and toward specific objectives (e.g., number of acres of a particular management practice put in place on the ground). The online tracking tool 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; this dashboard will be used as a model for a tracking tool for salt marsh bird conservation efforts. Completion of the dashboard tool is anticipated in 2020.



The ACJV will expand the current tidal marsh tracking tool to include Saltmarsh Sparrow projects. ACJV

SUMMARY OF MONITORING RECOMMENDATIONS

- A comprehensive regional survey of breeding Saltmarsh Sparrow is needed every five years to understand population trends and determine whether conservation measures are working.
- Existing coordinated efforts in the northeast to comprehensively survey Saltmarsh Sparrow must be expanded to include non-breeding grounds to identify priority migration and winter habitat.
- Vegetation data should be collected on all sites where bird surveys are 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; at a minimum it should be consistently monitored at 10-15 sites across the region, representing the range of Saltmarsh Sparrow habitats.
- The outcome of management actions called for in this plan must be monitored and evaluated to understand and improve their effectiveness. It is particularly important to understand how management affects Saltmarsh Sparrow reproductive success.

Other ecological factors should be considered when monitoring and evaluating conservation actions, such as the unvegetated to vegetated marsh ratio, degree and nature of historic modifications, erosion, sediment supply, and groundwater.

Saltmarsh Sparrow captured at Bald Head Island State Natural Area, North Carolina. Marae Lindquist

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Salt marshes provide critical habitat for many high priority birds, and other fish and wildlife species. Assateague Island, Virginia. Lynda Richardson/Natural Resources Conservation Service

APPENDIX 1: SCIENCE & RESEARCH NEEDS

The ACJV Saltmarsh Sparrow Working Group developed a prioritized list of science and research needs for Saltmarsh Sparrow to help guide conservation efforts moving forward (Table 5). The highest priority needs fall into four primary groups of activities:

1) Habitat Management: Determine which habitat features and/or which restoration, enhancement, and management approaches provide suitable and/or high-quality habitat for Saltmarsh Sparrows and use this knowledge to promote that management;
2) Monitoring: Develop common monitoring protocols for habitat and population response and consistently apply them at the site and regional scales;
3) Demographics: Investigate and evaluate how vital rates are affecting breeding populations
4) Methodology: Develop methodology around handling or sampling Saltmarsh Sparrow individuals or populations, respectively, and monitor habitat features; and
5) Non-breeding: Assess population distribution and survival rates in the nonbreeding season

Science Needs Prioritization Process

Each need was scored according to the following criteria:

Conservation Priority - Across the ACJV region, how important is this action for the species?
1 = high; 2 = medium; 3 = low

Immediacy - How soon does this action need to be taken?
1 = 0-2 yrs; 2 = 3-5 yrs; 3 = 5+ yrs

Scores were averaged and then ranked according to the combined average of the 'conservation priority' and 'immediacy' scores. Actions were divided into three priority Tiers based on natural breaks in the average score. Table 5 includes the action items in order of priority. Please visit the ACJV website to see the full table, with additional information (e.g., scale, cost, feasibility).

The use of standardized monitoring protocols can facilitate regional studies that pool data from multiple sites. SHARP

Table 5. Saltmarsh Sparrow Prioritized Science Needs. Categories of action include Habitat Management (Management), Population/Demographics (Demographics), Methodological, or Non-Breeding Season Needs (non-breeding). Average (Avg) score is the mean of Conservation Priority (Priority) and Immediacy scores.

Tier	Category	Action	Priority	Immediacy	Avg
1	Management	Identify and test strategies to reduce nest inundation in high marsh (short-term)	1.15	1.23	1.19
1	Demographics	Re-evaluate population change since 2011/2012	1.15	1.23	1.19
1	Management	Identify how to maintain high marsh habitat and slow loss (over the long-term)	1.00	1.46	1.23
2	Demographics	Link management of breeding habitat to population increase (through demographics)	1.23	1.54	1.38
2	Management	Test innovative ideas to produce nest refugia from flooding	1.38	1.46	1.42
2	Demographics	Identify potential surrogate reproductive success measures that are more easily monitored	1.31	1.62	1.46
2	Management	Develop methods to accelerate successful marsh migration	1.50	1.46	1.48
2	Demographics	Evaluate effectiveness of nest predator control strategies and develop BMPs	1.54	1.46	1.50
2	Non-breeding	Implement comprehensive SALS survey during non-breeding season to identify priority overwintering sites	1.62	1.46	1.54
3	Management	Complete range-wide marsh vulnerability assessment and tool to prioritize implementation actions	1.46	1.77	1.62
3	Methodological	Expand SALS surveys to areas that have not been extensively surveyed (e.g., western shore of Chesapeake)	1.77	1.46	1.62
3	Demographics	Investigate survival and movements of young birds post-fledging	1.54	1.77	1.65
3	Management	Identify marsh patches where *Phragmites* control would result in high quality SALS habitat	1.85	1.62	1.73
3	Methodological	Complete high marsh/low marsh vegetation map of Western shore of Chesapeake Bay and other areas	1.92	1.62	1.77
3	Non-breeding	Expand SHARP program to southeast (NC, SC, GA, FL)	1.69	1.85	1.77
4	Methodological	Create publicly accessible database to allows users to enter and access data	1.85	1.92	1.88
4	Non-breeding	Implement comprehensive SALS survey during non-breeding season to identify important migratory stopover locations	1.92	2.00	1.96
4	Non-breeding	Investigate management response (such as marsh burning) on wintering habitat	1.85	2.15	2.00
4	Management	Identify upstream dams with potential, if removed, to provide sediment to important salt marshes	2.00	2.15	2.08
4	Methodological	Improve quality of *Phragmites* map data layer	2.31	1.92	2.12
4	Demographics	Assess winter site fidelity and connectivity between breeding and non-breeding sites	2.23	2.38	2.31
4	Management	Assess the value of living shorelines in maintaining high marsh patches	2.46	2.31	2.38

Table 6: Tiered science needs organized by category.

Tier	Action
Habitat/Management	
1	Identify and test strategies to reduce nest inundation in high marsh (short-term)
1	Identify how to maintain high marsh habitat and slow loss (over the long-term)
2	Test innovative ideas to produce nest refugia from flooding
2	Develop methods to accelerate successful marsh migration
3	Complete range-wide marsh vulnerability assessment and tool to prioritize implementation actions
3	Identify marsh patches where *Phragmites* control would result in high quality SALS habitat
4	Identify upstream dams with potential, if removed, to provide sediment to important salt marshes
4	Assess the value of living shorelines in maintaining high marsh patches
Population/Demographics	
1	Re-evaluate population change since 2011/2012
2	Link management of breeding habitat to population increase (through demographics)
2	Identify potential surrogate reproductive success measures that are more easily monitored
2	Evaluate effectiveness of nest predator control strategies and develop BMPs
3	Investigate survival and movements of young birds post-fledging
4	Assess winter site fidelity and connectivity between breeding and non-breeding sites
Non-breeding Season Needs	
2	Implement comprehensive SALS survey during non-breeding season to identify priority overwintering sites
3	Expand SHARP program to southeast (NC, SC, GA, FL)
4	Implement comprehensive SALS survey during non-breeding season to identify important migratory stopover locations
4	Investigate management response (such as marsh burning) on wintering habitat
Methodological	
3	Expand SALS surveys to areas that have not been extensively surveyed (e.g., western shore of Chesapeake)
3	Complete high marsh/low marsh vegetation map of western shore of Chesapeake Bay and other areas
4	Create publicly accessible database to allows users to enter and access data
4	Improve quality of *Phragmites* map data layer

APPENDIX 2: STATE SUMMARIES

BREEDING RANGE*

CONNECTICUT
DELAWARE
MAINE
MARYLAND
MASSACHUSETTS
NEW HAMPSHIRE
NEW JERSEY
NEW YORK
RHODE ISLAND
VIRGINIA

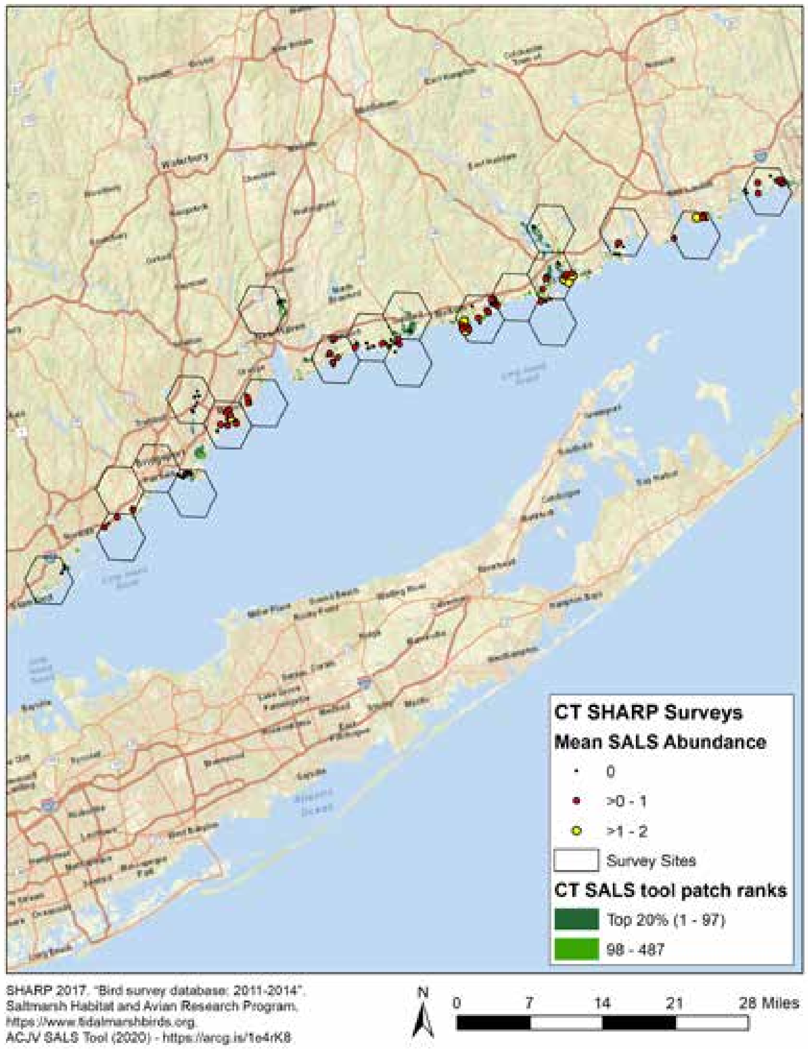
WINTER RANGE

FLORIDA
GEORGIA
NORTH CAROLINA
SOUTH CAROLINA

**Map data from ACJV (2020) and SHARP (2017).*

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Connecticut	1,600	(±800)	2.70%	668	2,177

STATUS AND DISTRIBUTION



Saltmarsh Sparrows occur in *Spartina patens* and *Distichlis spicata* salt marshes across Connecticut. They are rarely found in marshes less than 0.9-1.9 acres but have occurred in smaller marshes (NYS DEC, 2014). Connecticut supports 12,200 acres of salt marsh; however salt marshes in the state are relatively small, with only 21 marshes over 90 acres in size.

