Roseate Tern
Northeastern North American Population
(Sterna dougallii dougallii)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
New England Field Office
North Atlantic-Appalachian Region
Concord, NH

August 2020

5-YEAR REVIEW

Species reviewed: Roseate Tern (Northeastern North American Population)
(*Sterna dougallii dougallii*)

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1.0 GENERAL INFORMATION

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1.2 Methodology used to complete the review:

This 5-year review, conducted primarily by the lead recovery biologist for the Northeastern North American[1] population of the roseate tern (roseate tern) in coordination with other U.S. Fish and Wildlife Service (Service) offices and other technical experts, summarizes and evaluates new information relevant to the listing status of the species. New data and information regarding the species' population status and habitat used in this report were based on peer-reviewed literature, unpublished reports, annual roseate tern recovery meetings, and communications (see References section). The administrative record, including all pertinent literature and documents used for this review, is on file at the New England Field Office.

1.3 Background

1.3.1 FR Notice citation announcing the species is under active review:
83 FR 39113-39115 (August 8, 2018)

1.3.2 Listing history
Original Listing
FR notice: 52 FR 42064-42068
Date listed: November 2, 1987
Entity listed: Subspecies
Classification: Endangered

1.3.3 Associated rulemakings: None

1.3.4 Review History:
Previous 5-Year Review
Initiated: 73 FR 76373 76375
Request for Information: Clarification: 75 FR 17153-17154
Date Finalized: September 30, 2010
Results: Substantial new information was provided in the review, however, no change in listing status is recommended.

1.3.5 Species Recovery Priority Number at start of 5-year review:
3. This ranking refers to an entity listed at the subspecies level with a high degree of threat and high recovery potential.

1.3.6. Current Recovery Plan:
Name of plan: Roseate Tern (*Sterna dougallii*) Northeastern Population Recovery Plan, First Update
Date Issued: November 05, 1998

[1] Also known as the Northwest Atlantic population of the roseate tern, or the Northeastern population of the roseate tern. Herewith, the population will be addressed as the Northeastern population to distinguish the population from the Caribbean roseate tern population, or the Northeastern Atlantic roseate tern population of Europe.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

The roseate tern was reviewed under the DPS policy in the 2010 5-Year Review (USFWS 2010) (2010 review). For a more in-depth discussion on the application of the 1996 DPS policy to the roseate tern and description of the two listable roseate tern entities as the Northeast DPS and Caribbean DPS, see section 2.1.2 of the 2010 review.

There is no new information relative to the discreteness of the two populations that would indicate the status of the Northeast DPS and Caribbean DPS should be changed. Although the two populations intermix during migration and on the wintering grounds, there is still no concrete evidence for interchange of breeders (based on band resighting at breeding colonies).

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes, the 1998 updated recovery plan contains criteria that are objective and measurable.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

The recovery criteria no longer reflect the best available information and should be revised per the 2010 review recommendation. The downlisting criterion (i.e., Primary Objective, as described in the 1998 Recovery Plan) of 5,000 U.S. and Canada breeding pairs with high productivity is credible. Despite periodic declines in the rangewide population, the roseate tern rangewide population has recovered from the declines and currently is nearing the 5,000 breeding pair goal with the highest count of 4,593 breeding pairs in 2018. However, the requirement that the population should be spread over 6 large colonies (defined as having more than 200 breeding pairs) is likely unattainable.

The secondary objectives requiring 30 or more breeding colonies and an expansion of the breeding range to historically occupied areas south of the current range (New York to Quebec, Canada) are not realistic. The 2010 review also suggested that the delisting objective of 8,500 breeding pairs (United States and Canada) warrants review as this number was based on an abundance estimate from the 1930s (2010 review page 8). Historically, much more available nesting habitat was spread throughout a larger breeding range. Because of the reduced range and permanent loss of barrier beach nesting colony locations, it is unlikely that this goal can be achieved. Recent attempts to enhance and restore habitat to encourage roseate terns to expand to historic breeding sites have proven marginally successful at best (Veit et al. 2003, USFWS 2018a), despite early successful restoration at Ram Island and Penikese Island, Massachusetts (MA), and Seavey Island, New Hampshire (NH).

The current recovery criteria do not address threats to roseate terns wintering in South America. Roseate terns congregate in mixed flocks with other tern species along the north and east coasts

of South America (Nisbet et al. 2014). Increased development of the South American coastline for tourism, industry, renewable energy, and offshore oil and gas exploration are potential threats to the rangewide population, including extended impacts to nonbreeding juvenile roseate terns, the majority of which remain on the wintering grounds for at least a year prior to migrating north to breed as adults.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

No, the 2010 review summarized additional stressors that affect the species' ability to recover that were not addressed in the recovery criteria, specifically loss of breeding habitat to erosion and invasive vegetation. The current criteria, described as "objectives" in the 1989 recovery plan, focus on the two primary reasons the species was listed, reduction in colony size and reduction in numbers. The objectives include numerical, distributional, productivity, and persistence targets, but do not address recently identified threats to roseate tern breeding and nonbreeding habitats[2]. Specifically, Listing Factor E (other natural or manmade factors) is not addressed.

Specifically, threats to the species from climate change and sea level rise impacts to breeding and staging habitat, threats to forage fish (prey) from sand mining and climate change, threats from wind energy projects, and specific threats on the wintering grounds were not considered in the 1989 recovery plan. These threats must be further assessed to determine if and how recovery criteria should address them.

2.2.3 List the recovery criteria as they appear in the recovery plan.

The 1989 recovery plan and the 1998 updated recovery plan identified primary and secondary objectives for downlisting and delisting the species. Listing factors D (inadequacy of existing regulations) and E (other natural or manmade factors) are not addressed in the current recovery objectives. Factor B (overutilization) is not relevant to this species.

Primary Objective to reclassify the species to threatened: Increase the Northeast nesting population of roseate terns (United States and Canada) to 5,000 breeding pairs. This total should include at least 6 large colonies (> 200 pairs) with high productivity (> 1.0 young fledged per pair for 5 consecutive years) within the current geographic distribution. Listing Factors A (habitat and range) and C (disease and predation) are addressed in this objective.

This objective has not been met. The population has been increasing since 1988 (see section 2.3.2), and recent trends indicate that maintaining a 5,000-breeding pair population may be realistic over the long term. Since 1988, the roseate tern population has experienced significant fluctuations in abundance. At least one population decline was attributed to a catastrophic weather event (Hurricane Bob in 1991, Spendelow et al. [2002]). The overall decline from 2000 to 2010 had no known cause attributed to breeding pair loss. Roseate terns may naturally experience population fluctuations on the order of 1,000 pairs or more; these fluctuations should be taken into consideration when calculating a minimum population size maintained over a period of years as a recovery objective.

[2] The 1998 updated recovery plan described a recovery strategy that included protection and management of terns in their winter quarters (page 35), but did not include the strategy as a recovery objective.

The primary objective also requires at least six large colonies with high productivity within the current geographic distribution. This condition has been partially met. Despite generally high average estimated productivity for most of the roseate tern colonies, only 3 colonies have consistently supported 200 or more roseate tern nesting pairs since 1998, that being Great Gull Island in New York (NY), and Bird and Ram Islands in Buzzards Bay, MA. Currently, 90 percent of the Northeastern roseate tern population breeds on these three islands. Despite ongoing habitat management to increase suitable nesting habitat at other islands, the vast majority of roseate terns continue to select these three islands for breeding.

Secondary Objective: (1) Expand the number of roseate tern breeding colonies to 30 or more sites; (2) Expand the breeding range to historically occupied areas south of the current range. Listing Factor A is addressed in this objective.

This objective is not realistic. The first condition under the secondary objective, to expand breeding colonies to 30 or more sites, has not been met. Since 1998, between 13 and 21 sites in the United States have supported breeding pairs of roseate terns, with only an additional 3 to 4 sites in Atlantic Canada supporting more than a few pairs. Overall, the number of breeding sites occupied by the population since 2000 has declined by more than 30 percent.

The second condition of the secondary objective, to expand the breeding range to historically occupied areas south of the current range, is also unmet. In fact, since 1998 there has been a further contraction of the breeding range to the north, and fewer formerly occupied sites along southern Long Island are now active. For example, Gardner's Island/Cartwright Point supported more than 150 pairs from 2002 to 2004 and in 2007, but no pairs have been documented since 2010 (appendix A).

Reclassification Objective: Evaluate with regard to reclassifying from Endangered to Threatened when the Primary Objective is met. No Listing Factors are addressed in this objective.

Delisting Objective: Delisting would be warranted if the nesting population reaches the historic high level of the 1930s, 8,500 pairs.

Summary

Over the past three decades, state and Federal agencies and nongovernmental environmental organizations have implemented a comprehensive program of colony stewardship, nesting and staging habitat enhancement, predator management, population monitoring, and life history research at all major and most of the smaller breeding colonies. The rangewide population demonstrated a slow increase nearing the downlisting objective of 5,000 U.S. and Canada breeding pairs despite some significant declines and recoveries over the last 10 years; however, the increase is not occurring rangewide. The U.S. population has maintained over 4,000 breeding pairs since 2016; however, the Canadian population began declining in 2008 and has not reached pre-2007 levels since, averaging approximately 57.5 pairs per year. The Canadian decline is primarily attributed to a loss of habitat (see Section 2.3.2.1). Expanding the current number of large colonies in the United States has been unsuccessful. The breeding population continues to concentrate on three islands in NY and MA. No other colonies consistently have 100 or more

breeding pairs. Due to habitat degradation and loss, recolonization of breeding colonies in the southern extent of the species' range is no longer probable.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

The 2010 review summarized information available through 2009. An updated species account for roseate terns was published in Birds of the World (previously Birds of North America) (Billerman et al. 2020), covering the Northeast, Caribbean, and European populations. Much of the information provided in the Birds of the World species account is based on research prior to 2014 when the updated roseate tern species account was first published in Birds of North America (Nisbet et al. 2014). This section (2.3.1.1) focuses on information for the Northeast population that has become available since the 2010 review, including information from the Birds of North America species account.

The 2010 review described models that calculated adult survival rates for five breeding colonies for years prior to 1998 (see section NE 2.3.1.2.3). The annual survival of warm water subregion adults was estimated to range from 0.81 to 0.85 for all years, with the exception of the hurricane year of 1991, based on the survival estimates for the five warm water subregion colonies (Spendelow et al. 2008). Recruitment of new birds into the breeding population has not been estimated post-1997 (see 2010 review NE section 2.3.1.2.9). The annual survival of cold water subregion adults has not been estimated.

The roseate tern metapopulation structure and dynamics were detailed in the 2010 review, section NE 2.3.1.2.10 (Metapopulation structure and dynamics). In the 2010 review, the three large colonies were described as central colonies, and other breeding colonies were considered to be "peripheral" sites. The larger colonies were thought to be sources and many of the smaller colonies to be sinks. Recent genetics analyses (Dayton and Szczys *in review*), inter-island movement observations (Spendelow et al. 2016, J. Spendelow, pers. comm., 2020), and population modeling (Garcia-Quismondo et al. 2017) highlight the importance of the smaller colonies, despite the potential for them to be population "sinks."

Since the 2010 review, metapopulation structure and dynamics investigations focused on the distribution and behavior of roseate terns post-breeding, particularly during the typical 3- to 4-year maturation period until they recruit into the breeding population. Documentation of encounters of field readable color banded birds suggests a greater proportion of the entire population of adults (not just breeding birds) may be returning to the summer range in northeast North America than previously thought (J. Spendelow, pers. comm., 2020). More 1-year old terns migrate north to the summer breeding range than previously thought (J. Spendelow, pers. comm., 2020, I. Nisbet, pers. comm., 2020a). Two-year old individuals that return to their

summer range may "prospect" at breeding colonies in addition to spending time nearshore or offshore of the staging areas[3] (J. Spendelow, pers. comm., 2020, I. Nisbet, pers. comm., 2020a).

2.3.1.2 Abundance, population trends, demographic features, and/or demographic trends

Nisbet and Spendelow (1999) divided the regional population into two subregional groups: the warm water group south and west of Cape Cod, and the cold water group north and east of Cape Cod, including Canada. The warm water subregion includes more than 90 percent of the total population, the majority of which breeds on only three islands. The cold water subregion breeding colonies are more widely scattered apart, generally have less than 100 breeding pairs and in some years none (figure 1). Diets may differ between subregions, depending upon forage fish availability. Limited exchange of breeding birds occurs between the two subregions (Spendelow et al. 2010); nevertheless, it is vital to maintain the genetic diversity of the metapopulation (Dayton and Szczys *in review*). Roseate tern breeding colonies are primarily owned and/or managed by federal, state, and non-governmental organizations. Colony managers are responsible for monitoring the populations, and maintaining suitable nesting habitat. The majority of breeding colonies continue to be monitored annually for breeding pair abundance and productivity, with the exception of a few, very small, ephemeral colonies (appendix A and appendix B).

[3] "Staging" consists of adult and juvenile roseate tern congregations at barrier beaches during northward and southward migrations. Summer staging areas in New York and New England may be selected based on prey fish availability, may change from year to year, are important to optimize body condition for migration, and critical for parent roseate terns to teach young how to forage and become independent.

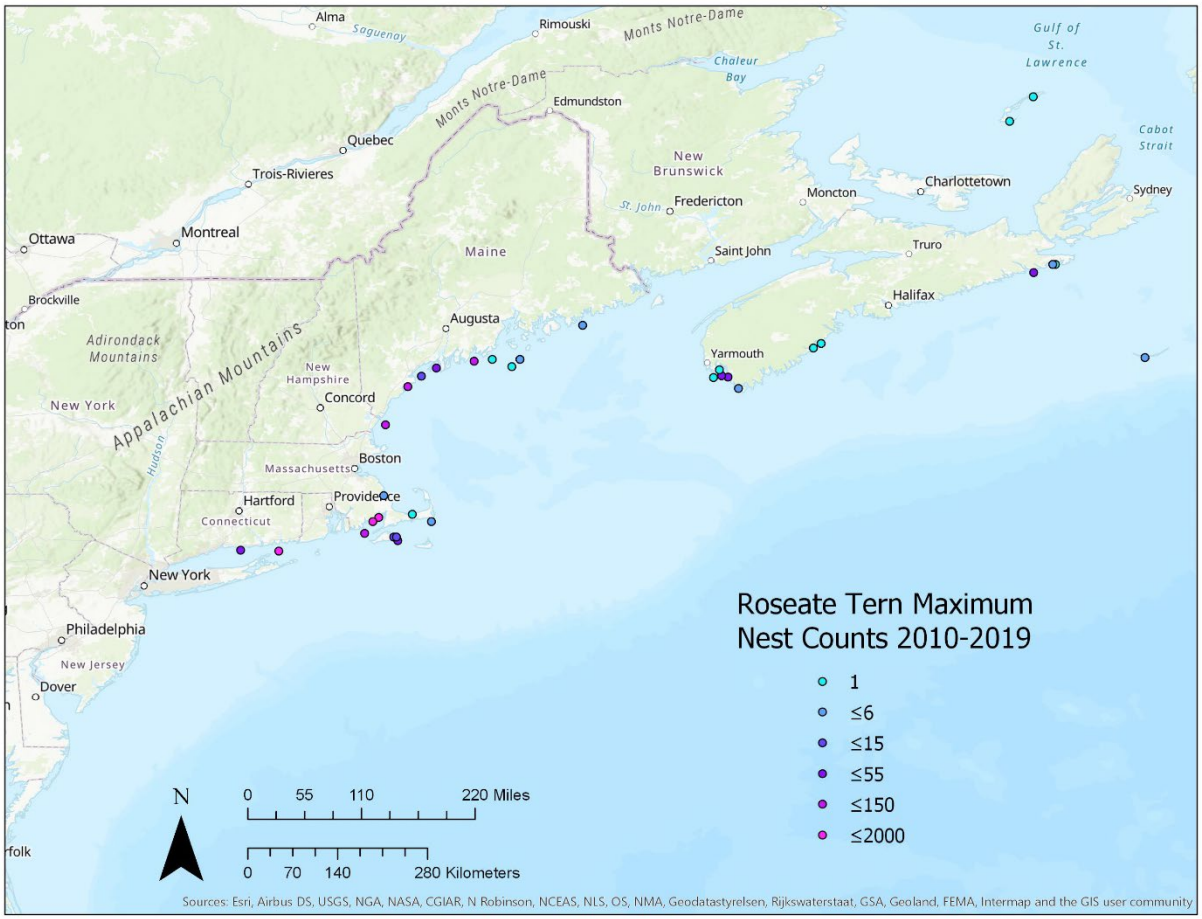

Figure 1. Map of Roseate Tern colonies 2010 to 2019[4].

Abundance and population trends

Peak and total season breeding pair counts are estimated based on standardized survey. Adjusted peak period nest counts (representing number of potential breeding pairs) are considered to most likely represent the real breeding population estimate because total season counts are less precise and less comparable among sites. From a demographic standpoint, the total number of pairs that establish nests during the season lies between the peak period and total season values, but the effective number of breeding pairs (those that breed successfully and contribute to future generations) is closer to the peak period value (see NE section 2.3.1.2.2 of the 2010 review).

The rangewide breeding population was estimated to be 4,374 breeding pairs at peak period count in 2019, down slightly from 4,593 in 2018. The U.S. roseate tern breeding population has exceeded 4,000 breeding pairs annually since 2016. Canada's total roseate tern population has been below 100 breeding pairs since 2008, hovering between 50 and 65 breeding pairs (table 1). Annual peak and total season counts, and productivity estimates are compiled by the Massachusetts Division of Fisheries and Wildlife (MADFW) (Mostello 2019). Summaries of

[4] The colonies mapped for Nova Scotia and Long Island represent breeding locations where roseate terns have nested more than once in the past 10 years. Those colonies with at least 1 year of documented roseate tern breeding pairs are included in appendix A.

peak period and total season counts for the cold water and warm water subregions for each site occupied one or more times between 2010 and 2019 are found in appendix A.

Table 1. Peak period breeding pair counts, 2010 to 2019.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019[5]
Canada Subtotal	43	65	43	54	51	51	63	49	51	63
U.S. Subtotal	2,970	3,043	3,089	3,136	3,560	3,901	4,021	4,446	4,542	4,311
Rangewide total	3,013	3,108	3,132	3,190	3,611	3,952	4,084	4,495	4,593	4,374

From 1987 to 1990, breeding pair numbers increased at average rates of 4 to 5 percent per year. From 1991 to 1992 they declined by about 20 percent; this decline was attributed to Hurricane Bob (Spendelow et al. 2002), which passed through the main staging area of the population on 21 August 1991 and apparently eliminated many adults and most young from the 1991 cohort (see 2010 review, NE section 2.3.1.2.2). The increasing trend continued from 1992 to 2000 but abruptly reversed to a decline, at about 4 percent per year starting in 2000 and continuing to 2008, possibly reflecting a change in postfledging survival of hatch-year roseate terns and their recruitment into the breeding population (J. Spendelow, pers. comm., 2020). The increasing (1992-2000) and decreasing (2000-2008) trends were manifested at all the large colonies and evidently resulted from factors that affected the entire warm water subregion. Between 2008 and 2013, the breeding pair population slowly increased, and in 2014 to 2019 the number of breeding pairs rapidly increased (figure 2). The average rate of increase of 5 percent, similar to the rate of increase from 1992 to 2000, was primarily attributed to a substantial increase in breeding pairs in the Buzzards Bay colonies.

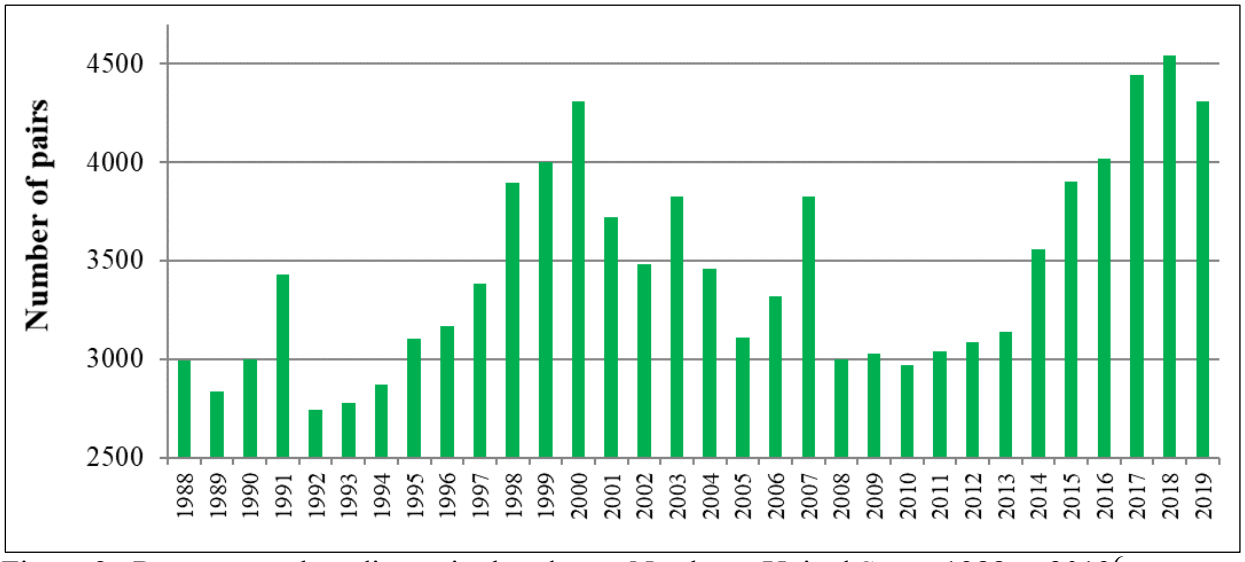

Figure 2. Roseate tern breeding pair abundance, Northeast United States 1988 to 2019[6].

[5] Preliminary figures.
[6] Figure taken from Mostello 2019.

It should be noted, that first, second and third-year nonbreeding individuals may be present in the summer roseate tern population in addition to the breeding pairs counted at colonies (J. Spendelow, pers. comm., 2020). Preliminary resighting data suggest that a greater proportion of 1-year old birds migrate north to the summer breeding range than previously thought (J. Spendelow, pers. comm., 2020). Most 2- and 3-year old birds migrate north (Nistbet et al. 2014) to the summer breeding range.

Productivity

Productivity, the average number of chicks raised to fledging per adult pair, is difficult to measure reliably in roseate terns due to the inability to follow individual chicks through fledging. As the breeding season progresses, chicks are concealed in dense cover in rock crevices, and may be moved by the parents. Attempts to follow chicks after the first few days of life usually yield underestimates of survival and productivity (Nisbet et al. 1990). Nisbet et al. (1999) devised a method for estimating colony productivity, based on the finding that in the absence of predation, survival of the A chicks (first hatched) is generally high. Survival of the B chicks (second hatched) could be predicted with 83-percent reliability from their body-mass on day 2 of life. The Nisbet et al. (1999) method was explicitly stated to be valid only for sites where survival of A-chicks is uniformly high.

Individual colony productivity estimates may be based on a variation of the Nisbet et al. (1999) method, a combination of methods, and/or best professional judgement. Estimates are often reported as a range, and should be considered primarily as an indication of whether the annual productivity was high, moderate, or low.

Productivity is estimated based on number of fledged chicks per breeding pair. A survey of breeding colony managers for productivity data they collected and their definition of "fledging" highlighted the difficulty in estimating annual productivity for this species (Staudinger 2019a). The range of productivity data collected at breeding colonies is generally similar: clutch size, fledge success, hatch data, and early chick growth (Staudinger 2019a). However, the definition of fledging (when chicks are assumed to be capable of flight) varied among breeding colonies, including: "use day number and look of chicks and if they are flying or not," "5 days of age," "15 or more days of age," and the age-weight criteria outlined in Nisbet et al. (1999). The variations in the definition of a fledged chick, and subsequently a more precise productivity estimate, make it difficult to reach more than a general rangewide productivity estimate. The rangewide productivity estimate is important to assess whether the current recovery objective requirement of maintaining a productivity of 1.0 or greater chicks fledged per pair for 5 consecutive years has been reached.

The Nisbet et al. (1999) method of estimating productivity is generally used on the breeding colonies in Buzzards Bay in combination with number of observed fledglings. Estimating productivity at Great Gull Island is extremely difficult due to the dense vegetation and boulders in which many nests are found, preventing surveyors from locating chicks through most of the chick-rearing period. Productivity estimates at Great Gull Island are derived from a modified use of Nisbet et al. (1999) methodology and best professional judgement relying on past annual productivity records, documentation of dead chicks, and resighting reports (Cormons 2017, 2018, 2019).

We recognize that estimating annual average productivity over the 11-year period since the 2010 review can only generally assess the average productivity status of each subregion. Warm water subregion productivity (± 1.2 chicks fledged per pair) was reported to be higher than cold water subregion productivity (± 1.0 chicks fledged per pair) in the 2010 review (see NE section 2.3.1.2.4). The combined average annual estimated productivity from 2010 to 2019 for the cold waters subregion breeding colonies (± 0.9 chicks fledged per pair) appears to be nearing the warm water subregion colonies (± 1.0 chicks fledged per pair). Annual average productivity estimates for each subregion were not always similar, most likely affected by predation events or limited accessibility to suitable forage fish (figure 3).

Productivity estimates reported from each colony are found in appendix B (Mostello 2019). Colony data are only provided for those sites that reported one or more pair nesting at a site between 2009 and 2019. Productivity estimates by subregion, adjusted to address the range of estimates for annual productivity and median productivity, are found in appendix C.

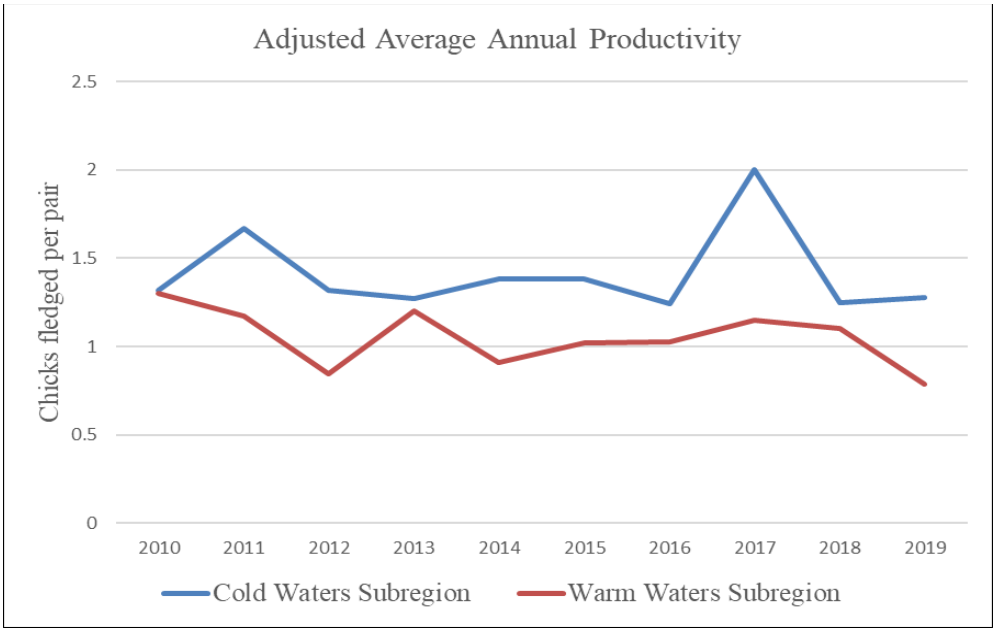

Figure 3. Adjusted average annual estimated productivity (chicks fledged per breeding pair) by subregion [7].