Globally Important Bird Areas for the species include (from west to east): Quinnipiac River Tidal Marsh, the East River Marsh Complex, Hammonasset Beach State Park, Salt Meadow Unit of the Stewart B. McKinney NWR, the Old Saybrook Marshes, the Mouth of the Connecticut River, Pattagansett Marsh, and Barn Island Wildlife Management Area. The marshes in Old Lyme at the mouth of the Connecticut River (Great Island, Upper Island, and Black Hall Marsh) are almost certainly the most important sites for nesting Saltmarsh Sparrow in Connecticut (C. Elphick unpublished report 2009). Great Meadows Marsh in Stratford, CT contains the largest block of unditched high salt marsh (±225 acres) left in Connecticut, which could also play a role in the conservation efforts for the species along the Connecticut coast.

PRIMARY THREATS

The primary threats to Saltmarsh Sparrows in Connecticut are sea level rise and the loss and degradation of salt marsh habitat. In the last century, sea level has increased by 30 cm in New York City and 22-39 cm in surrounding areas (Hartig et al. 2002; Donnelly et al. 2004; Watson et al. 2017). Like many other states in the northeast, Connecticut's coastline is densely populated, with development often sprawling right to the high marsh boundary. Connecticut's four coastal counties had an estimated population of 2.2 million people in 2019 (U.S. Census), and an average of 985 people per square mile. Past development pressure has resulted in extensive draining and filling of tidal marshes in urban areas. High-density housing developments directly adjacent to many existing salt marshes limits potential marsh migration into uplands and tidal flow restoration where it could increase flooding. Connecticut's steeper gradient coastal slope shoreline further limits marsh migration opportunities (ACJV, 2019).

While development is of high concern along the Connecticut coastline, it is important to note that 60% of the upland borders of existing salt marshes abut forested land (C. Elphick, pers. comm.). It is suggested that trees might resist a state change from forest to tidal marsh, inhibiting the marsh migration process. Therefore, the death of the established trees is likely to be a critical component of the marsh migration process (Field et al. 2016).

Salt marsh at Long Beach in Stratford, Connecticut. Jerry and Marcy Monkman/EcoPhotography

Additional factors associated with salt marsh habitat loss and degradation in Connecticut include excess nitrogen leading to marsh destabilization (Alldred et al. 2017), lack of mineral sediment and increased organic matter deposition (Peteet et al. 2018), mosquito ditching, and impeded tidal flow. 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.

In the Long Island Sound area, nest flooding is the primary cause of nest failure (Bayard and Elphick 2011; Ruskin et al. 2017). It has also been hypothesized that nesting higher up in vegetation to avoid this flooding may result in increased nest depredation (Greenberg et al.2006). Continued efforts to find a middle ground for this issue will be vital to Saltmarsh Sparrow conservation.

KEY OPPORTUNITIES

Salt marsh undergoing invasive plant control (light colored areas) and native plant restoration at the mouth of the Connecticut River. Natural Resources Conservation Service

Since much of Connecticut's coastline has been developed, it is important to protect undeveloped coastal areas and facilitate marsh migration. Landowners do have the option to participate in federal "buyout" programs, which aim to bolster natural defenses in the wake of major storms by acquiring properties. However, throughout coastal Connecticut, such programs have experienced very low participation rates despite being promoted by governments at local, state, and federal levels, perhaps because Connecticut homeowners are among the wealthiest in the U.S. Opportunities to partner with municipalities and landowners to take advantage of buyouts may therefore be limited. Although funding for conservation easements is currently available and partners are working on connecting with landowners, easements may not be the most effective approach. Currently, just 7.1% of the marsh migration zone is owned by landowners who are likely or very likely to participate in easements (Field et al., 2017) and recent surveys revealed that landowners preferred alternatives, such as restrictive covenants, even though they do not offer a monetary incentive. Overall, landowner surveys have greatly informed managers about challenges and opportunities that can inform long-term strategies for marsh protection and enhancement. However, if government programs are to play an important role in conserving lands threatened by sea level rise, further research into the underlying cause of low participation rates would be helpful, as would exploring alternative approaches. Developing ecological models that better reflect human decisions would be especially valuable for coastal areas in the short term (Field et al. 2017).

Managers have used the Sea Level Affecting Marshes Model (SLAMM) and other tools (e.g., https://circa.uconn.edu/sea-level-rise-and-storm-surge-viewer/) to identify coastal areas that lend themselves to marsh migration under various sea level rise scenarios. The office of the Long Island Sound has modeled the marsh migration corridors around the East River, which will continue to guide future restoration efforts throughout the East River salt marsh.

Habitat restoration in more urban settings should include a matrix of low, high, and upland marsh zones to facilitate landward migration of salt marshes providing additional options for nest site selection by simulating conditions at more successful nesting sites (Kocek 2016).

Within salt marshes, reduction in surface water pooling (ditch remediation and/or marsh subsidence), preventive measures that reduce conversion of high marsh to low marsh, and an increase in suitable habitat that is preventative to nest flooding (i.e., high marsh) would be beneficial for Saltmarsh Sparrows (Kocek, 2016). New mosquito control projects using an integrated marsh management technique to restore flow to degraded tidal marshes have been found to be beneficial in reducing invasive vegetation and increasing native vegetation, nekton, and avian species (Rochlin et al. 2012). Although this methodology has not been proven to benefit Saltmarsh Sparrow specifically, it may provide a framework for future conservation efforts.

The Great Meadows Marsh, located in Stratford, Connecticut, is the target of a new coastal restoration project. As suggested in the preliminary design plan, a series of hummocks will be created at the site, approximately 0.5 ft higher than existing bird nesting locations. It is also suggested that these hummocks be varied in height, with some containing less than a 6-inch-depth of fill material to allow for existing plants to emerge. Alternatively, hummock height could be set on flood frequency elevation and incorporate plantings or seeding of salt hay/salt grass to set them at a higher elevation and increase resilience to future sea level rise. Additionally, the plan is to adjust the elevation of the Great Meadows Marsh through a soil placement and regrading process. The hope is to generate more area for *Spartina patens* to establish as well as a zone of transitional vegetation (J. Turek, pers. comm. 2020).

A sentinel monitoring program has been developed to measure changes in coastal systems (Field and Elphick 2014). The parameters and methods 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.

The use of drone technology has begun to take off in conservation efforts for many plant and animal species. Drones have been used for several years to map vegetation types and have enhanced the study of landscape ecology, which can now be directly applied to Saltmarsh Sparrow conservation work. Implementing a yearly drone mapping/analysis protocol for all priority salt marshes could help gain a visual and quantitative understanding into the extent of change occurring, and specifically looking at and analyzing S*partina paten*s, a high marsh vegetation species key to the survival of the Saltmarsh Sparrow.

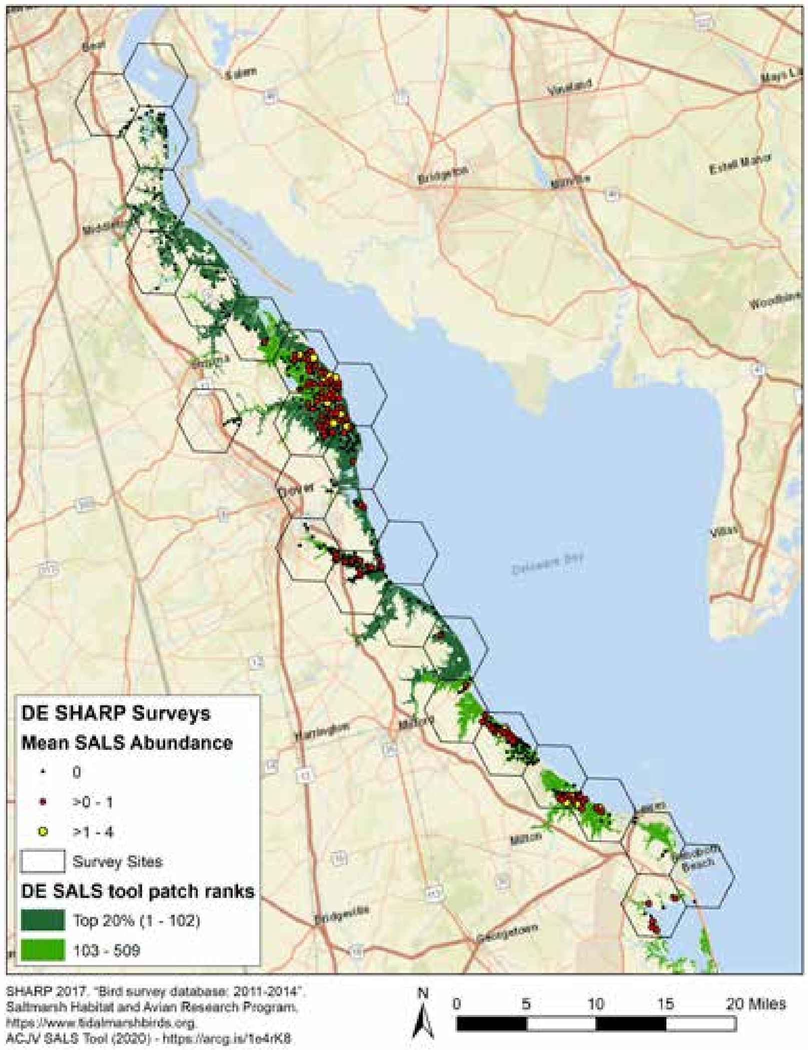
Saltmarsh Sparrow. Ray Hennessy/rayhennessy.com

DELAWARE

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Delaware	4,118	(± 4,400)	6.9%	1,711	2,842

STATUS AND DISTRIBUTION

Higher estimated abundances of Saltmarsh Sparrow are reported at survey sites within Prime Hook NWR, Cedar Creek and Inland Bays (Tymkiw et al. 2019). Vegetation surveys from these sites indicate that the proportion of high marsh habitat is more than 11% (range = 11–35% of total salt marsh).



PRIMARY THREATS

Sea level rise and the subsequent loss of high marsh and/or conversion to low marsh are the main threats in Delaware.

KEY OPPORTUNITIES

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.

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 2020, led by Dr. Greg Shriver.