Dispersal

From 1998 to 2018, 56,416 roseate terns have been banded with Bird Banding Lab (BBL) metal bands. Additionally, a substantial number of roseate terns were banded with a variety of field readable bands, most recently plastic field-readable color bands. From 2010 to 2018, 16,247 roseate terns were banded in the Northeast (appendix D). The encounter data provided by the BBL and resighting observations compiled by field biologists and the general public (for example in eBird or WikiAves) provide insight into roseate tern dispersal, including movement

[7] Annual productivity for each site was adjusted to reflect the site's contribution to overall productivity prior to averaging each subregion's annual productivity.

between breeding colonies within subregions, movement between breeding colonies and subregions, postbreeding movement, migration movement, and wintering ground locations.

Based on banding resights at Falkner Island, 25 to 40 percent of all of the earliest arriving roseate terns did not stay to nest at the colony, but moved on presumably to nest elsewhere (Spendelow and Eichenwald 2018, J. Spendelow, pers. comm., 2020). This "prospecting behavior" may be indicative of prebreeding movements of roseate terns evaluating conditions at more than one potential colony site before choosing the final breeding location (J. Spendelow, pers. comm., 2020). Postbreeding movements of banded hatch-year and adult roseate terns indicate year-to-year variability in movements between staging areas, from breeding colonies to staging areas (and back upon occasion), and the timing of arrival at staging areas (J. Spendelow, pers. comm., 2020). Hatch-year roseate terns from throughout the entire breeding range tend to concentrate at a few major daytime staging sites around Cape Cod, MA in most years. During the postfledging period generally only one adult provides parental care, thus their vulnerability to catastrophic events (such as a major hurricane) likely is greater than when they are still at their colony sites (J. Spendelow, pers. comm., 2020).

Population modeling

The 2010 review discussed the population modeling efforts done prior to 2010 (see section NE 2.3.1.2.9). Two population models were developed to describe the roseate tern population: a 2007 population viability analysis (PVA) (Arnold 2007), prepared for an offshore wind energy project environmental impact analysis, and a life-table model of the Northeast population (Nisbet and Ratcliffe 2008), developed to test whether the available estimates of demographic parameters were consistent with the observed population trends. These PVAs have not been updated.

Recent population modeling focused on the dispersal dynamics of the Northeast roseate tern breeding population. Spatial and temporal variation in breeding dispersal/fidelity rates of adult roseate terns was analyzed using 22 years of capture-mark-reencounter data collected from 1988 to 2009. Some evidence was found that colony-site fidelity remained higher at long-established sites (typically the larger, warm water subregion colonies) compared with newer ones and breeding dispersal was more likely to occur among nearby sites than distant ones (Spendelow et al. 2016). This study supported the assumption that smaller colonies appear to be more ephemeral. Although ephemeral, these smaller colonies support more unique genetic diversity than the larger, long-established populations (see section 2.3.1.3).

To assess the stability of the species, the colonization and decolonization (abandonment) of breeding colonies were modeled as descrete events (Garciá-Quismondo et al. 2017) using historical data for the period 1870-2015 (I. Nisbet, pers. comm., 2020b). The majority of colonizations and decolonizations involved 1 to 10 pairs (Garciá-Quismondo et al. 2017). In small colonies, testing was conducted to attempt to fit the models to the data in the real world, given known parameters of density dependence on adult survival. The numbers of breeding pairs in each of the three large colonies and the total number of pairs in the metapopulation remained within a narrow margin over a period of decades. For that reason, colonization-extinction dynamics of the small colonies had to be modeled separately from the dispersal dynamics among the large colonies (I. Nisbet, pers. comm. 2020b).

Based on these analyses the only likely parameter that helped fit the trends seen in the populations is that juvenile survival decreases with increased population size (negative density-dependence). This may account for much of the observed stability of the population documented over many decades in the past; however, not all other possibilities have been explored that could influence this stability (I. Nisbet, pers. comm. 2020b). The modeled population would collapse to zero (within 50 years, with >50% probability) for mean productivity <1.2, mean adult survival <0.82, or mean juvenile survival <0.7 (figure 8, Garciá-Quismondo et al. 2017). These values are precariously close to the current estimates of mean values for these parameters, indicating that there is little margin for maintaining the population should adverse factors affect productivity, adult survival, or juvenile survival (I. Nisbet, pers. comm., 2020b).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation

Genetics research into metapopulation connectivity and effects to the genetic diversity of roseate terns suggest that five decades of breeding colony management appears to have maintained the metapopulation by facilitating the redistribution of genetic variation between the large, warm water subregion colonies and small cold water subregion colonies. Metapopulation-wide there appears to be a stable effective population size of 4,173 to 4,545 individuals (Dayton and Szczys *in review*). The roseate tern metapopulation remains highly vulnerable to stochastic events. However, the metapopulation also harbors redundancy and representation in the form of several breeding colonies that exhibit low, but unique genetic diversity, and resiliency in the form of small, stable colonies connected by dispersal and subsequent gene flow (Dayton and Szczys *in review*). The research highlights the critical importance of maintaining numerous small colonies in order to provide important "refugia" of allelic variation generated in the large warm-water regions via gene flow perhaps mediated by common migratory staging sites and shared wintering distribution. Protecting areas where nonbreeding individuals from the different subregions interact (e.g., staging sites and wintering grounds) will be critical in facilitating gene flow and important to the long-term stability of the metapopulation (Dayton and Szczys *in review*).

2.3.1.4 Taxonomic classification or changes in nomenclature

There have been no changes in the taxonomic classification or nomenclature of the Northeast and Caribbean populations, they remain classified in the subspecies *Sterna dougallii dougallii*.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range

The breeding range of the species has not changed since the 2010 review which documented substantial contraction of the southern part of the breeding range since historic times. Roseate terns no longer breed in Virginia, Maryland, New Jersey, and western and central Long Island (Nisbet et al. 2014) due to a combination of factors including increased predation, disturbance, erosion, and changes in habitat structure. Small breeding colonies in the cold water subregion demonstrate high year-to-year variability in use, particularly in Nova Scotia where small numbers of roseate terns (one to five pairs) may nest on islands for a year or 2 (appendix A). Many islands in Maine, Nova Scotia and Quebec that had small numbers of breeding roseate terns prior to 2014 no longer support roseate tern colonies (Mostello 2013, 2019); however, as a whole the northern extent of the breeding range has not contracted.

The proportion of roseate terns breeding on the three largest colonies (Bird, Ram, and Great Gull Islands) with respect to the entire population has increased since the 2010 review, ranging from 85 to 92 percent throughout the period 2010 to 2019 (appendix A).

2.3.1.6 Habitat or ecosystem conditions

The coastal islands and barrier beaches used for nesting by roseate terns in the Northeast are subject to dynamic changes both in formation and vegetative cover. The 2010 review described the cold water subregion and warm water subregion island conditions in section NE 2.3.1.6. Erosion of low lying nesting habitat is increasingly affecting some large and small breeding colonies. Lack of sand deposition to naturally restore habitat may be a function of hardened structures built elsewhere that affect sand transport, or sea level rise and climate change. Breeding colonies require annual ongoing habitat management to maintain appropriate vegetative structure (e.g., invasive plant treatments) and cover for nesting (e.g., nest box installation).

Falkner Island historically had over 200 breeding pairs; however, recent breeding pair counts fluctuate between 20 and 55 pairs (appendix A). Much of the nesting habitat has been lost to erosion. The U.S. Army Corps of Engineers (ACOE) completed Phase I of a shoreline protection and erosion control project to protect a lighthouse on Falkner Island in 2001, altering roseate tern nesting habitat on the island's beaches. Phase II of the project was not undertaken. The revetment built on the eastern side of the island precludes roseates from nesting in that area. The revetment prevents the eastern side of the island from eroding, most likely starving the northern spit of sediment. Since completion of Phase 1 of the ACOE project, the north spit of the island has significantly eroded and provides limited nesting habitat. In 2019 approximately 40 square meters (m^2) (430 square feet (sq ft)) remained of the 167 m^2 (1,798 sq ft) of roseate tern northern spit nesting habitat available in 2011 (USFWS 2019). Nest boxes are placed on the spit to enhance the remaining nesting habitat for roseate terns. The southern end of the island is also eroding as a result of storm action and lack of sediment deposition. Historically, 70 to 90 roseate tern pairs nested on the southern end of the island, almost triple the total number of Falkner Island breeding pairs in 2019 (K. Vagos, pers. comm., 2020).

Low lying, sandy islands and barrier beaches in the warm water subregion are subject to overwash and erosion. Minimoy Island, part of the Monomoy National Wildlife Refuge, once hosted a small breeding colony (1 to 6 pairs) but has now eroded to a small fraction of its size and no longer supports a roseate and common tern nesting colony. Ram Island is also experiencing erosion and overwash, although roseate and common tern breeding pair numbers appear to be more or less stable (see appendix A). The future of Ram Island as a breeding colony may be dependent on implementation of significant erosion control measures such as installation of an offshore living reef to break up wave actions.

Bird Island experienced a 50-percent reduction in nesting habitat since 1970 due to overwash and erosion. The large roseate and common tern colony experienced overcrowding, resulting in a displacement of roseate terns by the more aggressive common terns. Funding secured by the MADFW and ACOE and from a Natural Resource Damage Assessment Restoration settlement fund were used to stabilize, renourish, and revegetate the island (Mostello 2020). The multi-year

project successfully restored roseate and common tern nesting habitat in 2018. The life expectancy of the project is 40 to 50 years.

A USFWS-funded Cooperative Recovery Initiative project (CRI), initiated in 2013 and completed in 2017, focused on the restoration of 83 acres of roseate tern nesting habitat for 7 breeding colonies (USFWS 2018b). A variety of habitat management actions implemented across the seven colonies included hand-pulling invasive vegetation, prescribed burning, herbicide application, the use of outdoor carpeting to minimize regrowth of undesirable vegetation, mowing, rototilling, planting native vegetation, placing nesting boxes, building new nesting terraces, and controlling competing species. The primary goal of the habitat management actions was to increase site-specific productivity. Most of the sites met or exceeded their site-specific productivity in most years. However, since 2017, intensive habitat management at some of the sites has ceased or declined due to lack of funding and/or staff.

2.3.1.7 Other

2.3.1.7.1 Predation

Effects to productivity by avian and mammalian predators continues to be reported at all roseate tern breeding sites, although significant events leading to colony abandonment are only periodically reported. The 2010 review described a number of species known to prey on roseate tern nests, chicks, and adults (section NE 2.3.1.7.1 Predation) and incidents of colony abandonments due to nocturnal predators such as owls, mink (*Mustela vison*), and black-crowned night herons *(Nycticorax nycticorax*). An increase in peregrine falcon presence has been documented at a number of the roseate colonies in recent years, most likely due to an increasing migrating and/or coastal population of peregrine falcons in the Northeast. Not all peregrine visits cause mortality, although repeated colony unrest has been documented (Craig 2019). Snowy owls have recently been documented at breeding colonies as well (Craig 2019).

Predation management is implemented on all active breeding colonies, minimizing the impact of predation on productivity and/or adult mortality. Colony managers harass, cull, or remove nests of herring (*Larus argentatus*), great black-backed (*L. marinus*), and/or laughing gulls (*Leucophaeus atricilla*) and fish crows (*Corvus ossifragus*), trap and remove mammalian predators, and harass or remove other avian predators as needed.

2.3.1.7.2 Disease and parasites

Occasionally, individual roseate terns are found dead, and predation is not the apparent cause. While disease is sometimes found to have contributed to the death of individual birds, it is infrequent and not known to cause population-level effects in this species.

2.3.1.7.3 Staging, migration, and wintering areas

Since the 2010 review, additional information on migratory flights, wintering grounds, and staging areas in the Northeast United States has been documented through the application of geolocators, digitally coded VHF transmitters, band resighting, and bird captures.

Staging

The 2010 review provides a discussion of staging and roosting areas in Massachusetts, summarizing the number of sites at which staging and/or roosting terns have been observed. In most years during the postbreeding season (contingent on forage fish availability), almost the entire population of roseate terns stages on beaches of outer Cape Cod, although recent research (Spendelow 2018, Davis et al. 2019) suggests that substantial numbers of roseate terns from New York and Connecticut may spend more time on New York and Rhode Island coasts than previously thought. These staging areas are critical for juvenile and adult roseate terns as they prepare for migration. Since the 2010 review, additional staging research focused on identifying critical staging areas, investigating roseate tern postbreeding activities at staging areas, identifying the types of disturbance that most affects roseate terns at staging areas, and providing recommendations for protecting staging areas.

Ongoing band resighting efforts continue to report primary staging areas (sites with more than 1000 terns and/or high percentages of roseate terns) are mostly focused on outer Cape Cod, Massachusetts (Spendelow 2017). Known postbreeding staging areas[8] that continue to be consistently used include Hatch's Harbor, Race Point and Wood End (Provincetown, MA), Jeremey Point (Wellfleet, MA), Nauset Estuary (Eastham and Orleans, MA), Monomoy Islands/North and South Beach Islands (Chatham, MA), Smith's Point/Esther Island (Nantucket, MA), and Muskeget Shoals (Nantucket, MA) (Spendelow 2017).

Staging areas used by smaller numbers of roseate terns are also reported from other locations in Massachusetts, Rhode Island, New York, and Maine (Spendelow 2018). The 2013 CRI addressed habitat management and an education campaign on U.S. Fish and Wildlife National Wildlife Refuge staging areas. A total of 42 acres of staging habitat were enhanced and protected on Rachel Carson NWR, Monomoy NWR, Nantucket NWR, and Trustom Pond NWR in addition to other Rhode Island sites managed by the Rhode Island National Wildlife Refuge Complex (USFWS 2018b).

Davis et al. (2019) quantified hatch-year roseate tern weekly residency and weekly recruitment rate into the staging population, and derived weekly hatch-year staging population growth rates at staging areas on Cape Cod National Seashore. Critical arrival times for most terns to the focal staging areas was from mid-July to mid-August. Davis et al. (2019) also noted that hatch-year terns from the southernmost colonies spent less time staging at Cape Cod National Seashore than their northern counterparts, possibly indicative of alternative staging strategies for individuals originating in the different subregions as a result of differences in prey fish availability.

Staging areas are critical for terns to optimize their body condition in preparation for their southward migration to South America. Activities on staging areas that disturb roosting terns, especially when large flocks are forced to relocate, increases the energy demands at a time when the terns should be building up reserves. The behavioral effect of potential natural (gulls and shorebirds) and anthropogenic (pedestrians) disturbance sources to roseate and common tern flocks on staging areas varies by the source of the effect (Althouse et al. 2019). The magnitude of response (distance from the source eliciting flight) to approaching humans was much larger

[8] For a complete list of known staging areas with observation so 1000 or more terns with a high percentage of roseate tern see figure 3 in the 2010 review.

than the potential disturbance from gulls and shorebirds. Results of the study indicate that buffer zones should be implemented to minimize the effects of human disturbance on staging terns.

Migration

The Birds of North America roseate tern species account provides details on the timing and routes of migration (Nisbet et al. 2014). Recent geolocator and digitally coded VHF telemetry data suggest that migration from staging areas to the wintering range appears to be concentrated in late August to mid-September (Mostello et al. 2014, Loring et al. 2019). Geolocator data from six roseate terns tagged at Bird Island, Massachusetts suggest that southbound migration flight paths are transoceanic until reaching the Caribbean, where terns may stopover for a period of time (Mostello et al 2014.) The geolocator tagged birds stopped in the vicinity of Puerto Rico and the Dominican Republic. BBL encounter data and resighting reports documented Northeast population roseate terns in Puerto Rico in September, also suggesting Puerto Rico may be an important stopover area (Hays et al. 2010). Five of the six geolocator-tagged terns continued their migration southward after a 7- to 13-day hiatus in the Caribbean, making prolonged stopovers in Suriname/Guyana and northern Brazil. Exact locations are not known; however, it appears that roseate terns pass through and stop along the north coast of South America. Understanding where roseate terns congregate in specific stopover over areas in the Caribbean and South America may be critical to the conservation and recovery of the species.

Wintering grounds

Based on band resightings and one limited geolocator study, most Northeastern birds winter on the north and east coasts of South America, particularly on and off the coast of northern and northeastern Brazil (Nisbet et al. 2014). In a study conducted in 2007 and 2009, six geolocator-tagged birds were tracked to wintering grounds, one in Suriname and five in northern and eastern Brazil (Mostello et al. 2014). Geolocator data indicated that the tagged terns remained more or less stationary for long periods of time, but all birds changed locations one or more times during the winter leaving their general areas either permanently, or returning after 5 days to 2 weeks (Mostello et al. 2014). The geolocator data, although not precise, overlap with the locations identified through recent band encounter and field reports from Brazil (figure 4).

Figure 4. Stopover and winter locations in the Caribbean and South America of banded Northeast population roseate terns 2000 to 2018[9].

Wintering ground activities implemented or reported on by Brazilian biologists including banding, conservation, and documentation of mortality events (Hays et al. 1999, Walsh 2019, F. Silva, pers. comm., 2020a, P. Lima, pers. comm., 2020a, P. Lima, pers. comm., 2020c) identified areas with significant numbers (more than 100) of roseate terns at night roosts during the winter and early spring months, particularly on sandbanks along the coast of the State of Bahia. Known sites with more consistent reports of roseate terns include:

Mangue Seco, State of Bahia, Brazil

Roseate terns continue to frequent sand banks located at the mouth of the Rio Mangue Seco for night roosts since first reported by Hays (1999) (P. Lima, pers. comm., 2020a). The sand banks of Mangue Seco are considered areas of Global Interest for Conservation by BirdLife International, due to their importance as a wintering place (Lima et al. 2020) and is an Important Bird and Biodiversity area (IBA). Conservation efforts in Brazil have been focused on preventing development from impacting the transient sand banks, affording a measure of protection for night roosting roseate terns (P. Lima, pers. comm., 2020a).

Igrapiúna, State of Bahia, Brazil

Field visits and banding efforts undertaken since 1997 indicate this may be a significant night roosting roseate tern concentration area (P. Lima, pers. comm., 2020a, 2020c). This site is included in an IBA by BirdLife International (P. Lima, pers. comm., 2020c).

[9] Banding encounter data provided by the BBL.

Galinhos, State of Rio Grande de Norte, Brazil

Roseates are present throughout the winter, but the largest influx of night roosting roseate terns occurs in February through mid-April, prior to their northward migration (P. Lima, pers. comm., 2020b). Mostello et al. (2014) noted that two of their tagged birds moved from their eastern locations to northern sites in February. Although exact locations are unknown, the probable location includes Galinhos. BBL encounter data document roseate tern presence in this area as early as the end of September with observations through late April. Most encounter dates are in February, March, and April.

2.3.1.7.4 Food and foraging

The 2010 review discussed studies detailing chick provisioning rates by adult roseate terns at breeding locations in Maine, and identified forage fish species for the cold and warm water subregion colonies. Additional research has further refined our understanding of preferred prey for both subregions for chicks and adults, pre-nesting forage fish species for adults, and forage flight distances. Ongoing research will provide additional information relative to prey availability, reproductive success, and potential changes in foraging strategies as forage fish availability changes in response to climate change and/or changes in commercial fisheries management.

Sand lance (*Ammodytes sp.*) are the primary forage fish species for the warm water subregion breeding colonies, although other fish species have been observed during provisioning studies. Chick provisioning reports from the Buzzards Bay colonies and Falkner Island document that sand lance constitute over 50 percent of the prey brought to chicks (MADFW 2017, USFWS 2019). Small herring, silversides, hake, and bluefish make up very small percentages of prey brought to chicks.

A comprehensive literature search and synthetic diet analysis found that throughout the Northeast United States and Canada, sand lance is also targeted by roseate terns and 71 other predators, including 45 species of fishes, 2 squids, 15 seabirds and 9 marine mammals (Staudinger 2019b, Staudinger et al. 2020). Twelve published studies of roseate tern chick and adult diets between 1984-2016 showed sand lance comprised ~36%-100% of their diets across the region over historical periods (Staudinger 2019b, Staudinger et al. 2020). Compared to the 71 other predators for which data was found, roseate terns consumed sand lance in some of the highest proportions and showed the greatest and most consistent evidence across studies of dietary specialization on sand lance. Consequently, it is possible that roseate terns may be an indicator species of changes in sand lance populations (Staudinger 2019b).

Recent steps to move towards ecosystem-based approaches to fisheries management have been taken by the Mid-Atlantic Fishery Management Council to recognize forage species as key components of the regional ecosystem (Staudinger et al. 2020). These steps have increased protections for unmanaged forage species and limit development of large-scale commercial fisheries for over 50 previously unmanaged forage species. The New England Fishery Management Council has also begun to take steps towards more holistic approaches, although actions to date have been limited to managed forage fishes, Atlantic herring in particular (Staudinger 2019b).

Yakola (2019) researched long-term data sets from the Gulf of Maine breeding colonies to understand dietary composition during the chick rearing period for three tern species, common, Arctic and roseate tern. These cold water subregion colonies demonstrated more variability in the primary prey species brought to chicks, although some of the major prey species were the same as consumed in the warm waters subregion (sand lance, and herring) (Yakola 2019). The roseate tern chick diet was almost exclusively piscivorous and invertebrates were rarely provisioned. Hake and sand lance were the most frequent prey delivered to chicks. Together, hake, sand lance and herring comprised 74% of the total chick diet (Staudinger 2019b, Yakola 2019). Roseate terns had the lowest dietary diversity of the three tern species examined in this study.

In 1992 on Eastern Egg Rock in the Gulf of Maine, roseate terns provisioned an unusually high amount of pollock (28 percent) to chicks, suggesting they may be able to take advantage of highly abundant forage fish that are similar to their preferred prey and are experiencing periodic population explosions. Pollock and haddock are closely related to hakes and are species that may be benefiting from increased temperature in the region (Yakola 2019). In summary, Yakola's analyses provide insight into long-term trends across nesting islands, within season dietary phenology and the potential impacts of climate change, in particular increasing sea surface temperatures, and earlier spring onset on tern diet.

Goyert (2014) analyzed the relationship among prey availability, habitat, and social foraging behavior, distribution, and abundance of common and roseate terns. The distribution and abundance of sand lance and herring were positively associated with the spatial patterns of both tern species, indicating the importance of these prey species to adults as well as chicks (Goyert 2014).

Braton et al. (*in review*) evaluated the pre-breeding foraging ecology of roseate terns relative to other species at shared summer nesting colonies in the Gulf of Maine using stable isotopes as ecological tracers. Overall, the observed variation in isotopic niche breadths across islands and years indicates roseate terns have some trophic plasticity, which might make them more resilient to changing environmental conditions. However, their relatively narrow trophic niches compared to other species suggests they may be more susceptible to competition and have less flexibility to withstand poor foraging conditions for their preferred prey (Staudinger 2019b).

Foraging distances are related to prey availability. Roseate terns forage over shallow coastal waters within 3 to 15 miles (5 to 25 km) of their breeding colonies when nearshore forage fish are available (Nisbet et al. 2014). Recent telemetry-based research documented greater foraging distances for breeding and post-breeding roseate terns than was reported in the 2010 review. Recent tracking studies and ship-based observations documented breeding roseate terns traveling over 30 miles (50 km) during chick provisioning flights to feeding areas (Loring et al. 2019). At-sea studies reported roseate terns from May through mid-August in high densities up to approximately 50 to 60 miles (80 to 100 km) offshore, possibly keying in on adult sand lance that move offshore (Robards et al. 2000, Goyert et al. 2014, Goyert and Nevins 2018). Roseate terns in the offshore environment have been found to forage in the presence of tuna and relatively high densities of dolphins (Goyert et al. 2014).

2.3.2 Five Factor Analysis

In the following sections, we update information contained in the 1987 final rule, 1998 updated recovery plan, and the 2010 review about factors affecting the northeastern North Atlantic roseate tern in the breeding and wintering ranges. We also consider how risks to the roseate tern from the major ongoing and reasonably foreseeable future threats would be affected if ESA protections were removed.

2.3.2.1 Factor A. Present or threatened destruction, modification or curtailment of its habitat or range

Breeding range

As stated in the 2010 review, roseate tern breeding colonies situated on coastal islands and barrier beaches are subject to dynamic changes in configuration, habitat substrate suitability, and vegetative cover. Erosion and invasive plant species continue to be the primary threats to breeding colony habitat (USFWS 2010; section 2.3.2.1). This section addresses new information relative to the habitat threats associated with an increasing rate in sea level rise, and impacts from a changing climate. Sea level rise and climate change are largely responsible for the accelerated rates of erosion experienced at Bird and Ram Islands (Buzzards Bay, Massachusetts), Great Gull Island (New York), Falkner Island (Connecticut), and The Brothers Islands (Nova Scotia, Canada).

Invasive native and non-native plants continue to impact nesting habitat and must be managed at most breeding colonies in order to maintain the tern colonies. The magnitude of this threat has not changed since the 2010 review.

Habitat Loss due to Sea Level Rise and Climate Change

According to the 2019 IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC 2019), the global mean sea level (GMSL) is rising and accelerating over time as evidenced by a steady increase in GMSL between 1901 and 2015. An analysis of discreet time periods documented a more than double increase in GMSL between 1901 and 2015. Due to a variety of factors, including increased land subsidence, atmospheric shifts, and ice mass loss from Greenland and Antarctica, among others, the mid-Atlantic Coast (North Carolina to Massachusetts) is experiencing a much higher rate of sea level rise (SLR) than the GMSL (Dupigny-Gieroux et al. 2018). An analysis of tide gauge records for this area of the Atlantic Coast documented that SLR was three to four times higher than GMSL between 1950 and 1979, and 1980 to 2009 (Boon 2012; Sallenger et al. 2012; Dupigny-Giroux et al. 2018).

By 2100, GMSL is anticipated to continue to increase under all Representative Concentration Pathway (RCP) emission scenarios. It is estimated that SLR may increase around 0.84 m (0.61–1.10 m, likely range) for the RCP8.5 scenario[10] (IPCC 2019). Given that the northeast Atlantic Coast is experiencing a greater increase in SLR than the GMSL, it is expected that SLR for the Northeast U.S. Atlantic Coast will continue to be greater than the estimated GMSL (Boon 2012). The expected impacts of SLR on coastal ecosystems over the course of the century include the

[10] The RCP8.5 scenario is currently the most likely to occur based on current trends of emissions (Jackson et al. 2017.) and the long-lasting influence of greenhouse gasses already in the atmosphere (Collins et al. 2013).

loss or alteration of coastal habitats including salt marshes, barrier beaches, and barrier islands and subsequent impacts to habitat functionality and biodiversity.

Roseate tern breeding colonies, especially those on low lying, barrier islands or barrier beaches, are particularly vulnerable to impacts from climate change and SLR (2010 review NE section 2.3.2.1). Several roseate tern breeding sites are low profile islands with significant portions of the islands at less than 10 feet above sea level. Without intervention to slow the rate of erosion, some of the low lying breeding sites (e.g. Ram Island, MA, Falkner Island, CT, North Brother Island, NS) are likely to lose the majority of nesting habitat within the next 40 to 60 years, or less. North Brother Island has an estimated rate of erosion of 26.9 m^2 (290 sq ft) per year resulting in an approximate 20 percent loss of habitat between 2010 and 2020. If the rate of erosion remains constant, the nesting habitat in 2010 of 1411 m^2 will be reduced to 66 m^2 (710 sq ft) by 2060 (J. McKnight, pers. comm., 2020). The loss of breeding colony habitat, particularly the low lying colonies vulnerable to SLR could affect the genetic diversity of the species if small, cold water subregion colonies disappear (see section 2.3.1.3) or population stability if one or more of the large warm water subregion colonies were to lose significant portions of nesting habitat.