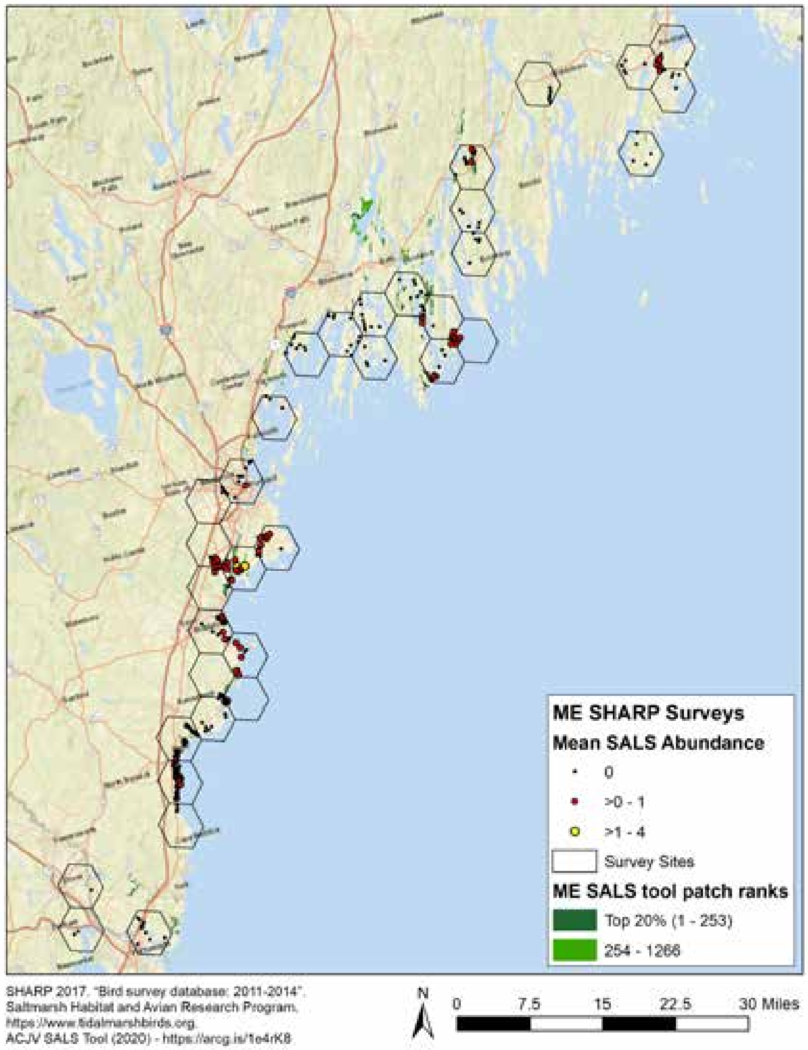
Prime Hook NWR completed a tidal marsh restoration in 2016, following a breach during Hurricane Sandy in 2012. This was the largest tidal marsh restoration project in the Eastern U.S., with ~4,000 acres of marsh restored. Response by Saltmarsh Sparrow is being monitored.

Scientists monitor wetland health at dozens of sites in Delaware, such as the Smyrna River and Cedar Swamp. Delaware lost more than 200 acres of vegetated wetland per year over the last 15-year study period. Partnership for Delaware Estuaries

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Maine	1,600*	(± 1,200)	2.7%	668	2,511

** Due to survey methodology, many observations were recorded as unidentified sharp-tailed sparrows rather than as Saltmarsh or Nelson's Sparrow. Unidentified sharp-tailed sparrow observations were not included in this abundance estimate. Additionally, in Maine, there are known errors with the timing of surveys (i.e., too early in the season). For these reasons, the Saltmarsh Sparrow population estimate for Maine needs to be corrected.*

STATUS AND DISTRIBUTION



Saltmarsh Sparrows are found in Maine's tidal marshes south of Penobscot Bay, which is the species' northern range limit. From Thomaston to the Canadian border, Maine's tidal marshes are occupied by the closely related Nelson's Sparrow. There is little evidence for northward range expansion by Saltmarsh Sparrow (Walsh et al. 2017). Saltmarsh Sparrow population and occupancy estimates in Maine are complicated by the co-occurrence of Saltmarsh and Nelson's Sparrow and the fact that the two species readily hybridize along a ~200 km zone of overlap extending across coastal New Hampshire and into the Great Marsh of Massachusetts. Within the hybrid zone, these species co-occur in the same habitat, so accurate species identification for some individuals requires capture and genetic analyses. Point count observations in the hybird zone were counted as Saltmarsh Sparrow, Nelson's Sparrow, or "unidentified sharp-tailed sparrow," with the latter category including individuals where a distinct species identification (i.e., Saltmarsh or Nelson's) was not made. As a result, unidentified sharp-tailed sparrows may comprise around 20% of counted birds depending on the survey location and were not included in the 2011/2012 state population estimate. Therefore, the estimate of breeding Saltmarsh Sparrow in Maine is likely biased low.

Maine's Saltmarsh Sparrow population is declining at a rate of -10.6% annually, somewhat higher than the annual range wide decline of -9% reported (SHARP SWG Report 2015). In Maine, nest flooding rates are high and nest depredation rates are low, relative to other parts of the range, despite a lower observed sea-level trend compared to other states in the northeast (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; SHARP SWG Report 2015).

Jones Creek marsh in Scarborough is one of only five sites (out of 21) across the breeding range with an estimated positive population growth rate and had the highest population growth rate range-wide (Field et al. 2017). This site presently sits behind a severe tidal restriction. At present, this restriction appears to be providing a short-term benefit to the population of breeding Saltmarsh Sparrows through reduced tidal inundation. However, that marsh complex is likely experiencing subsidence and encroachment by *Phragmites* due to the lack of tidal flow.

Maine salt marshes also provide valuable habitat for high priority species like American Black Duck. Henry T. McLin

PRIMARY THREATS

Flooding is the primary cause of nest failure within studied populations in Maine. Further, nest depredation is relatively low, indicating that predator control is not likely to be an impactful management tool in Maine at this time. Southern Maine's coastline is dotted with residential housing and commercial development, so many large marsh systems are bisected by roads or separated from sandy beaches by homes. Most of Maine's rivers have one or more upstream dams. Therefore, natural sediment processes have likely been disrupted in most salt marshes, leaving them more prone to subsidence and erosion. Maine salt marshes have been extensively altered for salt marsh farming practices, for the construction of ships, wharves, and by other structures and uses. Although ditch, berm and alteration densities tend to be lower in Maine than in most of New England, such alterations are problematic in virtually all salt marshes.

KEY OPPORTUNITIES

Saltmarsh Sparrow populations throughout the state would benefit from restoration practices aimed at increasing the overall extent and availability of high marsh habitat, preventing the conversion of high marsh to low marsh, decreasing horizontal erosion and vertical subsidence, and identifying and conserving areas where salt marsh migration is feasible.

Many of Southern Maine's tidal marshes, such as this one along the Mousam River, were altered by agricultural activities over the last 400 years. InAweofGod'sCreation,/Creative Commons

Restoring degraded salt marsh, particularly high marsh, and prioritizing areas for restoration and enhancement for breeding marsh birds are top priorities. Examples include assessing ditch plug areas to determine whether remediation, modification, or removal is warranted. Additionally, restoration practices aimed at reducing the extent of surface water (i.e., pooling as a result of historic marsh modifications and/or marsh subsidence) are an important first step in salt marsh restoration in Maine. Restoration techniques should be assessed on a case-by-case basis as some relic modifications for Saltmarsh Sparrow may currently be beneficial to their population.

Removing tidal restrictions via culvert or bridge replacement, or otherwise addressing road crossings should be carefully considered; restoring tidal flow to tidally restricted marshes in other states did not improve

Saltmarsh Sparrow habitat (Elphick et al. 2015). Even if birds are reproducing successfully in marshes that are tidally restricted, it is important to recognize that such marshes are not sustainable for birds in the long term, due to lack of sediment supply. Therefore, partners need to develop methods that reverse the degradation of restricted marshes, while carefully preserving successful reproduction where it is occurring, so that there are sources for colonization once higher quality habitats are achieved.

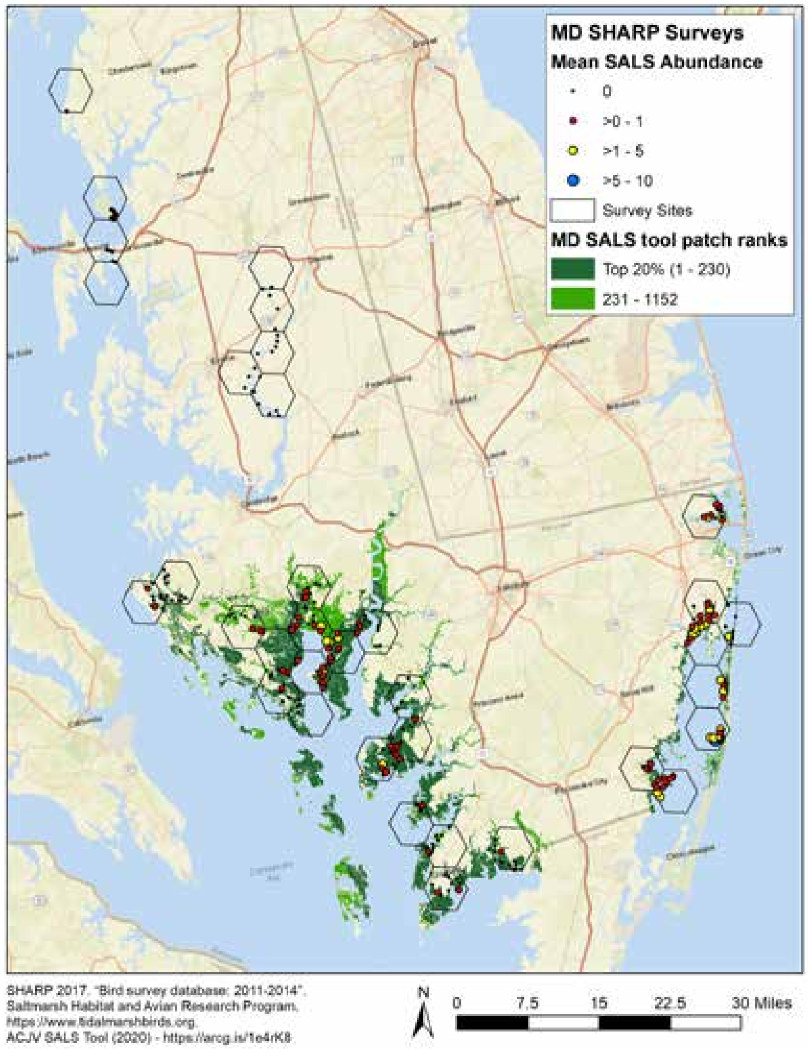
In southern Maine, protecting marsh migration space is challenging due to human development and Maine's steep coastal slopes. Relatively few areas have good potential for marsh migration under current land use; these should be conserved immediately. Land prices are lower in Maine than the rest of the region, making land protection a more viable option than in many other places. The Maine Natural Areas Program has created GIS layers of existing salt marsh habitat and marsh migration areas under differing sea level rise scenarios, degree of development, future marsh type, and buffer zones. These data can help identify places on the landscape that can accommodate and protect future tidal marsh function and values. Partners also 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. Riverine salt marshes that are located further inland may prove to be highly valuable habitats if they serve as refugia from sea level rise. Riverine salt marshes appear to experience different tidal flooding than coastal marshes. Amplified high marsh flooding follows heavy rain events when the river outputs increase the overall tidal range. However, the upstream location of these marsh systems may subject them to less extreme flooding during lunar tide cycles (i.e., spring tides) and may promote successful Saltmarsh Sparrow breeding under changing climatic conditions.