Climate change may also affect the intensity, seasonality and number of severe storm events. Storm events that consistently exceed historical intensity, seasonality, and/or numbers (per year or season) increase the rate of erosion of coastal habitats and affect the ability of coastal habitats to recover quickly, if at all (Hayhoe et al. 2018). Storm-driven precipitation and tidal surges are major drivers of coastal change, and in combination with rising sea levels will accelerate the rate of habitat alteration and/or loss in the future (Dupigny-Giroux et al. 2018). Tidal flooding in the Northeast is resulting in 100 to 200 percent increases in high tide flooding in certain locations, increasing risk from storm surge and greater coastal impacts from more frequent and intense Nor'easters and hurricanes (Staudinger 2019b). An increase in the frequency of intense winter storms is predicted for the Northeast United States (Hayhoe et al. 2018). Coupled with the increased frequency of severe coastal storms, is an increase in the frequency, depth, and extent of tidal flooding associated with those storms (Hayhoe et al. 2018), further intensifying the impact of climate change on coastal communities.

Under most climate change scenarios, hurricanes in the U.S. Northeast are anticipated to occur more frequently, be more intense, and have greater amounts of precipitation (Hayhoe et al. 2018). In 2012, Hurricane Sandy severely impacted the three major roseate tern breeding colonies. Post hurricane reports documented significant damage to Great Gull Island infrastructure, an increase in rock revetment instability, and pockets of erosion at Great Gull Island (Cormons 2014). Ram Island was completely overwashed during the hurricane, several feet of beach was lost around the perimeter, and the high tide abutted significant stretches of roseate tern nesting habitat (C. Mostello, pers. comm., 2012). Hurricane Sandy accelerated the ongoing erosion of Bird Island.

Irrespective of unusual storm events such as Hurricane Sandy, impacts to low lying, large breeding colony islands are anticipated to continue with sea level rise and increased winter coastal storms (Nor'easters). Prior to restoration efforts being completed on Bird Island, surveys associated with the restoration documented that erosion lowered the ground elevation of the island, changing the areas of surface characteristics from that of gravel and sand to salt marsh

and salt pannes, causing a reduction in suitable roseate tern nesting habitat (U.S. Army Corps of Engineers 2006).

In summary, climate change and sea level rise are anticipated to reduce the available roseate tern breeding habitat, especially for islands in the warm water subregion, through reduction in the islands' area and alteration of suitable nesting habitat to unsuitable nesting habitat. The lack of potential habitat for the establishment of similar large colonies (greater than 200 breeding pairs) underscores the precarious nature of the existing breeding colonies.

Invasive plants

The 2010 review addressed the impacts of invasive plants on nesting habitat. Invasive plants out-compete native plants and alter the structure, microhabitat, and accessibility of breeding colony habitat. If not controlled, invasive vegetation becomes so dense and impenetrable that nesting habitat is lost. Invasive plant management requires ongoing efforts by colony landowners and/or managers and is generally limited to maintaining a smaller area of nesting habitat than would be present in the absence of the invasive plants. Restoring degraded or unsuitable habitat through invasive plant removal has had limited success, often because of a seed bank that quickly reestablishes the invasive species once management is halted. Some invasive species, such as black swallowwort (*Vincetoxicum nigrum*) on Great Gull Island, or wild radish (*Raphanus raphanistrum*) (multiple islands) are virtually impossible to eradicate and need to be managed periodically to maintain nesting habitat. In addition to the three major breeding colonies (Bird, Ram, and Great Gull Islands), numerous smaller colonies, including Falkner Island (CT), Seavey Island (NH), Stratton Island (ME), and Eastern Egg Rock (ME), require regular invasive plant species management. A Cooperative Recovery Initiative provided funding to implement habitat management at seven colonies from 2015 to 2017. Since 2017, funding invasive plant management has been provided to a limited extent by state natural resource agencies and the Service, significantly reducing the extent to which habitat management efforts can be implemented.

Staging habitat

Staging habitat is characterized by tidal flats, sandbars, or low lying barrier island beaches located within the breeding range of the species (Althouse et al. 2019). Staging areas are similarly vulnerable to the impacts of sea level rise and climate change as described for breeding habitat.

Winter grounds

Recent data suggest the primary wintering range of roseate terns extends from the coasts of northwestern Colombia through eastern Brazil. A number of concentrated night roost locations, particularly in Brazil, have been identified through band resighting, bird captures, and geolocator data. General threats facing the species and its habitat on the wintering range are similar to threats on the summer range including the effects of sea level rise on the coastal habitat, particularly the sand bank islands at the mouths of large rivers, and climate change impacts to the habitat. Development of the roseate tern's coastal habitat for tourism infrastructure is an ongoing threat, particularly for those areas known to host large numbers of roosting terns (Lima et al. 2011). The rate of habitat loss due to the development of tourism-based infrastructure (hotels,

restaurants, stores, roads) is unknown, as is the extent. The threat of habitat degradation or alteration from invasive species is unknown.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes

Overutilization is not known to be a threat to the species on either the breeding or wintering grounds.

The benefits of obtaining new life history, nonbreeding movement, and stopover and wintering ground information are carefully weighed against known impacts to roseate terns from handling and application of auxiliary markers including geolocators, satellite transmitters and digital VHF transmitters, Passive Implanted Transponder (PIT) tags, and field readable leg bands. Between 1998 and 2019, over 60,000 roseates were banded with USGS metal leg bands, a subset of which were banded with auxiliary markers of varying sizes and materials. Most recently, plastic field-readable markers are being used to increase accuracy for productivity estimates and investigations of movements. Some banding injuries have been documented, although an assessment of banding effects has not yet been conducted.

A pilot study using miniature (2.5 gram) satellite transmitters attached with a modified wing harness to 10 roseate terns documented significant impacts to the species, most likely from the attachment method (Loring 2018, Paton et al. *in review*). Individuals were observed with harness impacts (bills under harness loops) or not detected during blind stints or by the satellite receiver shortly after tagging. Based on the pilot study, no further use of satellite transmitters will be authorized until such time as improved methods of attachment are developed and tested.

Since capture and marking of roseate terns for scientific purposes are regulated and monitored by the USFWS and the Canadian Wildlife Service, overutilization for research purposes is of relatively low concern at this time. However, Factor D below assesses the risk posed by overutilization were the species not listed under the ESA.

2.3.2.3 Factor C. Disease or predation

Disease

Disease has not been identified as a factor impacting the roseate tern at the population level, although individuals have been affected. An outbreak of a bacterial infection, primarily affecting common tern chicks on South Monomoy Island in 2016, caused the mortality of at least one roseate tern chick. The bacteria, Bisgaard Taxon 40 (BT 40), was found to occur in healthy terns as well as those that died; however, it is unknown at this time if a different strain of BT40 caused the tern chick mortalities (K. Iaquinto, pers. comm. 2020). No other disease outbreaks or indications of potential disease issues have arisen since the 2010 review.

Predation

Predation is intensively managed, often addressed shortly after mortality events are observed and a predator identified as the cause. Predation of adults, chicks, and eggs may cause major disruption of nesting, leading to repeated shifts away from affected breeding colonies, sometimes to breeding sites that are less suitable. Some predator removal occurs prior to the return of terns to their colonies in the spring. Monitoring staff regularly visit or remain on most breeding colony

islands to monitor the populations, estimate productivity, and manage vegetation and predators. The consistent presence of monitors may deter predators.

The ability of management staff to respond quickly to predation events is critical to maintaining the breeding colonies. The 2020 COVID-19 pandemic requiring shelter-in-place and social distancing guidelines precluded staffing the Great Gull Island field station for the 2020 breeding season, and reduced the management capabilities at many of the other breeding colonies by reducing the number of visits to the islands and staffing. In the future, lack of funding to support predator removal and intensive management would also affect the ability of colony managers to respond quickly to predation events. The impact of reduced or no predator management on roseate tern breeding colonies in 2020 is currently unknown. However, multiple years of reduced or no predator management almost certainly will result in increased predation, causing a significant decline in the rangewide population and reducing the number of occupied breeding colonies.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms

Because the purpose of this 5-year review is to determine whether roseate terns continue to warrant protection under the ESA, we focus here on the sufficiency of other (i.e., non-ESA) existing regulatory mechanisms to address the continuing and foreseeable threats discussed under factors A, B, C, and E, were the species not listed under the ESA. Implementation of ESA protections has resulted in some progress towards roseate tern recovery since the species' 1987 listing, although it has not been sufficient to attain the colony number or range expansion criteria in the 1998 recovery plan.

Role of ESA protections

The regulatory requirements under ESA section 7 and the prohibition of take under ESA section 9 have protected the roseate tern from disturbance and habitat degradation. Through informal ESA section 7 consultations conducted with the USACE, the Federal Emergency Management Agency, the National Park Service, the U.S. Coast Guard, and other Federal agencies, adverse effects to roseate terns have been minimized or avoided. No formal consultations have been undertaken for roseate terns since the 2010 review, and approximately 247 informal consultations have been completed since 2010. Were the species not ESA listed, the absence of regulatory requirements under section 7 and the prohibition of take under section 9 could result in increased disturbance, culminating in colony abandonment, and habitat degradation. Overutilization of the species for commercial, recreational, scientific, or educational purposes is not anticipated to increase greatly. Banding roseate terns will continue to be authorized and tracked by the USGS Bird Banding Laboratory.

Current adequacy of non-ESA existing regulatory mechanisms and their potential role in roseate tern conservation

In the past, enforcement of the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-712) has sometimes played a limited role in protection of roseate terns. However, the 2017 legal reinterpretation constrains the MBTA prohibitions to directed (intentional) killing and wounding (Office of the Solicitor, U.S. Department of Interior 2017), thus making that statute inapplicable to protection of roseate terns from almost all current and foreseeable threats.

Regardless of listing under the ESA, the roseate tern is state listed as endangered in Maine, New Hampshire, Massachusetts, Connecticut, and New York. However, the state endangered species statutes vary in strength, they do not cover activities in all portions of the species' range (e.g., Federal waters), and oversight and management of roseate tern breeding colonies varies by state.

The adequacy of State laws with regard to protection of the Northeastern roseate tern and its habitat absent the ESA also varies considerably from state to state. For example, in New Hampshire, RSA 212-A extends protection to individuals of a State-listed species, but these protections are less clear with regard to habitat, particularly if a potentially destructive activity does not require a State permit. Similarly, in Connecticut, General Statute 26-310 provides protection to species and habitat where the State agency undertakes an action, the State funds an action, or a State permit is required. Connecticut GS 26-310 has an affirmative consultation requirement for State agencies whose actions may affect listed species, but there is no such requirement for the actions of private citizens. Although existing regulatory protections are sufficient to prevent intentional take of individuals in most states, disturbance of breeding colonies and terns at staging sites could occur more frequently in the absence of the ESA, and colony abandonment is possible at some sites. Overall, some State endangered species statutes are not sufficient to protect nesting and staging habitats used by the species.

Several Federal and provincial laws provide protection to the roseate tern in Canada. The roseate tern is federally designated as Endangered (Whittam 1999, COSEWIC 2009) and is further protected by the Federal Migratory Birds Convention Act (1994) as a migratory nongame bird. Canada's Species at Risk Act (SARA) contains prohibitions (sec. 32) that make it an offence to kill, harm, harass, capture or take; possess, collect, buy, sell or trade an individual endangered roseate tern and identified critical habitat in a December 3, 2019, Order (Critical Habitat of the Roseate Tern (*Sterna dougallii*) Order, SOR/2016-281, https://laws-lois.justice.gc.ca/eng/regulations/SOR-2016-281/page-1.html, accessed April 28, 2020). Critical habitat for the roseate tern, encompasses North Brother Island, South Brother Island, and Country Island in Nova Scotia, and portions of Sable Island, Nova Scotia. Environment Canada also developed a recovery strategy to address roseate tern recovery in Canada (Environment Canada 2014).

Roseate terns are listed as endangered and afforded protection under the Province of Nova Scotia Endangered Species Act, under which it is listed as Endangered. In Québec Province, the roseate tern is listed as threatened under the Act Respecting Threatened or Vulnerable Species (chapter E-12.01 r.2). In the absence of ESA protections, SARA would continue to provide protection for roseate terns when breeding in eastern Canada.

The degree to which the species and its roosting, foraging, and resting habitat is afforded protection by law in Brazil, French Guyana, Guyana, or other South American or Caribbean countries during the nonbreeding period is not known.

The ESA currently plays a critical role in progress towards the recovery of the Northeast roseate tern population. Many of the major threats are being managed, but not eliminated. The absence of ESA protections would create a large gap in mechanisms to address continuing threats to roseate tern colonies and staging areas from habitat loss and degradation, disturbance by humans,

predation, and accelerating sea level rise. Management of these threats is necessary for roseate terns to reach and sustain abundance and distribution of breeding colonies that will ensure the representation, redundancy, and resiliency of the Northeast roseate tern population.

2.3.2.5 Factor E. Other natural or manmade factors affecting its continued existence

2.3.2.5.1 Contaminants

The 2010 review reviewed two incidences of impacts from environmental contaminants that affected roseate terns: the release of polychlorinated byphenyls (PCBs) into New Bedford Harbor and the Bouchard-120 oil spill. In both situations, direct impacts to the terns and/or their habitat were documented. Mitigation and remedial measures were implemented to address impacts.

Impacts to roseate terns, their nesting and roosting habitat on Ram Island from the Bouchard120 oil spill and response to the spill, have not been mitigated at this time, although a restoration plan is being developed to identify compensation measures to address the loss of productivity and habitat that occurred as a result of the spill and response activities.