The secretive Saltmarsh Sparrow at Scarborough Marsh, south of Portland, Maine. Tom Wilberding/Creative Commons

Sea level rise is creating "ghost forests" on the landscape of Maryland's Eastern Shore, as pictured here in the distance. The removal of these dead snags and control of phragmites (foreground) is a promising start to allow successful migration of marsh habitat that will support Saltmarsh Sparrow and other priority high marsh species. Gwen Brewer

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Maryland	15,100*	(± 13,300)	25.20%	6,302	24,785

STATUS AND DISTRIBUTION



The breeding range of Saltmarsh Sparrow in Maryland has contracted significantly over the past 40-60 years. Historically, this species was considered a common to locally abundant breeding bird in Maryland tidal marshes as far north as Kent Narrows on the Eastern Shore, and uncommon and local on the Western Shore of the Chesapeake Bay as far north as Sandy Point State Park and up the Potomac River to Cobb Island. The only relatively recent breeding record on the Western Shore was at its very southern end, along the lower tidal portion of the Potomac River. In 2016 it was listed as In Need of Conservation on the Maryland Threatened and Endangered Species List.

Saltmarsh Sparrow breeds in most of the large marshes in Dorchester, Somerset, and Worcester Counties, although SHARP surveys in 2011-12 revealed distinct differences in abundances across this region due to differences in marsh vegetation. Abundance was highest in the Coastal Bays of Worcester County (mean detection = 1.00 birds/survey; n=72 points), where marshes are dominated by short-statured meadows of *Spartina patens* and short-form *Spartina alterniflora*. Saltmarsh Sparrow was found throughout the Coastal Bays but was particularly abundant in Newport Bay. In Dorchester County, mean detection during SHARP surveys was 0.36 birds/survey (n=88 points), with considerable variation across the county. Abundance was highest in the most extensive intact marshes around Fishing Bay and along the Transquaking River, where short-statured *Spartina* grasses dominate.

Abundance was very low in smaller marshes in the west of the county and the Toddville-Bishops Head area where marshes are largely dominated by black needlerush (*J. roemerianus*), and in severely ponded fragmenting marshes in the Blackwater River system, which are dominated by Olney's three-square (*Schoenoplectus americanus*). In Somerset and Wicomico counties, abundance was very low (mean detection = 0.09 birds/survey; n=59 points) due to the prevalence of black needlerush, except for the Deal Island peninsula where Saltmarsh Sparrows were more abundant in extensive *Spartina* marshes.

A significant population of Saltmarsh Sparrows occurs in one area of Somerset County that was not covered by the SHARP survey. The marshes on either side of Rumbly Point Road at the Irish Grove sanctuary, owned by Maryland Ornithological Society, were surveyed by walking a transect in May 2009, which yielded a count of 49 individuals over a 2.25 km transect along the road. The Central Chesapeake Islands (Bloodsworth, South Marsh, and Smith Islands) were not covered by the SHARP survey, but supported Saltmarsh Sparrow in both the first (1983-87) and second (2002-06) Breeding Bird Atlas projects.

PRIMARY THREATS

Causes of recent population declines in Maryland are unknown, but most likely due to marsh loss and habitat changes from sea level rise and other climate change effects (e.g., increased storm frequency and intensity). These impacts are exacerbated by land subsidence. Extensive or ill-timed marsh burning is a concern because of potential impacts on wintering birds and the potential for reduced habitat suitability (e.g., preferred deep thatch layer in high marsh) and food availability for breeding birds. Invasive *Phragmites* has degraded potential Saltmarsh Sparrow habitat, particularly in forest-marsh transition zones. On Assateague Island, horse-grazing may adversely impact Saltmarsh Sparrow by reducing the density of nesting vegetation.

KEY OPPORTUNITIES

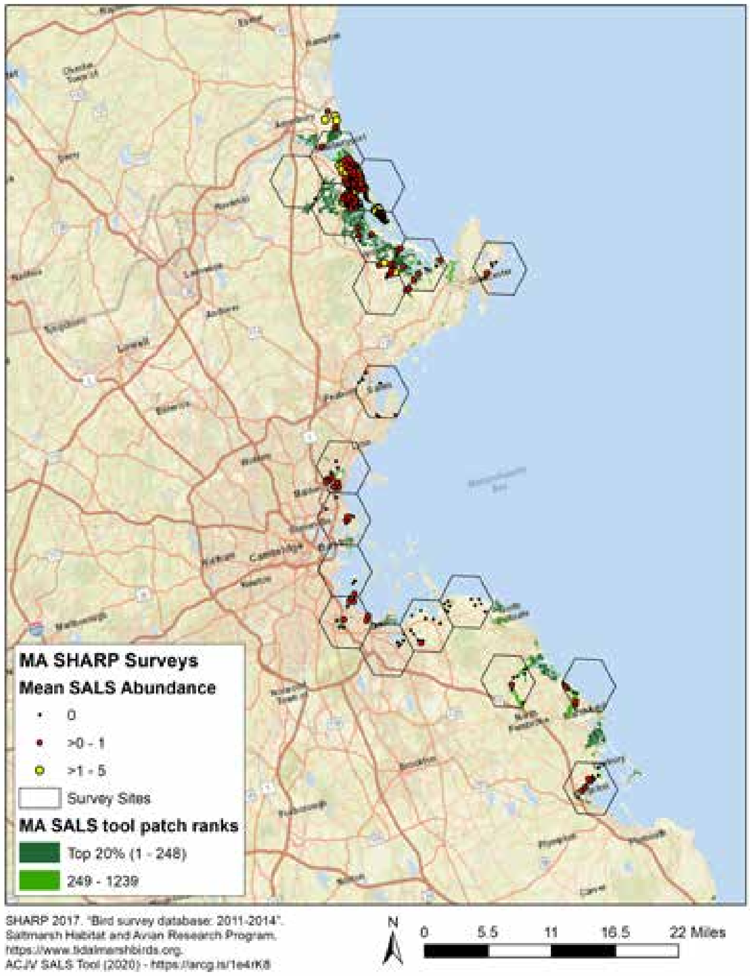
Maryland's extensive public marshlands provide many opportunities to support high marsh through ongoing and future marsh restoration projects. Maryland's first thin-layer deposition project restored 30 acres of disintegrating marsh at Blackwater NWR in 2016 (Whitbeck et al. 2019). The beneficial use of sediments dredged from federal navigation channels by USACE provides the best opportunity for rebuilding eroding and subsiding marshes. In 2020, USACE will place 135,000 cubic yards of material dredged from the Wicomico River on subsiding marsh at Deal Island WMA as a thin-layer deposition project, and there are plans to use Deal Island also for future dredge cycles, which occur every four years.

Subsidence in Maryland has caused widespread inundation of marshes. Excavating channels to drain waterlogged marsh is a promising management approach. Dave Curson

MASSACHUSETTS

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Massachusetts	6,200	(± 2,700)	10.40%	2,588	7,598

STATUS AND DISTRIBUTION

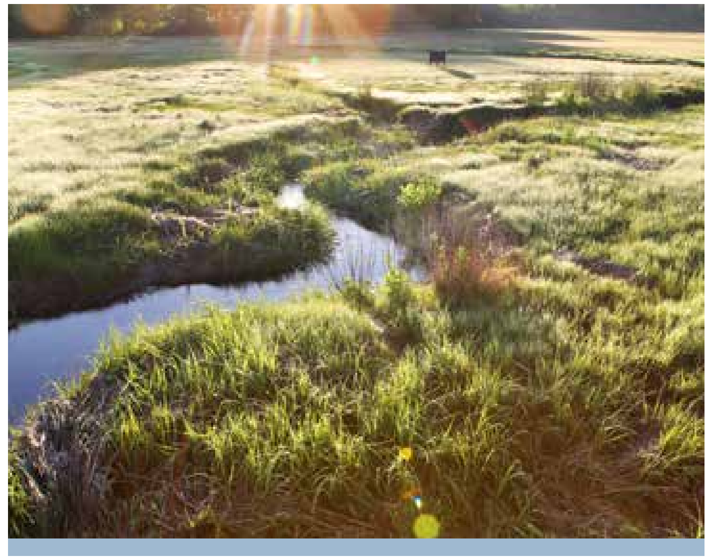


Massachusetts supports an estimated 6,200 nesting adult Saltmarsh Sparrows. This equates to 10% of the global population and the largest population in New England. Saltmarsh Sparrows are distributed throughout coastal areas of the state, although suitable habitat is intermittent and is naturally fragmented by sandy beaches and rocky coastlines. Patchiness of habitat quality has been exacerbated by human activities such as wetland filling and shoreline development. A possible result of having naturally fragmented habitat, Saltmarsh Sparrow can be found nesting in small salt marsh patches in southern New England ([Greenlaw et al. 2018](#)).

Salt marsh habitat with relatively high numbers of birds is still found on Cape Cod, Martha's Vineyard, Nantucket, the New Bedford area, Boston Harbor marshes, and the Great Marsh, which stretches from the New Hampshire border south to Cape Anne. The Great Marsh is the largest contiguous salt marsh in New England and is thought to be the single most important area for Saltmarsh Sparrow in Massachusetts and probably all of New England. Parker River NWR lies within the Great Marsh and supports over 3,000 acres of salt marsh habitat. For years, intensive studies on Saltmarsh Sparrows have been conducted on the refuge revealing high densities of the birds.

Although global population trends for the Saltmarsh Sparrow are particularly troubling, recent data suggests that its population in Massachusetts appears to be relatively stable. In 2011-2012, 257 point counts were conducted in salt marsh habitat throughout Massachusetts and no evidence for a population change was found. In contrast, populations declined at a rate of

-9.0% annually across the region since 1998. SHARP results from a single site where nest success was calculated revealed productivity rates consistent with a stable population. Similarly, the Massachusetts Breeding Bird Atlases provide evidence that the range of this species has increased in the state between the 1970s and the early 2000s. In the second atlas, an increase in occupied blocks was documented in every ecoregion where they had been documented during the first atlas, with the most pronounced increase in occupied blocks on Cape Cod, the islands, and the Boston Basin (Walsh and Petersen 2013).



The Great Marsh, on the north shore of Massachusetts, is the largest contiguous salt marsh complex north of New Jersey. Although relatively healthy and productive for Saltmarsh Sparrows, many parts of the marsh have been extensively modified since the colonial era by farming, roads, and other developments. Division of Ecological Restoration, Mass. Department of Fish & Game

PRIMARY THREATS

The primary threat to Saltmarsh Sparrow in Massachusetts is sea level rise and resulting reproductive failure from nest flooding during high tide and storm events (Ruskin et al. 2017). In the mid-Atlantic region, the impacts of nest failure from increased flooding has been exacerbated by high rates of nest predation (Roberts et al. 2017), and this could also be an issue in Massachusetts.

KEY OPPORTUNITIES

Geoff Wilson examines a marsh platform to evaluate hydrology and potential restoration strategies. Division of Ecological Restoration, Mass. Department of Fish & Game

Salt marsh restoration activities have begun at various locations across Massachusetts, including Herring River and Neponset River, and are currently ramping up in the Great Marsh. Due in large part to historical human activity (e.g., agriculture, mosquito control) the Great Marsh is undergoing subsidence that is converting high marsh habitat that is critical for nesting sparrows to open water and low marsh habitat. However, recent efforts directed in the Great Marsh have shown promise and include ditch remediation and runnelling to restore hydrology, sedimentation, and create micro-topography to reduce nest flooding. Over 50% of the Great Marsh is managed by the USFWS, Massachusetts Division of Fisheries and Wildlife, The Trustees of Reservation, and Greenbelt. These organizations have formed a strong partnership that is working on saltmarsh restoration in the region.