The 2010 review noted that the accumulation of PCBs in common and roseate tern eggs from the New Bedford Harbor PCB contamination declined progressively over time toward nontoxic levels because of effective cleanup measures addressing the source of the contamination. The restoration of Bird Island was partially funded by NRDAR (Natural Resource Damage Assessment and Restoration) settlement funds to compensate for impacts to roseate terns resulting from the PCB contamination.

Other than the incidents describe above, specific environmental contaminants have not been identified as a factor affecting long-term roseate tern survival or reproduction in the breeding range. Currently available information (subject to revision if indicated by new information) indicates that environmental contaminants pose a low threat to breeding roseate terns, barring a catastrophic release of oil or other contaminants. In the event a catastrophic release of oil occurs, the Rhode Island and Southeastern Massachusetts Area Contingency Plan incorporates a separate protection plan for southern New England for post-spill response measures for four species of terns, including the roseate tern. The protection plan is applicable to oil spills that might occur throughout the breeding range, the objective is to avoid and minimize impacts to roseate terns from post-spill response activities (S. Lehman, pers. comm., 2020).

An oil spill first documented in August 2019 of unknown origin has affected roseate tern wintering habitat in Mangue Seco and other areas along the northeastern coast of Brazil. No oiled roseate terns have been recovered. However, the spill occurred at sea, and roseate terns resting on the water and subsequently oiled would not likely be documented (https://www.birdlife.org/worldwide/news/full-impact-mysterious-brazil-oil-spill-remains-unknown accessed July 7, 2020).

2.3.2.5.2 Wind Turbines

Offshore wind energy development is an emerging activity affecting the roseate tern and/or its habitat. During the fall (mid-August through mid-October), roseate terns have been documented far offshore, up to approximately 155 miles (250 km), often in association with tunas or marine mammals. This range places them at risk of collision and/or displacement by the development of wind energy facilities on the Atlantic Outer Continental Shelf (Goyert and Nevins, pers. comm., 2018).

Roseate tern migratory flights may intersect the lease areas, although flight height, speed, and avoidance behavior are unknown. More data relative to these parameters and a collision risk model specific to roseate terns in the offshore environment are needed to better estimate the risk from wind energy projects.

Since the 2010 review, the USFWS concurred with a determination that a five-turbine wind energy project, now operating approximately 3 miles southeast of Block Island, Rhode Island, was not likely to adversely affect roseate terns (Chapman 2013). In 2018, Cape Wind Associates relinquished its Bureau of Ocean Energy Management (BOEM) lease that had authorized construction of 130 wind turbine generators approximately 5 miles off the coast of Cape Cod, Massachusetts (BOEM 2018). Informal consultation with the BOEM regarding the 800-megawatt Vineyard Wind project (80 to 100 turbines) proposed for construction south of Martha's Vineyard, Massachusetts has been ongoing since 2017.

As of 2020, 14 individual leases have been identified by the BOEM for wind energy projects off of the coasts of Massachusetts to Virginia, covering a total of 1,619,847 acres. Of these leases, nine projects completed Site Assessment Plans and seven completed Construction and Operations Plans (table 3). BOEM is considering that approximately 22 gigawatts of Atlantic offshore wind development is reasonably foreseeable (BOEM 2020). Based on current technology for wind turbine generators ranging from 8 megawatts to 12 megawatts, this could equate to approximately 2,750 to 1,833 wind turbines in leases from Massachusetts to Virginia.

Wind energy is likely the second main source of energy for Brazil. It is estimated to reach 20 gigawatts nationwide by 2022 (Lucena and Lucena 2019). The northeast region of Brazil has more than 85 percent of the wind capacity and the highest concentration of wind farms in the country. Although the largest wind farms may be in the interior (e.g. Araripe plateau), wind energy projects are also heavily concentrated on the northeast coast (Dantas et al. 2019). Land-based wind turbines in Brazil may displace roseate terns from traditional night roosts or cause collisions with turbines when constructed on the coast.

A wind energy project consisting of 71 turbines in Galinhos, Brazil is adjacent to the recently documented roseate tern mortality event that may be associated with power transmission line collisions. The state company-owned power transmission line was installed in the 1980s. The mortality events increased after the wind energy project was constructed in 2014. There is some speculation that the construction of the wind energy project displaced terns from a traditional night roost site to areas under the transmission lines; however, no preconstruction survey data are available regarding the presence of terns (Dantas et al. 2019). There is no

information available regarding the impact to the coastal ecosystem from the development of the wind energy project or avian collisions; therefore, it is difficult to assess the threat to roosting and staging roseate terns from this or other Brazilian coastal wind energy projects at this time.

In summary, the magnitude of future threats to roseate terns from wind turbine projects throughout the summer and winter ranges continues to be uncertain. However, it may be at least a moderate threat, depending on the numbers and locations of existing Brazilian coastal wind energy projects and future wind energy development in the winter and summer ranges of the roseate tern.

2.3.2.5.3 Sand extraction

Sand lance, the primary prey species for roseate terns, may be directly impacted by construction, dredging, and resource mining (e.g., sand mining) (Staudinger et al. 2020). Sand lance adults bury within sandy substrate, and sand lance eggs develop on and within the substrate, making this fish species, relative to other prey species, extremely vulnerable to activities that disturb or remove their habitat (Staudinger et al. 2020).

The increase in shoreline erosion due to climate change and sea level rise, has increased the demand for offshore sand used to renourish coastal beaches, either for planned projects or emergency needs. BOEM identified offshore mineral resources throughout the U.S. Atlantic Coast to reduce response time for post emergency recovery (e.g. beach stabilization and renourishment) and facilitate long-term planning (https://www.boem.gov/marine-minerals/building-national-offshore-sand-inventory; accessed May 5, 2020). The areas of marine mineral resources overlap the breeding and migratory range of the roseate tern. Atlantic Outer Continental Shelf Aliquots with sand resources have been identified off the coasts of New York, Rhode Island, and Maine. If aliquots occurring within the vicinity of breeding colonies and/or staging sites are mined, sand lance productivity could be impacted, subsequently affecting roseate tern productivity. At this time, sand mining is considered a potential threat.

2.3.2.5.4 Wintering grounds

Roseate terns are far more pelagic when on their wintering grounds, spending most days and nights foraging and resting offshore. Band resightings have been reported from (or bands have been collected from) ships at sea, often fishing vessels. Little is known about threats to wintering roseate terns when they occur offshore of South America, in particular the potential impacts from roseate terns attracted to well-lit offshore drilling sites, or squid fishing fleets (McKnight 2013).

In 2015, biologists from the Costa Branca Cetacean Project - University of Rio Grande do Norte State and the Center for Environmental Studies and Monitoring first documented an increase in injured or dead common and roseate terns during beach monitoring for oiled wildlife in Galinhos, Brazil (F. Silva, pers. comm., 2020). The mortalities were concentrated along approximately 3 kilometers (1.8 miles) of coastal power transmission lines. Injuries (blunt trauma and hemorrhage, wing amputations) were consistent with overhead collisions with transmission lines. Between 2015 and 2019, approximately 133 roseate terns were

recovered (Walsh 2019). The majority of injuries occurred between 2017 and 2019, primarily in late February and March when the terns begin staging prior to their northward migration. Eighty-three common and roseate tern mortalities were documented through March, 2020, species-specific numbers were currently unavailable (D. Farias, pers. comm., 2020). Scavenger rates have not been determined; therefore, we anticipate the actual number of mortalities is much higher. Dead banded roseate terns recovered at Galinhos were from Great Gull Island (20), Bird and Ram Islands (5), and Maine (1). It is not possible to distinguish the Northeast and Caribbean population birds when in nonbreeding plumage, it is very likely some Caribbean population roseate terns have also been killed.

2.3.2.5.5 Recreational Disturbance

Staging habitat is critical to adult and juvenile roseate terns because it allows roseate terns to accumulate energy resources for migration in preparation for their first migration south. Anthropogenic disturbance appears to cause greater impacts to staging roseate and common tern flocks than wildlife disturbance causes (Althouse et al. 2019). Disturbance of mixed offspring and parental flocks resulted in behavioral effects on hatch-year terns (increased locomotion), although it is unknown whether the behavioral responses were great enough to impact the survival of the young terns after departure (Davis 2016). Few staging areas are protected by symbolic fencing or other measures to prevent pedestrians from disrupting resting tern flocks. In the absence of protective management of consistently used staging areas, particularly those areas with large numbers of terns, roseate and common terns may be displaced from preferred habitat near foraging areas to less suitable areas by repeated disturbance from recreational beach users, and hatch-year terns may not accumulate sufficient energy resources to complete migration or may arrive at wintering grounds in a depleted state.

The level of anthropogenic disturbance on the wintering grounds is unknown. However, some of the known roseate tern roosting sites in Brazil are also promoted as recreational beaches (e.g., Galinhos, Mangue Seco). Currently, it is unknown if the few documented consistently used roosting areas are protectively managed for wintering terns or other avian species.

2.4 Synthesis

This review has updated information including roseate tern life history, biology, population trends, distribution, and threats that has become available since the 2010 review. The Synthesis section brings this information together to draw an overall assessment of the species' biological and conservation status in order to determine whether the roseate tern remains in danger of extinction throughout all or a significant portion of its range (the ESA definition of endangered) or is likely to become endangered in the foreseeable future (the ESA definition of threatened). The information pertinent to addressing this question includes: (1) roseate tern population status and distribution, (2) implementation and success of recovery actions, and (3) threats to the long-term survival of the species.

Ongoing habitat management and predator management at most of the breeding colonies resulted in relatively high annual estimated productivity and contributed to the steady increase in the population despite two steep declines that occurred between 1992 and 2019. The current

population is nearing the 1998 recovery plan objective of 5,000 breeding pairs, the recovery objective threshold for downlisting, although the temporal threshold (over 10 years) has not been met. However, the concentration of the majority of breeding pairs at three colonies and a significant decline in the Canadian breeding pair population leaves the species vulnerable to stochastic events.

The southern extent of the roseate tern range contracted significantly since the species was listed as noted in the 2010 review, and appears to have been further reduced with the loss of small breeding colonies on southern and central Long Island. The northern extent of the breeding range has not contracted, although a number of small colonies in Canada and Maine are no longer occupied. The genetic viability of the species is dependent on the existence of small, cold water subregion breeding colonies as well as the larger warm water subregion colonies. Continued loss of these small colonies could preclude the species from being recovered as the redistribution of genetic variation between the two subregions is affected.

Funding directed to support conservation of the roseate tern is attributed in part to its status as an ESA-listed species. ESA section 6 funding has supported annual monitoring, colony management, and research. The ACOE provided funding for the Bird Island restoration effort under section 206 Aquatic Ecosystem Restoration Authority and Section 204 of the Water Resources Development Act of 1992 (PL 102-980) in part because of the listing status of the roseate tern (ACOE 2006). NRDAR projects implemented to compensate for the New Bedford Harbor PCB contamination provided funding for the Bird Island Restoration project and for roseate tern management on Buzzards Bay colonies from 1999 through 2017 via the New Bedford Harbor Damaged Resource Restoration Trust Fund. Additional NRDAR projects may address the ongoing erosion at Ram Island in the near future. Were the species not ESA listed, funding for these conservation activities could become unavailable or significantly reduced.

Although threats from offshore and onshore wind turbine generators are foreseeable, their magnitude remains poorly understood, and in Brazil, not well researched. Information is lacking to assess site-specific and cumulative effects of future offshore wind energy projects. Key risk factors such as avoidance rates, flight heights, and migratory pathways in the vicinity of proposed wind projects are needed to more accurately predict risk. The future of wind energy along the northeastern coast of Brazil is largely unknown, despite the government's focus on wind energy development as a critical source of that country's energy supply.

Investigations into the effects of human disturbance on staging adults and juvenile (hatch-year) documented that anthropogenic disturbances have greater impacts on staging roseate terns than do wildlife disturbances. However, the magnitude of the effect on hatch-year survival is unknown. Recommendations to protect staging areas that are consistently visited by roseate terns based on past observations may be challenging to implement given the variable nature of staging area use by roseate terns. Long-term management strategies to protect staging terns from human disturbance need to be identified and implemented to enhance juvenile survival during migration.

The effects of climate change may be most pronounced on roseate tern breeding colonies as sea level rise increases the rate of erosion at low lying sites, and forage fish species' availability declines or forage fish species change to less suitable species. Ongoing acceleration of sea level

rise is well documented. Further increases in sea level rise rates are foreseeable with a high degree of certainty, and effects of sea level rise on roseate terns and their breeding, staging, and wintering habitats will be partially determined by efforts to address coastal erosion and shoreline stabilization.

In summary, although current breeding pair numbers indicate the population is stabilizing from past fluctuations, there is great uncertainty as to the long-term population viability. Maintaining stable and/or increasing breeding colonies requires annually managing breeding habitat, including predator and vegetation management. Monitoring and management at breeding colonies is contingent upon funding from state agencies and private entities. Because of recent reduced availability of state and private funding, the level of future management is uncertain. Reduced management will need to achieve a sufficient level of predator and/or vegetation management to maintain breeding colony habitat and population stability. Sea level rise is expected to continue to accelerate the rate of erosion on vulnerable breeding colonies including those supporting the majority of the roseate tern breeding population (Bird, Ram, and Great Gull islands). The rate of erosion varies by site; however, in the absence of significant stabilization measures such as was implemented at Bird Island, the life expectancy of some of these islands will be limited to 40 to 60 years. Climate change impacts to forage fish populations and species compositions and the roseate tern's flexibility to adjust to changing prey availability and species is uncertain given their proclivity to focus on only a few prey species.

Based on our review of the status of the species, information regarding new threats to the species throughout its range, uncertainties with respect to the long-term management of breeding colonies and the effect of climate change and sea level rise on breeding colony, staging, and wintering habitat, we recommend that the species remain listed as "endangered."