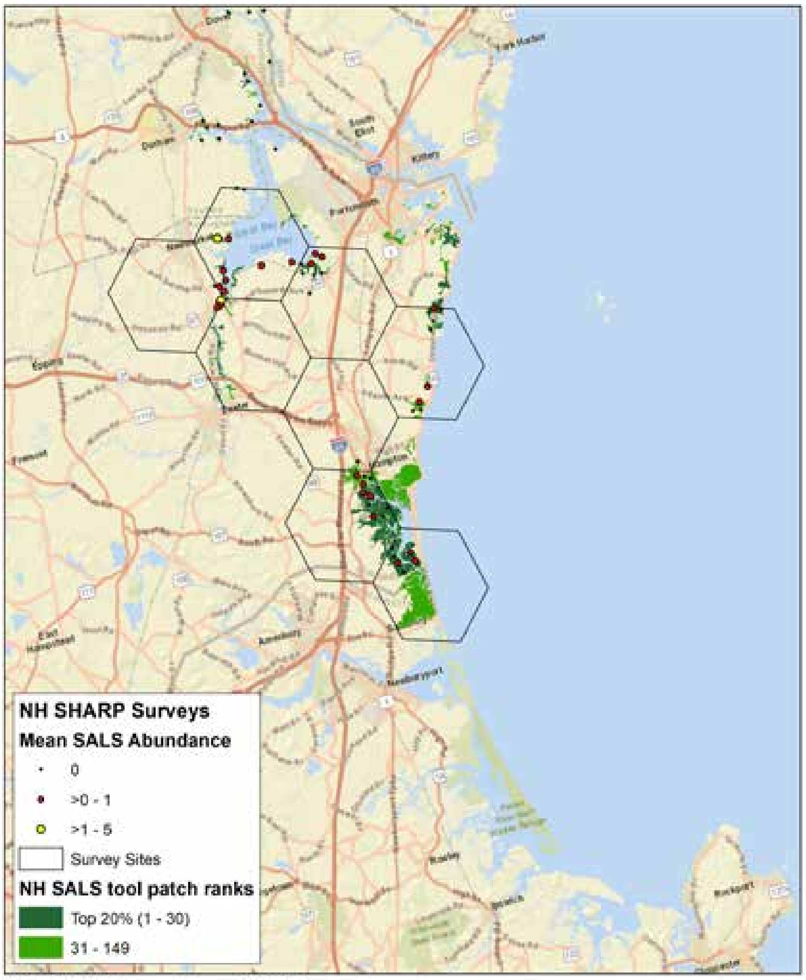
A primary focus of these saltmarsh restoration efforts is to support sustainable populations of Saltmarsh Sparrow in the Great Marsh while demonstrating actions that can be extended to salt marsh habitat throughout Massachusetts. Although Massachusetts appears currently to be a stronghold for the species, the threat of sea level rise is extreme. As a result, the Saltmarsh Sparrow is considered a species of greatest conservation need (SGCN) and was recently listed as a species of Special Concern under the Massachusetts Endangered Species Act.

NEW HAMPSHIRE

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
New Hampshire	1,080*	(± 1,692)	2%	459	2,315

STATUS AND DISTRIBUTION

The breeding range of Saltmarsh Saltmarsh Sparrows are found in most salt marshes along the immediate coast, with highest densities in an unditched section of Hampton Marsh north of Route 101. Within the overall Hampton-Seabrook estuary, the second highest density is in the area west of Route 1. The species is also found in marshes along the southern edge of Great Bay, with highest densities probably at Chapman's Landing where the Squamscott River enters the bay. It is also found in low numbers up the Squamscott River to Exeter. Apparently it once occurred more frequently in the northern section of Great Bay and even up the Piscataqua River, but very few records have been documented in recent years. Demographic studies in Great Bay marshes had the highest reproductive success found in the entire breeding range.



SHARP 2017. "Bird survey database: 2011-2014". Saltmarsh Habitat and Avian Research Program. https://www.tidalmarshbirds.org.
ACJV SALS Tool (2020) - https://arcg.is/1e4rK8

N 0 2.5 5 7.5 10 Miles

New Hampshire hosts approximately 2% of the breeding population of Saltmarsh Sparrows. However, like Maine, this estimate is complicated by the fact that all of New Hampshire is within the hybrid zone with the closely related Acadian Nelson's Sparrow, which also breeds around Great Bay and in smaller marshes along the northern coast. Hybrid individuals occur throughout New Hampshire's tidal marshes and cannot be distinguished from "pure" Saltmarsh Sparrows. Thus, 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" category can comprise around 20% of surveyed sparrows depending on the survey location and are not included in the state population estimate. Therefore, the presence of Saltmarsh Sparrows and their hybrids likely results in an underestimate of breeding sparrows within the State of New Hampshire.

PRIMARY THREATS

Despite its somewhat inland location, the Great Bay has considerable areas of salt marsh that provide important habitat for Saltmarsh Sparrows. rickpilot_2000/Creative Commons

Flooding is the primary cause of nest failure in populations studied in New Hampshire. Mitigating nest flooding will likely be a critical management tool for increasing Saltmarsh Sparrow populations throughout the state.

Under projected sea level rise predictions, many of New Hampshire's coastal salt marshes are likely to experience high marsh habitat loss. The riverine salt marshes along Great Bay may prove to be essential habitat under these changing conditions by serving as a refugia. Riverine marshes appear to experience tidal flooding that differs from that of coastal marshes, such that they tend to experience amplified high marsh flooding following heavy rain events. However, the upstream location of Chapman's Landing and Lubberland Creek salt marsh within Great Bay, may in fact subject them to less extreme flooding during astronomical tidal cycles (i.e., spring tides) and may therefore promote successful Saltmarsh Sparrow breeding under changing climatic conditions.

Nest depredation is relatively low, indicating that predator control is not likely to be an impactful management tool in New Hampshire at this time. According to the state's Wildlife Action Plan, the high ranking threats include tidal restrictions, sea level rise, shoreline hardening, fragmentation, and oil spills. Debris deposition, insecticide use, stormwater runoff, ditching, and invasive species (e.g., green crab) were listed as medium threats.

KEY OPPORTUNITIES

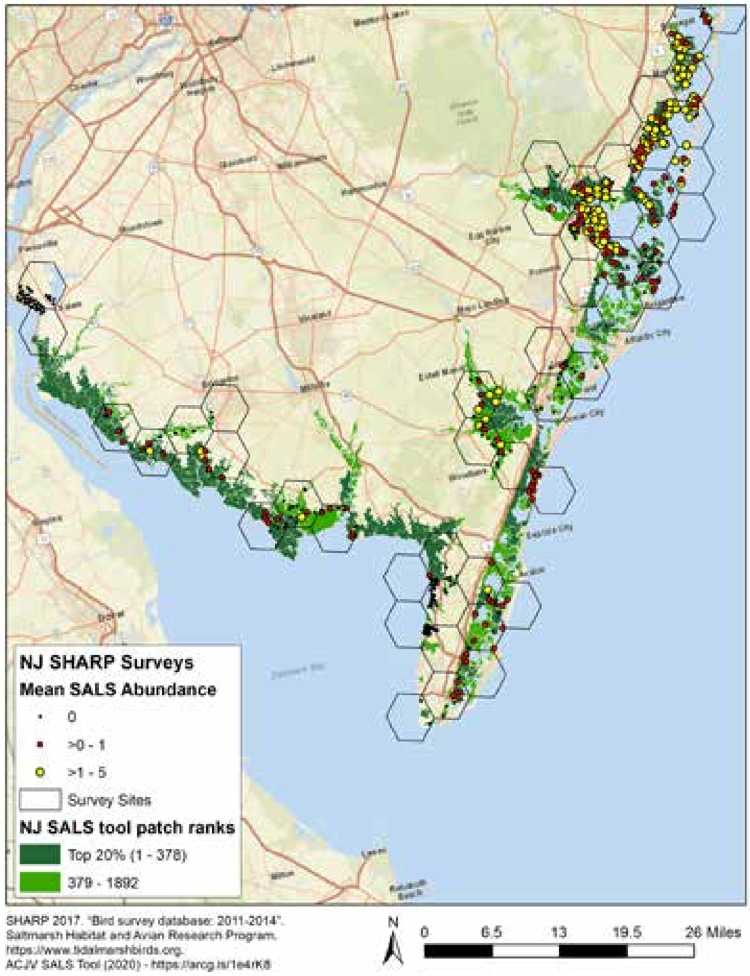
Saltmarsh Sparrows populations throughout the state would likely benefit from restoration practices aimed at reducing the extent of surface water (i.e., pooling as a result of historic marsh modifications and/or marsh subsidence), preventing the conversion of high marsh to low marsh, and increasing the overall availability of high marsh habitat that is needed to prevent nest flooding.

OTHER INFORMATION

- Hampton-Seabrook Restoration Compendium (from Eberhardt and Burdick 2008) https://scholars.unh.edu/cgi/viewcontent.cgi?article=1094&context=prep
- SLAMM models: https://www.nhcaw.org/project/resilient-nh-coasts-sea-level-affecting-marshes-model-and-data-development/
- Avian Use of Hampton-Seabrook Estuary (NH Audubon report from 2008): contact Pam Hunt (phunt@nhaudubon.org)

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
New Jersey	19,900	(± 13,600)	33.20%	8,306	25,734

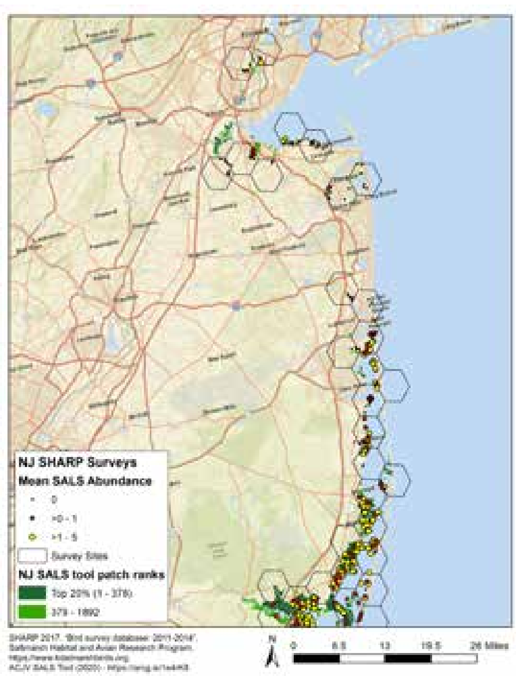
STATUS AND DISTRIBUTION



Saltmarsh Sparrow is most common in Atlantic Coast *Spartina* salt marshes in Atlantic and Ocean counties, with limited numbers in Atlantic-side marshes of Cape May County. They are a relatively scarce and local breeder on the Delaware Bayshore in Cape May and Cumberland counties. New Jersey has the highest breeding abundance of Saltmarsh Sparrows of any state, containing a third of the global population. New Jersey supports the second highest area of salt marsh in the northeast region (202,436 acres) (SHARP 2015).