RESULTS

Recommended Classification: Given your responses to previous sections, particularly section 2.4. Synthesis, make a recommendation with regard to the listing classification of the species

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X_ **No change is needed**

RECOMMENDATIONS FOR FUTURE ACTIONS

1. Revise the 1998 recovery plan.
   The recovery criteria no longer reflect the best available information and most likely are not realistic. The natural population dynamics may demonstrate periodic declines and

recoveries over the long term; a revised recovery objective should reflect this natural variation. New threats to the species were identified, especially on the wintering grounds, and should be considered in revised recovery criteria.

   a. Update juvenile survival and recruitment estimates (Lebreton et al. 2003).
   b. Develop cold water subregion adult survival estimates.

2. Long-term breeding colony conservation.
   a. Identify and secure reliable funding to support continuing management of threats from invasive plant species, predation, and human disturbance by landowners and recovery partners.
   b. Develop standardized methodology for evaluating the success of habitat management strategies.
   c. Develop standardized productivity estimate methodologies for cross-colony comparisons to improve accuracy of annual population productivity estimates.

3. Threats assessment of climate change and sea level rise on breeding, staging, and wintering habitat.
   a. Conduct a site-specific and rangewide vulnerability assessment of coastal impacts of sea level rise, storm surge and extreme events on roseate tern breeding colonies, important staging areas, and key wintering sites.
   b. Identify conservation strategies to secure breeding, staging, and wintering areas.

4. Threats assessment of the impact of offshore wind development in the breeding range.
   a. Assess collision risk of foraging and traveling roseate terns in BOEM offshore wind energy lease areas throughout the tern summer season (includes prebreeding, breeding, staging, and migration flight movements).

5. Investigation of forage fish availability.
   a. Evaluate relationships between prey occurrence and prey quality in roseate tern diets and effects on chick productivity and population dynamics.

6. Staging grounds management.
   a. Develop sustainable management strategies for critical staging areas.

7. Winter site conservation.
   a. Promote international partnerships to identify key stopover sites, winter roosting or premigration staging areas.
   b. Identify conservation strategies to address site specific threats on key wintering sites.
   c. Investigate threats from coastal wind farms on wintering roseate terns.

8. Stopover habitat conservation.
   a. Identify key stopover sites in the Caribbean.
   b. Identify conservation strategies to address site specific threats on key stopover sites.

REFERENCES

Althouse, M. A., J. B. Cohen, S. M. Karpanty, J. A. Spendelow, K. L. Davis, K. C. Parsons and C. F. Luttazi. 2019. Evaluating response distances to develop buffer zones for staging terns. Journal of Wildlife Management 83(2):260–271.

Arnold, J. 2007. Population viability analysis for the roseate tern nesting in the northwest Atlantic. Appendix 3.6-J in EOEA (2007).

Billerman, S. M., B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg (Editors) (2020). Birds of the World. Cornell Laboratory of Ornithology, Ithaca, NY, USA. https://birdsoftheworld.org/bow/home

Bureau of Ocean Energy Management [BOEM]. 2018. Retrieved from https://www.boem.gov/renewable-energy/studies/cape-wind April 30, 2020.

BOEM. 2020. Vineyard Wind 1 Offshore Wind Energy Project Supplemental Draft Environmental Impact Statement. June 2020. Published by U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

Boon, J.D., 2012. Evidence of sea level acceleration at U.S. and Canadian tide stations, Atlantic Coast, North America. Journal of Coastal Research, 28, 1437-1445. http://dx.doi.org/10.2112/JCOASTRES-D-12-00102.1 accessed January 13, 2020.

Bratton, R.M., H.D., Legett, P. Shannon, K. Yakola, A.R. Gerson, and M.D. Staudinger. 2019. *In review*. Pre-breeding foraging ecology of three tern species nesting in the Gulf of Maine. Submitted to Marine Ecology Progress Series, May 2020.

Chapman, T. 2013. Letter dated July 31, 2013 from Thomas R. Chapman, USFWS New England Field Office to Robert J. DeSista, U.S. Army Corps of Engineers, Concord, Massachusetts regarding the Deepwater Wind proposal.

Collins M., R. Knutti, J. Arblaster, J. L. Dufresne, T. Fichefet, X. Friedlingstein, P. Gao, W. J. Gutowski, T. Johns, G. Krinner, and M. Shongwe. 2013. Chapter 12 - Long-term climate change: Projections, commitments and irreversibility. In: Climate Change 2013: The Physical Science Basis. IPCC Working Group I Contribution to AR5. Eds. IPCC, Cambridge: Cambridge University Press. pp. 1029-1137.

Cormons, G. D. 2017. Annual field report 2017: Monitoring roseate terns, *Sterna dougalli*, on Great Gul Island, N.Y. Report to the New England Field Office, USFWS, Concord, NH.

Cormons, G. D. 2018. Annual field report 2018: Monitoring roseate terns, *Sterna dougalli*, on Great Gul Island, N.Y. Report to the New England Field Office, USFWS, Concord, NH.

Cormons, G. D. 2019. Annual field report 2017: Monitoring roseate terns, *Sterna dougalli*, on Great Gul Island, N.Y. Report to the New England Field Office, USFWS, Concord, NH.

COSEWIC. 2009. Assessment and update status report on the roseate tern *Sterna dougallii* in Canada. Committee on the Status of Endangered Wildlife in Canada.

Craig, E. 2019. Isles of Shoals tern conservation program 2019 annual report. Report to the New Hampshire Fish and Game Department. Shoals Marine Laboratory, Durham, NH.

Dantas, E.J.A.; L. P. Rosa,. N. F. Silva, and M. G. Pereira. 2019. Wind Power on the Brazilian Northeast Coast, from the whiff of hope to turbulent convergence: The case of the Galinhos wind farms. Sustainability 2019, 11, 3802.

Davis, K. L., S. M. Karpanty, J. A. Spendelow, J. B. Cohen, M. A. Althouse, K. C. Parsons, C. F. Luttazi, D. H. Catlin, and D. Gibson. 2019. Residency, recruitment, and stopover duration of hatch-year Roseate Terns (*Sterna dougallii*) during the premigratory staging period. Avian Conservation and Ecology 14(2):11.

Dayton, J and P. Szczys. *In review*. Metapopulation connectivity mitigates permanent loss of historical genetic diversity in a federally endangered seabird.

Dupigny-Giroux, L.A., Mecray, E. L., Lemcke-Stampone, M. D., Hodgkins, G. A., Lentz, E. E., Mills, K. E., Lane, E. D., Miller, R., Hollinger, D.Y., Solecki, W.D., Wellenius, G.A., Sheffield, P.E., MacDonald, A.B., and Caldwell, C. 2018. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. doi: 10.7930/NCA4.2018.CH18.

Environment Canada. 2014. Action Plan for the Roseate Tern (*Sterna dougallii*) in Canada [Proposed]. Species at Risk Act Action Plan Series. Environment Canada, Ottawa. iv + 13 pp.

Farias, D. S. D. 2020. Technical Administrative Director. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated April 2, 2020. Center for Environmental Studies and Monitoring (CEMAM): Natal, Brazil.

Garcia-Quismondo, M., I.C.T. Nisbet, C. Mostello, and J. M. Reed. 2017. Modeling population dynamics of roseate terns (*Sterna dougallii*) in the Northwest Atlantic Ocean. Ecological Modelling, Vo. 368, 298-311.

Goyert, H.F. 2014. Relationship among prey availability, habitat, and the foraging behavior, distribution, and abundance of common terns *Sterna hirundo* and roseate terns *S. dougallii.* Marine Ecology Progress Series 506, 291-302.

Goyert, H. F. and H. Nevins. 2018. Personal communication. Comment letter on initiation of 5-year review of roseate tern, northeastern North American population. Dated September 7, 2018. American Bird Conservancy, Washington, D.C.

Goyert, H.F., Manne, L.L., R. R. Veit. 2014. Facilitative interactions among the pelagic community of temperate migratory terns, tunas and dolphins. Oikos 123, 1400-1408.

Hayhoe, K., D.J. Wuebbles, D. R. Easterling, D. W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner. 2018. Our Changing Climate. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. doi: 10.7930/NCA4.2018.CH2.

Hays, H., P. Lima, L. Monteiro, J. DiCostanzo, G. Cormons, I. C. T. Nisbet, J. E. Saliva, J. A. Spendelow, J. Burger, J. Pierce, and M. Gochfeld. 1999. A nonbreeding concentration of roseate and common Terns in Bahia, Brazil. Journal Field Ornithology 70(4):455-464.

Hays, H., G. Lugo, and G. Cormons. 2010. Puerto Rico – stopover for migrating roseate terns. North American Bird Bander. Vol. 35 No. 3.

Iaquinto, K. 2018. U.S. Fish and Wildlife Service. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated January 18, 2018. U.S. Fish and Wildlife Service: Bandon, OR.

IPCC. 2019. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

Jackson, R. B., C. LeQuere, R. M. Andrew, J. G. Canadell, G. P. Peters, J. Roy, and L. Wu. 2017. Warning signs for stabilizing global CO2 emissions. Environmental Research Letters. 12:110202.

Lehman, S. 2020. NOAA Scientific Support Coordinator, Emergency Response Division/Office of Response and Restoration. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated May 6, 2020. Lowell, MA.

Lima, P. C. 2020a. President of the BioBrasil Foundation. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated February 7, 2020.

Lima, P. C. 2020b. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated March 2, 2020.

Lima, P. C. 2020c. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated May 15, 2020.

Lima, P. C., R. C. F. R Lima, and T. N. C. Lima Neto. 2011. A biodiversidade do Litoral Norte da Bahia e o impacto da especulação imobiliária. (The biodiversity of the North Coast of

Bahia and the impact of real estate speculation) In: I Seminário Costeiro, 2011, Salvador. I Seminário Costeiro, 2011. https://translate.google.com/translate?hl=en&sl=pt&u=https://docplayer.com.br/6777305 7-A-biodiversidade-do-litoral-norte-da-bahia-e-o-impacto-da-especulacao-imobiliaria.html&prev=search Accessed May 11, 2020.

Loring, P. C. 2018. Annual Report: Permit Number: TE85396C-O. Report to the U.S. Fish and Wildlife Service, Hadley, MA.

Loring P. H., P. W. Paton, J. D. McLaren, H. Bai, R. Janaswamy, H. F. Goyert, C. R. Griffin, and P. R. Sievert. 2019. Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017.

Lucena J. de A. Y. and K. A. A. Lucena. 2019. Wind energy in Brazil: an overview and perspectives under the triple bottom line. Clean Energy, 2019, Vol. 3, No. 2, 69–84.

Massachusetts Division of Fisheries and Wildlife [MADFW]. 2017. Buzzards Bay tern restoration project: 2017 field season reports and summary of accomplishments, 1999 – 2017. Prepared for the New Bedford Harbor Trustee Council. October 2017.

McKnight, J. 2013. Canadian Wildlife Service. Presentation given at the 2013 Roseate Tern Recovery Meeting. Hadley, Massachusetts.

McKnight, J. 2020. Canadian Wildlife Service. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated January 14, 2020.

Mostello, C. 2012. Massachusetts Division of Fisheries and Wildlife. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated December 11, 2012.

Mostello, C. 2013. Table 34. Numbers of nesting pairs and productivity (chicks fledged per pair or per nest) of Roseate Terns in the Northeastern United States and Canada, 2005 – 2012). Unpublished Report. Massachusetts Division of Fisheries and Wildlife: Westborough, MA.

Mostello, C. 2019. Table 34. (PRELIMINARY, 14 Nov. 2019). Numbers of nesting pairs and productivity (chicks fledged per pair or per nest) of Roseate Terns in the Northeastern United States and Canada, 2012-2019. Unpublished Report. Massachusetts Division of Fisheries and Wildlife: Westborough, MA.

Mostello, C. 2020. Restoration of tern nesting habitat at Bird Island, Massachusetts. Presentation given at the North Atlantic Roseate Tern Webinar, February 24, 2020. Massachusetts Division of Fisheries and Wildlife: Westborough, MA.

Mostello, C. S., I.C. T. Nisbet, S. A. Oswald, J. W. Fox. 2014. Non-breeding season movements of six North American Roseate Terns *Sterna dougallii* tracked with geolocators. Seabird,

27. 1-21.

Nisbet, I. C. T. 2020a. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated May 7, 2020.

Nisbet, I. C. T. 2020b. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated July 27, 2020.

Nisbet, I.C.T. and J. A. Spendelow. 1999. Contribution of research to management and recovery of the Roseate Tern: Review of a twelve-year project. Waterbirds 22:239-252.

Nisbet, I.C.T., J. Burger, C. Safina, and M. Gochfeld. 1990. Estimating fledging success and productivity in Roseate Terns (*Sterna dougallii*). Colonial Waterbirds 13:85-91.

Nisbet, I.C.T., and N. Ratcliffe. 2008. Comparative demographics of tropical and temperate roseate terns. Waterbirds 31: 346-356.

Nisbet, I.C.T., J. S. Hatfield, W. A. Link, and J. A. Spendelow. 1999. Predicting chick survival and productivity of Roseate Terns from data on early growth. Waterbirds 22:90-97.

Nisbet, I. C. T., M. Gochfeld, and J. Burger (2014). Roseate Tern (*Sterna dougallii*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.370

Paton, P.W.C., P.H. Loring, G.D. Cormons, K.D. Meyer, S. Williams, and L.J. Welch. *In review*. Fate of common and roseate terns with satellite transmitters attached with backpack harnesses. Waterbirds.

Robards, M.D., M. F. Willson, R. H. Armstrong, and J. F. Piatt. 2000. Sand lance: a review of biology and predator relations and annotated bibliography. USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Sallenger, A.H., K. S. Doran, and P. A. Howd. 2012: Hotspot of accelerated sea-level rise on the Atlantic coast of North America. Nature Climate Change, 2, 884-888. http://dx.doi.org/10.1038/nclimate1597 accessed January 13, 2020.