PRIMARY THREATS

The primary threats are sea level rise, which causes the loss of high marsh habitat and conversion to low marsh. SHARP researchers working at Forsythe NWR have found that depredation of nests and young is the greatest cause of nest failure in New Jersey. It is unclear whether or what proportion of nests would be lost due to nest flooding by extreme tides or storm events (the primary cause of nest loss in the northern part of the breeding range) if they were not depredated.



KEY OPPORTUNITIES

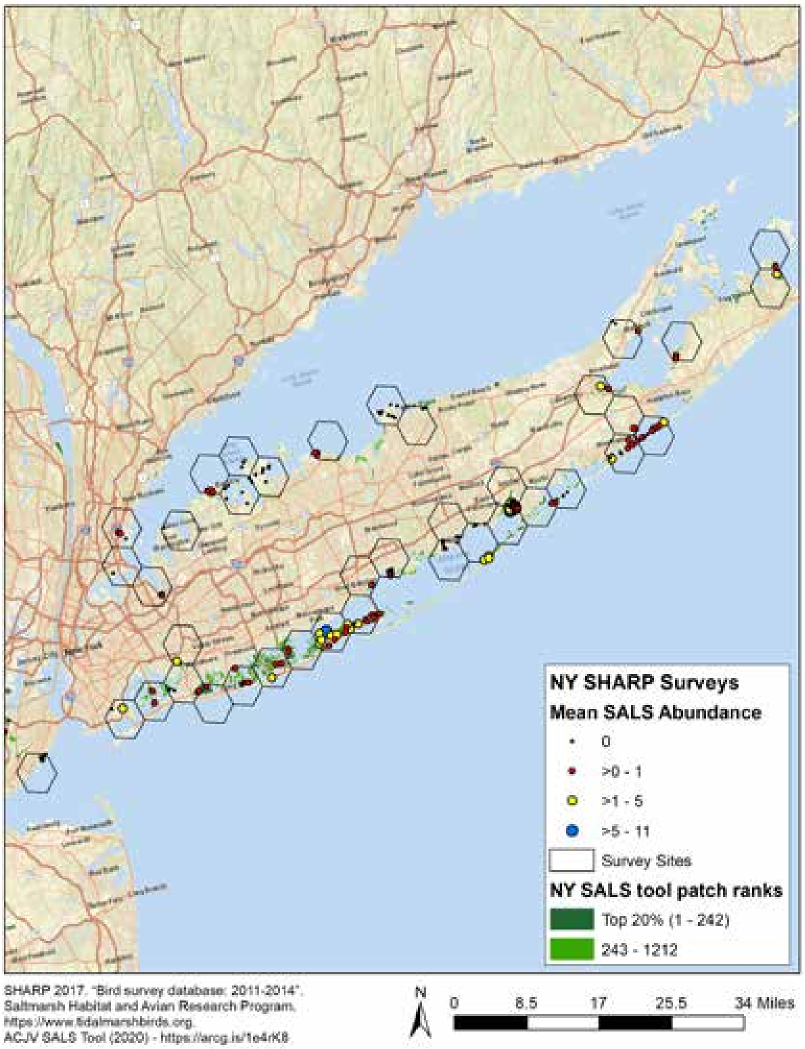
There are extensive acres of ghost forest in New Jersey that may be limiting marsh migration and rendering potential high marsh patches unsuitable for Saltmarsh Sparrow. Remediating the extensive grid-ditching across the state is a large area of opportunity. Also, much of New Jersey's marshes are along the Interstate Waterway and are dredged for navigation, which represents potential to use dredged sediments to maintain or improve resiliency (e.g., through thin-layer deposition) and nesting habitat for Saltmarsh Sparrow.

Most of New Jersey's marshes were at one point used for agriculture, and the majority of high marsh areas were managed with berms or dikes to reduce flooding and improve productivity of salt hay meadows. Most of these areas may have experienced subsidence due to the lack of regular flooding (i.e., aeration, decomposition, and compaction of marsh peat) and sediment inputs. However, there are tens of thousands of acres with restoration potential. Areas where tide gates may be needed to gradually reintroduce tidal flow represent opportunities for regulating (i.e., preventing) flooding of nesting habitat during extreme tides or storm events, which may provide areas of high breeding productivity, as long as nest predation rates are reasonably low or can be managed.

Thompson marsh restoration project. Shane Goodall

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
New York	5,300	(± 1,300)	8.7%	2,170	4,285

STATUS AND DISTRIBUTION



Saltmarsh Sparrows occur in *Spartina patens/Distichlis spicata* salt marshes in New York (NYS DEC 2014). They are rarely found in marshes less than 0.9-1.97 acres but have occurred in smaller marshes (NYS DEC 2014). New York has the fourth highest abundance of breeding Saltmarsh Sparrows in the northeast, containing 8.7% of the northeast regional population (ACJV 2019). The majority of Saltmarsh Sparrows breeding in New York (~5000 individuals) are found on Long Island (Wiest et al. 2016). Additional nesting sites in the New York City (NYC) area include Sawmill Creek in Staten Island, Idlewild in Queens, and Four Sparrow Marsh in Brooklyn (Ruskin et al. 2017).

New York supports 27,673 acres of salt marsh, the majority of which occurs on Long Island (ACJV 2019). NYC 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 seventeenth most populous island in the world (ACJV 2019).

Saltmarsh Sparrows are currently under state review for listing and are listed as a Species of Greatest Conservation Need by the New York State Department of Environmental Conservation. Audubon New York has identified Saltmarsh Sparrow as a highest priority and is actively engaged in furthering conservation for the species (ACJV 2019).

PRIMARY THREATS

The primary threats to Saltmarsh Sparrows in New York are sea level rise and the loss of marsh habitat. In the last century, sea level has increased by 30 cm in NYC and 22-39 cm in surrounding areas (Hartig et al. 2002). 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 (Hartig et al. 2002). Other factors that are associated with salt marsh habitat loss and degradation in New York include excess nitrogen leading to marsh destabilization (Alldred et al. 2017), lack of mineral sediment and increased organic matter deposition (Peteet et al. 2018), mosquito ditching, and impeded tidal flow. 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.

In Long Island Sound, nest flooding is the primary cause of nest failure (Bayard and Elphick 2011). It is not known if nest flooding events are a natural part of the reproductive biology of Saltmarsh Sparrows or due to increased sea level rise, but birds that nest higher up in vegetation to avoid flooding may suffer increased nest depredation (Bayard and Elphick 2011).

KEY OPPORTUNITIES

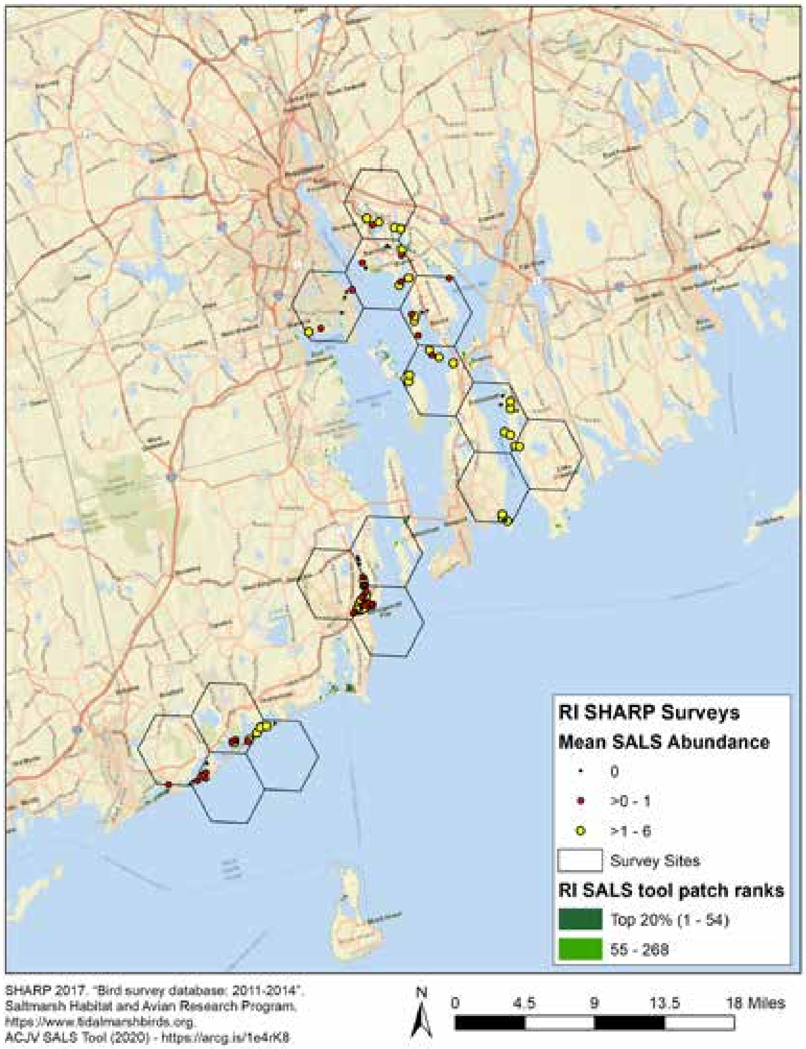
Since much of the New York coastline has been developed, the current potential for marsh migration is limited. It's important to protect undeveloped coastal areas and facilitate marsh migration. There are opportunities to partner with municipalities, such as the Town of Brookhaven, and other landowners to take advantage of buyouts and coastal retreat planning efforts.

In New York, beneficial actions for Saltmarsh Sparrow include reducing surface water pooling, through ditch remediation and/or raising marsh elevation; measures that prevent the conversion of high marsh to low marsh; and increasing suitable high marsh habitat at the highest elevations, which are less prone to nest flooding (Kocek 2016). New mosquito control projects using an integrated marsh management technique to restore flow to degraded tidal marshes have been found to be beneficial in reducing invasive vegetation and increasing native vegetation, nekton, and avian species (Rochlin et al. 2012).

Volunteers plant salt marsh grasses to restore and protect a degraded marsh at Sunken Meadow State Park, New York. Connecticut Fund for the Environment

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Rhode Island	900	(± 300)	1.5%	376	583

STATUS AND DISTRIBUTION



Saltmarsh Sparrows nest in marshes throughout Narragansett Bay and along the southern shores of Rhode Island. Initial nest laying occurs in late May and early June. A study in 2017 and 2018 on Jacob's Point breeding grounds found nests clustered non-randomly around certain areas of the marsh consistently between years. While this suggests a preference for specific marsh characteristics, further analysis is required to uncover determining factors. Most breeding residents migrate from the area to their wintering grounds in August. However, a small number of males will remain in the state through October, utilizing the *Spartina alterniflora* habitat for foraging alongside Nelson's Sparrow (Reinert et al. 2018).

SHARP researchers monitored 72 nests from 2011 and 2012 and found average seasonal fecundity of 0.46 successful broods per female per year. Researchers banded 174 individuals from two study sites and estimated that Saltmarsh Sparrow populations in Rhode Island were declining at the rate of 0.30-0.34 per year until 2018, which would accelerate to 0.6-0.64 per year by 2063 (Hodgman et al. 2015). A mark-recapture study from 1993-1997 at Galilee Bird Sanctuary in Rhode Island estimated a mean apparent annual survival rate of 14.4% and 39.6% for juveniles and adults, respectively (DiQuinzio et al. 2001), with no significant difference in survival between sexes. In comparison, a 2011-2014 study found survival rates for male and female Saltmarsh Sparrow across the breeding range to be 0.49 and 0.46, respectively.

From 2014-2019, Rhode Island Department of Environmental Management (DEM) and University of Rhode Island (URI) coordinated point count surveys throughout the state as part of the effort to publish the Rhode Island Bird Atlas 2.0. Saltmarsh sparrows were detected in a total of 35 blocks and confirmed as breeders within 12 of those blocks. This was a 17% increase in the overall distribution of Saltmarsh Sparrows from the Rhode Island Bird Atlas 1.0 surveys from 1982-1987, but a 40% decline in the total number of blocks with confirmed breeders.

PRIMARY THREATS

Back barrier salt marsh at high tide in Jerusalem, Rhode Island. Mary Gillham/Creative Commons

In Rhode Island, as in much of the breeding range, the primary threat is the loss of tidal marsh and statistically significant decreases in *Spartina patens* cover (high marsh nesting habitat) and increases in *Spartina alterniflora* cover documented between 2000 and 2013 (Raposa et al. 2017b). This is being driven primarily by sea level rise, which increased by 2.7 mm/yr from 1930 to 2012, with the rate from 1985 to 2000 averaging 4.6 mm/yr and from 2000 to 2013 averaging 7.5 mm/yr (Raposa et al. 2017a). Losses are exacerbated by historic and ongoing stressors related to coastal development (e.g., storm water run-off, nutrient input, tidal restrictions). An assessment of 49 Surface Elevation Tables across five marshes in Rhode Island found a mean rate of elevation gain of 1.4 mm/yr with none of the sites keeping pace with sea level rise, and all currently below the elevations where maximum productivity would occur for marsh plants (Raposa et al. 2017a). Overall, marshes in Rhode Island are expected to experience losses of 13 to 87 percent of marsh area (NWI 2010) by 2100 using sea level rise scenarios of 0.30 to 1.5 m (RI CRMC 2015).

Results of SHARP research and monitoring of population trends along northeastern states suggest that downriver tidal restrictions posed substantial risk to nest survival; 72% of the survey points at Rhode Island's study sites were affected by downriver tidal restrictions (Hodgman et al. 2015). Marshes require sediment accretion and accumulation of dead vegetation in order to respond to sea level rise, but tidal restrictions limit the sediment available downstream for this process. Additionally, Rhode Island is the second most populated state per capita, with extensive infrastructure along the coast. Impervious surfaces from roads and parking areas lead to surface water runoff into salt marshes. Marsh ditching for irrigation and farming alters local hydrology and makes marshes more susceptible to high-tides.

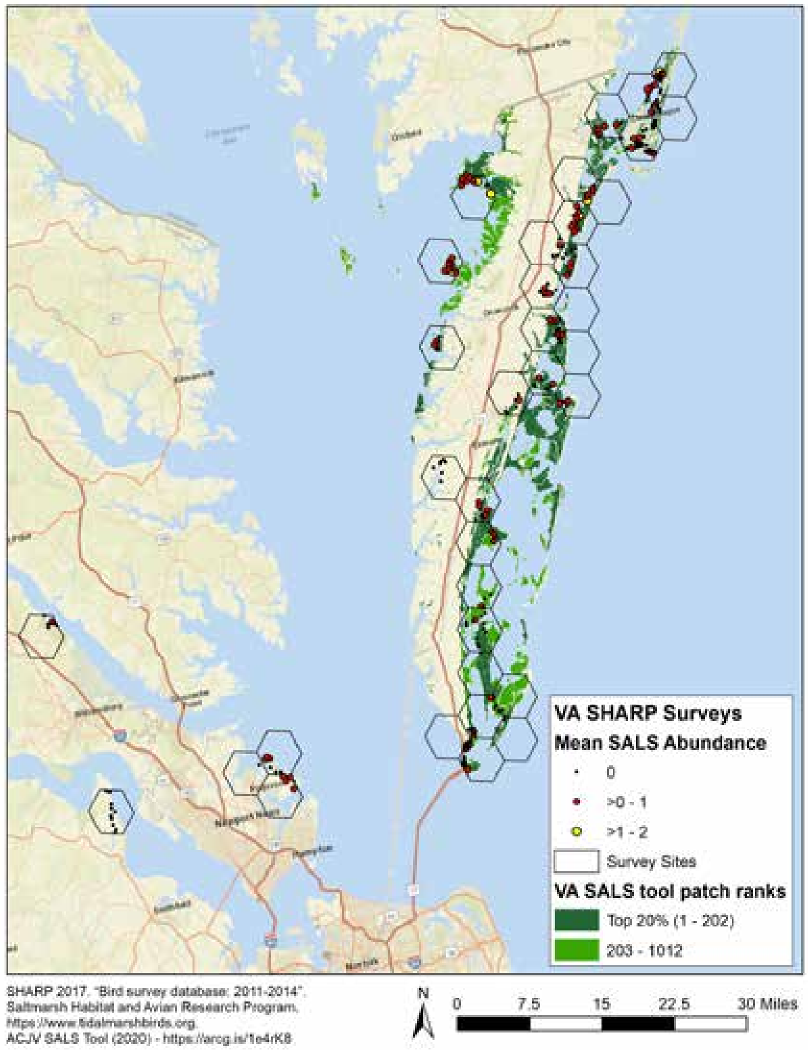
KEY OPPORTUNITIES

Salt marsh restoration at Sachuest Point. Save the Bay

Rhode Island is fortunate to have a collaborative group of partners who are working to evaluate marsh health, implement conservation actions, and monitor the results of those activities. The Coastal Resources Management Council and RI DEM are actively securing funding and spearheading projects, and the EPA Atlantic Ecology lab and the Narragansett Bay Estuarine Research Reserve are implementing extensive research. In addition, the URI, the RI Natural History Survey, NRCS, and the USFWS, as well as strong non-governmental partners like Save the Bay, are supporting various aspects of project implementation.

State	Population Estimate	±95% Confidence Interval	State % of Total	Population Goal	Minimum Acreage Needed to Meet Population Goal
Virginia	4,200	(± 2,600)	7.00%	11,117	583

STATUS AND DISTRIBUTION



Virginia represents the southern range limit for breeding Saltmarsh Sparrow. Breeding is currently confined to Accomack County in the northern portion of the Delmarva Peninsula. The peninsula is tilted upward and exhibits an elevation gradient from south to north. Saltmarsh Sparrow breeds in higher marshes from the MD/VA border south to the Accomack/ Northampton County line. Along the bayside (west) margin of the peninsula, occurrence during the breeding season has been documented in the extensive marshes from Saxis Marsh south to Hyslop Marsh. Along the seaside (east) margin of the peninsula, occurrence during the breeding season has been documented from Chincoteague south to the county boundary. A contraction of the breeding range in Virginia has been documented (Watts 2005). Historically, breeding occurred along the western shore of the Chesapeake Bay, apparently including the extensive marshes of Gloucester, Mathews, Middlesex, and Northumberland Counties (Bailey 1913). The southernmost evidence of breeding throughout the species range was from Buckroe in Hampton in 1911 (Clapp 1997). The last evidence of breeding within this large region was a nest documented by Watts in 1992 at Four Points Marsh in Gloucester County (Watts 1992, 2005). Breeding has also been documented within the complex of islands (i.e., Tangier, Smith, Great Fox) in the upper Chesapeake Bay of Accomack County. A nest with eggs was located by Huppman on May 12, 1976 in the Great Fox Island complex (Clapp 1997). No occurrences have been documented within the Bay islands in recent decades. Finally, breeding along the Delmarva Peninsula appears to be contracting to the north. Between the 1930s and 1990s nesting extended approximately 8-10 km into northern Northampton County within the seaside marshes (Kinsie and Scott 1981; Clapp 1997; Brinkley 2000). Birds have not been detected within this southern fringe of the breeding range in recent years.

Virginia represents a very significant wintering area for Saltmarsh Sparrow. Birds are distributed throughout large salt marshes on the outer coast, the main stem of the Chesapeake Bay and up major tributaries to approximately 5 ppt salinity. During the winter months, Saltmarsh Sparrow co-occurs with Nelson's Sparrow. Combined densities of the two species are 1.6 ± 0.15 birds/ha with the highest densities along the Western Shore of the Chesapeake Bay compared to those along the Delmarva Peninsula (Watts et al., unpublished). Saltmarsh Sparrows appear to use wetter portions of the marsh compared to Nelson's and seem to feed higher in the food chain as their diet has a higher invertebrate content. A winter banding study (2006-2014) throughout the state captured more than 1,000 individual Saltmarsh and Nelson's Sparrows (Watts and Smith 2015) in similar proportions (52.5% and 47.5%, respectively). Winter age ratios for Saltmarsh Sparrows in Virginia are biased toward hatch-year (HY) birds (HY = 61.9% versus After Hatch Year = 38.1%). However, this bias varied across years, with hatch-year birds representing 36.7% to 70.3% of the yearly sample.

PRIMARY THREATS

Sea level rise and associated flooding represents the most pressing threat to the population in Virginia. This threat manifests in three different ways including: 1) reduced reproductive rate due to nest flooding; 2) loss of nesting habitat as marshes convert from high to low vegetation; and 3) loss of winter habitat due to chronic inundation. Virginia has conducted no targeted work on nest loss rates due to flood tides. An examination of vegetation change, using a series of aerial photographs of several sites along the bayside of the Delmarva Peninsula, documented a dramatic shift of marsh composition from high to low marsh between 1994 and 2010 (Wilson and Turrin 2014).

Work on the Delmarva seaside during winter has shown that Saltmarsh Sparrows are forced to leave marsh islands for the mainland during extreme tidal events. These events may last days and chronic inundation over time renders these patches increasingly less suitable. An additional concern during the breeding season is nest loss to mammalian predators. An investigation of nest loss to predators using artificial nests within Accomack County recorded a daily nest survival rate of 0.88, including 64% loss after 7 days of exposure (Wilson and Watts 2014).

KEY OPPORTUNITIES

Saltmarsh Sparrows breeding in Virginia would likely benefit from focused research on the influence of tidal flooding on reproductive rates, which would help inform efforts to facilitate marsh migration. There is a need to identify where to facilitate marsh migration to maximize benefits to Saltmarsh Sparrow and other high-marsh obligates. Work is also needed to identify current breeding and winter strongholds to guide conservation implementation, help to refine population estimates, and clarify the importance of Virginia in global conservation efforts.

FLORIDA

Florida High March Acreage: 192,992
Priority High Marsh Acres: 124,512

STATUS AND DISTRIBUTION

Nelson's Sparrow in Florida marsh. Florida Fish & Wildlife Commission

Saltmarsh Sparrows are regular migrants and winter along both coasts of Florida, occurring in 24 of 35 coastal counties (eBird). Population estimates are not available for the state but anecdotal reports suggest that significant numbers occur in the marshes along the northeast Atlantic coast of Florida (A. Schwarzer 2020, pers. comm.). Lower densities are reported along the Gulf Coast, but their distribution is widespread, suggesting that cumulative totals may be significant. In fall, birds appear to arrive in October (eBird). Northbound migration appears to be similar to that in Georgia and South Carolina, with birds departing mid-April through mid-May. Saltmarsh Sparrows are dispersed widely but patchily across approximately 928,128 acres of coastal marshes and can be found regularly in coastal marshes from the Georgia-Florida state boundary south to Cape Canaveral on the Atlantic Coast, and from the eastern Panhandle (St. Vincent NWR/ Apalachicola Bay) to Tampa Bay on the Gulf coast. There are also recent records from south Florida, though both habitat acreage and bird numbers are smaller than farther north in the state (eBird). Along the Atlantic portion of their range, Saltmarsh Sparrow tends to be widely dispersed across tidal marshes at low tide, but congregates in much greater densities during extreme high tides along marsh edges in patches of Sea Oxeye (*Borrichia frutescens*), Black Needle Rush (*Juncus roemerianus*), and hammocks dominated by Wax Myrtle (*Myrica cerifera*) and other shrubby vegetation. During regular daily high tides, birds may also find temporary refuge in higher patches of tall-form Smooth Cordgrass (*Spartina alterniflora*). Much less is known about daily habitat use patterns along the Gulf Coast, where tidal amplitude is much smaller than the Atlantic coast. These marshes are typically dominated by Black Needle Rush with sometimes large patches of Sand Cordgrass (*Spartina bakeri*) in the high marsh and fringes of Smooth Cordgrass on the outer edges.

PRIMARY THREATS

Coastal marshes in Florida are threatened by sea level rise, fragmentation, and the northward migration of mangroves. Marshes in northeast Florida are particularly vulnerable; there may be little opportunity for marsh migration given the area's geomorphology and human development.

KEY OPPORTUNITIES

Florida marshes along the Gulf coast may have significant opportunities to migrate with proper upland management since large portions of the coast are under conservation management. Survey and banding efforts should be implemented to determine the current status of wintering Saltmarsh Sparrow in the state.

Saltmarsh Sparrow banding in Georgia. Todd Schneider
Inset photo: Nanotagged Saltmarsh Sparrow. Tim Keyes/GADNR

Georgia High March Acreage: 101,575
Priority High Marsh Acres: 77,843

Saltmarsh Sparrow habitat near the Georgia Coast in Brunswick. Todd Schneider

STATUS AND DISTRIBUTION

Saltmarsh Sparrow regularly migrates and winters along the entire Georgia coast. There is no winter population estimate for Saltmarsh Sparrow in Georgia, but given the extent of suitable winter habitat and the number captured at small areas that have been trapped, it is likely that many thousands of Saltmarsh Sparrow regularly winter in Georgia. Fall records indicate that birds arrive as early as late September (Beaton et al. 2003). Northbound migration of nano-tagged birds from Georgia was initiated from April 20th to May 12th, with arrival on presumed breeding grounds between April 26th and May 30th. A story map showing the northward migration of Saltmarsh Sparrow can be seen here: http://arcg.is/2AMaz0s.

From late September to early May, Saltmarsh Sparrow are widely dispersed across ~370,000 acres of coastal marshes. Banding efforts from Tybee Island to St Andrews Sound found the greatest numbers at remote marsh islands and hammocks (150 caught) accessible only by boat, compared to causeways (99 caught), despite greater effort on causeways. Saltmarsh Sparrow tend to be widely dispersed across tidal marshes at low tide, but during extreme high tides they congregate in much greater densities along marsh edges in patches of sea oxeye (*Borrichia frutescens*) and black needle rush (*Juncus roemerianus*).

Since 2011, 249 Saltmarsh Sparrow (both *A. cauducutus* and *A. diversus* subspecies) and 328 Nelson's Sparrow individuals were banded in Georgia. Of Saltmarsh Sparrows captured, 168 were identified as *A. cauducutus*, 58 as *A. diversus*, and one was apparently a hybrid Saltmarsh Nelson's Sparrow. Saltmarsh Sparrow tends to be slightly less common at trapping sites, which may reflect their behavior rather than abundance, as they tend to roost later and leave earlier around high tides. Band recaptures indicate high levels of site fidelity within and across years.

PRIMARY THREATS

Georgia coastal marshes continue to be impacted by sea level rise and fragmentation, though these threats are likely much less acute than on the breeding grounds. There is concern that exposure to contaminants at foraging sites in Georgia may be harmful. Many sparrows winter in the Brunswick area, which has high mercury levels due to historic industrial pollution. Research in Virginia suggested that Saltmarsh Sparrow accumulate mercury during the breeding season and lower their levels during winter through internal detoxification or feather molt and growth. If birds are exposed to additional mercury during winter on Georgia's coast, it may be problematic.

KEY OPPORTUNITIES

The vast expanse of coastal marsh in Georgia will provide abundant suitable wintering habitat for the foreseeable future. Systematic surveys such as low tide line-drag surveys through salt marsh habitat would allow a state-wide Saltmarsh Sparrow winter population estimate.

Pamlico Sound, North Carolina. Alan Strakey/Creative Commons

Georgia High March Acreage: 101,575
Priority High Marsh Acres: 77,843

STATUS AND DISTRIBUTION

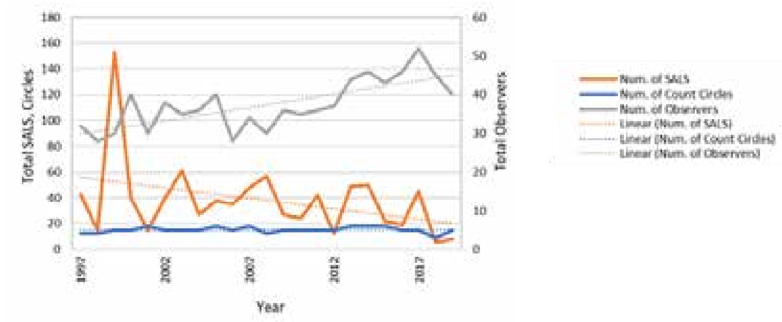


Figure A1. Results of Christmas Bird Count for Saltmarsh Sparrows in North Carolina, 1997-2019.

Saltmarsh Sparrow migrates and winters along the entire North Carolina coast, but is the rarest of the four coastal marsh-endemic sparrows that overwinter in the state. Despite an increase in the number of observers and a consistent number of count circles reporting Saltmarsh Sparrow presence, there was a persistent decline in the number of Saltmarsh Sparrow detected during Christmas Bird Count surveys from 1997-2019 (Figure A1).

Saltmarsh Sparrows is a Species of Greatest Conservation Need in the North Carolina State Wildlife Action Plan. The Natural Heritage program gives it a status of W3 on the North Carolina Animal Watch List due to inadequate information about their distribution and rarity. According to Natureserve it has a state rank of S4N, as it is apparently secure and widespread (non-breeding population), usually with more than 100 occurrences and more than 10,000 individuals; at a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors. Its global rank is G2, Imperiled. It is Endangered according to the IUCN Redlist.

Saltmarsh Sparrows typically arrive in southeast NC in October and depart for the breeding grounds sometime in late March-early April (Winder et al. 2012). They demonstrate a high degree of site fidelity both regionally across years and seasonally at a local scale (Winder et al. 2012; Danner et al. 2020; unpublished).

OTHER INFORMATION

According to Danner et al. (2020, unpublished), Saltmarsh Sparrow wintering in NC have relatively small home ranges. Radio-tracked adults show very specific habitat preference, spending most of their time in the short form *Spartina alterniflora*. Recent evidence suggests that mortality in the winter of 2019 (January–March: 0.43) was disproportionately higher than other seasons (Danner et al. 2020, unpublished).

PRIMARY THREATS

Sea level rise and extreme stochastic weather events will continue to compress availability of suitable habitat. There is a lack of adequate studies across the species' range, and a lack of sea level rise and habitat models that relate to this species and its specific habitat features (e.g., short vs. tall *Spartina alterniflora*).

KEY OPPORTUNITIES

Large expanses of relatively undisturbed marsh habitat, especially in the Albemarle and Pamlico Sounds, may provide sufficient wintering grounds to help sustain the full annual life-cycle.

Saltmarsh Sparrow habitat in South Carolina. Craig Watson/USFWS
Inset photo: Three subspecies of Nelson's Sparrow (from right to left; Ammodramus nelsoni nelsoni, A. n. alterus, A. n. subvirgatus. Pamela Ford

South Carolina High March Acreage: 101,319
Priority High Marsh Acres: 53,445

Coastal development is an ongoing threat throughout the wintering range. James Baughman/Creative Commons

STATUS AND DISTRIBUTION

Saltmarsh Sparrows regularly migrate and winter along the entire South Carolina coast. There is no population estimate for wintering Saltmarsh Sparrow in the state, but based on the extent of suitable wintering habitat and captures in the small areas where birds have been trapped, many thousands of Saltmarsh Sparrow likely winter in South Carolina. Fall arrivals in the state are similar to Georgia, with birds arriving in late September (eBird). Northbound migration is assumed to be similar to Georgia, with birds departing mid-April through mid-May.

Saltmarsh Sparrows are dispersed widely across approximately 432,430 acres of coastal marshes, and can be found from Savannah, Georgia north to Waites Island, near the North Carolina border. Saltmarsh Sparrow tends to be widely dispersed across tidal marshes at low tide but congregates in much greater densities during extreme high tides along marsh edges in patches of sea oxeye (*Borrichia frutescens*), black needle rush (*Juncus roemerianus*), and hammocks dominated by wax myrtle (*Myrica cerifera*).

Both Saltmarsh Sparrow subspecies (*A. caudacutus* and *diversus*) are found at most locations where banding has occurred. Saltmarsh Sparrows tend to be slightly less common than Nelson's Sparrows at trapping sites, though that may reflect behavioral differences because they tend to come in to roost later and leave earlier around the high tide. Band recaptures indicate a high degree of inter- and intra-annual site fidelity. In a collaboration between the Town of Kiawah Island and the USFWS, Saltmarsh Sparrows nano-tagged between 25 April - 6 May on Kiawah Island (n = 6) initiated northbound migration from the South Carolina coast between 11 - 15 May (Smith 2020, pers. comm.). Additionally, Saltmarsh Sparrows tagged in coastal Georgia migrated over the Charleston area between 17 April - 13 May (n = 9). Arrival on presumed breeding grounds of Kiawah-tagged Saltmarsh Sparrows was between 17 May - 2 June (n = 7).

PRIMARY THREATS

Coastal marshes in South Carolina will continue to be impacted by sea level rise and fragmentation; however, these threats are likely much more acute on the breeding ground.

KEY OPPORTUNITIES

The vast expanse of coastal marsh in South Carolina will provide abundant suitable wintering habitat for the foreseeable future, despite losses to sea level rise. Acquisition of high marsh and upland transition areas may be important. Survey efforts should be implemented to determine the current status of wintering Saltmarsh Sparrow in the state.