Silva, F. J. de L. 2020. Professor. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated February 14, 2020. Costa Branca Cetacean Project – University of Rio Grande do Norte State (PCCB-UERN), Natal, Brazil.

Spendelow, J. A. 2017. ROST postfledging survival and age at first return to North America. Presentation at the 2017 Roseate Tern Recovery Meeting, Westborough, MA.

Spendelow, J. A. 2018. Roseate Tern use of staging sites in the Northeastern United States. Pages 59-65 in C. Macleod-Nolan, editor. Annual Roseate Tern Newsletter 2017. Royal Society for the Protection of Birds, Sandy, Bedfordshire, United Kingdom.

Spendelow, J. A. 2020. USGS Emeritus. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated January 16, 2020.

Spendelow, J.A., J.D. Nichols, J.E. Hines, J.-D. Lebreton, and R. Pradel. 2002. Modeling postfledging survival and age-specific breeding probabilities in species with delayed maturity: a case study of roseate terns at Falkner Island, Connecticut. Journal of Applied Statistics 29: 385 to 405.

Spendelow, J.A., D. Monticelli, J.D. Nichols, J.E. Hines, I.C.T. Nisbet, G. Cormons, H. Hays, J.J. Hatch, and C.S. Mostello. 2016. Roseate Tern breeding dispersal and fidelity: responses to two newly restored colony sites. Ecosphere 7(10):e0150. 10.1002/ecs2.1510.

Spendelow, J. A., J. E. Hines, J. D. Nichols, I. C. T. Nisbet, G. Cormons, H. Hays, J. J. Hatch and C. S. Mostello. (2008). Temporal variation in adult survival rates of Roseate Terns during periods of increasing and declining populations. Waterbirds 31 (3):309-319.

Spendelow, J. A., C. S. Mostello, I.C.T. Nisbet, C. S. Hall, and L. Welch. 2010. Interregional breeding dispersal of adult Roseate Terns. Waterbirds 33:242-245.

Spendelow, J.A. and A.J. Eichenwald. 2018. Post spring migration colony-site prospecting by Roseate Terns (*Sterna dougallii*). North American Bird Bander 43:1-6.

Staudinger, M. 2019a. Towards standardization of seabird colony data collection: preliminary survey results. Unpublished report to the USFWS, New England Field Office, Concord, NH. Northeast Climate Adaptation Science Center: Hadley, MA.

Staudinger, M. 2019b. Northeast Climate Adaption Science Center (NE CASC) input to the 5-year [review] of the Northeastern North American roseate tern population. Unpublished report to the USFWS, New England Field Office. Concord, NH. Northeast Climate Adaptation Science Center: Hadley, MA.

Staudinger, M. D., H. Goyert, J. Suca, K. Coleman, L. Welch, J. Llopiz, I. Altman, D. Wiley, A. Appelgate, P. Auster, H. Baumann, J. Beaty, D. Boelke, L. Kaufman, P. Loring, J. Moxley, S. Paton, K. Powers, D. Richardson, J. Robbins, J. Runge, B. Smith, C. Spiegel, H. Steinmetz. 2020. The role of sand lances (*Ammodytes* sp.) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management. Fish and Fisheries. 2020;21:522–556. https://doi.org/10.1111/faf.12445

Thaxter, C. B., B. Lascelles, K. Sugar, A. S. C. P. Cook, S. Roos, M. Bolton, R. H. W. Langston, and N. H. K. Burton. 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation 145:53-61.

U.S. Army Corps of Engineers. 2006. Bird Island Restoration Project, Marion, Massachusetts. Detailed Project Report and Environmental Assessment. New England District, U.S. Army Corps of Engineers. Concord, Massachusetts.

https://www.nae.usace.army.mil/Portals/74/docs/Topics/BirdIsland/DPR-EAFinal.pdf Accessed May 6, 2020.

U.S. Fish and Wildlife Service [USFWS]. 1989. Roseate tern (*Sterna dougallii*) recovery plan– Northeastern population. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

USFWS. 1998. Roseate tern (*Sterna dougallii*) recovery plan –Northeastern population, first update. U.S. Fish and Wildlife Service, Hadley, Massachusetts.

USFWS. 2010. Caribbean roseate tern and North Atlantic roseate tern (*Sterna dougallii dougallii*) 5-Year Review: summary and evaluation. New England Field Office, Concord, New Hampshire and the Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

USFWS. 2018a. Annual Roseate Tern Recovery Report, 2018 Monomoy National Wildlife Refuge. Monomoy National Wildlife Refuge, Chatham, MA. Report submitted to Legacy Region 5, Hadley, MA.

USFWS. 2018b. Annual Report: FY 2013, 2014, 2015, 2016, and 2017 Cooperative Recovery Initiative for endangered roseate tern breeding and staging habitat management and enhancement. Report submitted to Legacy Region 5, Hadley, MA.

USFWS. 2019. 2019 Falkner Island report. Stewart B. McKinney National Wildlife Refuge, Westbrook, CT. Report submitted to Legacy Region 5, Hadley, MA

Vagos, K. 2020. U.S. Fish and Wildlife Service. Personal communication. Electronic transmission to the U.S. Fish and Wildlife Service dated July 28, 2020. U.S. Fish and Wildlife Service: Westbrook, CT.

Veit. R. R., M. Martin, and I.C.T. Nisbet. 2003. Establishing a nesting colony of common and roseate terns on Musekeget Island, Massachusetts. Report to The Nature Conservancy.

Walsh, J. 2019. Gerard Bertrand Chair of Natural History and Field Ornithology, Massachusetts Audubon Society. Presentation given at the 2019 Roseate Tern Recovery Meeting. Westborough, MA.

Whittam, R.M. 1999. Update COSEWIC status report on the roseate tern *Sterna dougallii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

Yakola, K.C. 2019. An examination of tern diets in a changing Gulf of Maine. Master Thesis, University of Massachusetts, Amherst, MA.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Roseate Tern

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__x__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review conducted by: Susi vonOettingen, New England Field Office

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Fish and Wildlife Service

Approve SHARON MARINO Digitally signed by SHARON MARINO Date: 2020.08.24 12:34:21 -04'00' Date _____

Appendix A

Cold waters subregion peak and total breeding pair counts for Canada and ME, 2010 to 2019

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019 preliminary	
	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total
Nova Scotia																				
Unnamed Island, NS													1	1	ND	ND	ND	ND	ND	ND
Western Island											6	6	0	0	ND	ND	ND	ND	ND	ND
Country Island	14	26	27	27	17	18	16	16	14	15	6	6	16	18	16	18	13	13	13	13
Grassy Island			0	1[11]	ND	ND	ND	ND	ND	ND	ND	ND	0	0	ND	ND	ND	ND	ND	ND
Gully Island			1	1	ND	ND	ND	ND	ND	ND	ND	ND	0	0	ND	ND	ND	ND	ND	ND
Sable Island	ND	ND	ND	ND	ND	ND	3	3	ND	ND	4	4	3	3	3	3	3	3	3	3
Toby Island													1	1	1[11]	1[11]	1	1	0	0
Coffin Island																			1[1]	1[1]
Bear Point Thrums																	3	3[12]	0	0
The Brothers	28	38	37	38	25	34	34	38	37	38	35	42	42	50	24	26	2	2	47	52
Gull Island															5	5	27	35.5	0	0
Pinch Gut																	1	1[12]	0	0
Peases Island																	1	3[12]	0	0
Quebec																				
Chenal Island	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	ND	ND	0	0
Subtotal	***43***	***65***	***65***	***66***	***43***	***53***	***54***	***58***	***51***	***53***	***51***	***58***	***63***	***73***	***48***	***52***	***51***	***61.5***	***63***	***68***
Northern U.S. Gulf of Maine (ME/NH)	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total
Petit Manan Island	2	2	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Seal Island	2	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Matinicus Rock	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metinic Island	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Egg Rock	82	84	90	96	71	74	83	86	65	70	77	83	78	78	104	104	82	87	73	83
Pond Island	3[13]	3[13]	2	2	1[13]	1[13]	0	0	0	0	0	0	1	3	0	3	2	8	0	2
Jenny Island	29	33	8	8	11	11	7	7	12	16	15	15	13	24	22	23	24	26	21	21
Outer Green Island	15	16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0
Stratton Island	35	41	51	62	51	71	93	106	103	110	108	116	86	90	119	120	128	128	125	126
White Island	1	1	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0		
Seavey Island	47	52	41	49	49	61	51	59	69	76	68	74	83	103	92	97	55	65	61	80
Subtotal	***215***	***233***	***193***	***218***	***187***	***222***	***236***	***260***	***249***	***272***	***268***	***288***	***261***	***299***	***337***	***347***	***291***	***318***	***280***	***312***
Total	**258**	**298**	**258**	**284**	**230**	**275**	**290**	**318**	**300**	**325**	**319**	**346**	**324**	**372**	**385**	**399**	**342**	**379.5**	**343**	**380**

[11] Number denotes pairs believed attached to sites but for which no nests were located. Not included in annual total count of breeding pairs.
[12] Crude estimate.
[13] All nests abandoned, not included in total counts.

Warm waters subregion peak and total breeding pair counts for MA and CT, 2010 to 2019

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019 Preliminary	
	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total
Cape Cod, Nantucket, Martha's Vineyard, MA																				
Plymouth Beach	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray's Beach	0	0	1[14]	1[14]	1[14]	2[14]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimoy Island	1	1[15]	3	5	6	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0
S. Monomoy Island	8	8	7	7	1	2	8	8	8	8	11	11	12	14	11	18	30	30	12[16]	12[16]
Little Beach	0	0	0	0	0	0	0	0	0	0	7	7	0	0	0	0	0	0	0	0
Norton Point	26	36	0	0	0	5	15	35	0	0	35	35	4	7	0	7	0	0	19	19
Cape Pogue															10	10	0	0	0	0
Muskeget sandbars			0	1[17]																
Tuckernuck Island																	20[18]	20[18]	0	0
Subtotal	**37**	**47**	**11**	**13**	**7**	**13**	**23**	**43**	**8**	**8**	**53**	**53**	**16**	**21**	**21**	**35**	**30**	**31**	**31**	**31**
Buzzards Bay, MA																				
Bird Island	735	765	937	937	814	814	772	772	1121	1121	1127	1127	1153	1153	595	595	1175	1175	1101	1101
Ram Island	584	638	377	385	439	439	535	535	682	682	735	735	886	886	1555	1555	1093	1093	919	919
Penikese Island	37	37	34	34	9	9	0	0	20	20	23	23	11	11	90	95	12	13	15	15
Subtotal	**1356**	**1440**	**1348**	**1356**	**1262**	**1262**	**1307**	**1307**	**1823**	**1823**	**1885**	**1885**	**2050**	**2050**	**2240**	**2240**	**2280**	**2281**	**2035**	**2035**
Central Connecticut Coast																				
Falkner Island	45	45	48	48	36	36	26	26	21	21	36	36	30	30	55	55	28	28	33	33
Subtotal	**45**	**45**	**48**	**48**	**36**	**36**	**26**	**26**	**21**	**21**	**36**	**36**	**30**	**30**	**55**	**55**	**28**	**28**	**33**	**33**

[14] Number denotes pairs believed attached to sites but for which no nests were located. Not included in annual total count of breeding pairs.
[15] Site is known to be productive but for which a rigorous productivity estimate was not available or could not be properly calculated due to insufficient information.
[16] 2019 productivity based on fledges per nest; likely more pairs nested since roseate terns were observed in areas where nests not found.
[17] One pair observed with nest material, however, nest not confirmed.
[18] Courting pairs only.

Warm waters subregion peak and total counts for NY, 2010 to 2019

	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019 Preliminary	
	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total	Peak	Total
Eastern Long Island Sound & Gardiners Bay (CT/NY)																				
Great Gull Island	1303	1375	1439	1500	1596	1596	1543	1543	1459	1610	1659	1849	1664	1858	1793	2089	1903	2200	1932	2200
Subtotal	1303	1375	1439	1500	1596	1596	1543	1543	1459	1610	1659	1849	1664	1858	1793	2089	1903	2200	1932	2200
Southern Long Island - Shinnecock Bay to Rockaway Inlet (NY)																				
Lanes Island			1	1																
New Made Island	2	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	ND	0	0	0
Goose Flat	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ND	0	0	0
Cedar Island			2	2	0	0	0	0	0	0	0	0	0	0	0	0	ND	0	0	0
The Grouts			1	2	1	1	0	0	0	0	0	0	0	0	0	0	ND	0	0	0
Subtotal	14	14	4	5	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B

Raw productivity estimates for the Northeastern United States Roseate Tern breeding colonies

	Site (listed from north to south)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 Preliminary
Cold Waters Subregion	Petit Manan I., ME	0.33	0		0.25	0						
	Seal I., ME		0.5		1.0							
	Matinicus Rock, ME		0									
	Eastern Egg Rock, ME	0.78	0.72	0.85	1.31	0.93	1.21	1.19	1.24	1.29	1.13	1.1
	Pond I., ME		0		0				0	1.0		0.5
	Jenny I., ME	1.5	1.25	1.42	1.21	0.73	0.8	0.88	0.54	0.86	0.68	1.10
	Outer Green I., ME		1.32						1.0		0	
	Stratton I., ME	1.31	0.98	1.24	1.32	1.27	0.99	1.38	1.0	1.03	1.25	1.28
	Seavey I., NH	0.93	1.27	1.16	0.86	1.12	0.91	0.93	0.94	0.91	0.82	1.02
	Plymouth Beach			1.0								
	Minimoy I., Chatham, MA			1.67	0.5						0	
	S.Monomoy I., Chatham, MA		1.0	0.29	1.0	1.13	1.38	1.27	1.17	0.81	0.37+	0.75
	Little Beach, Martha's Vineyard, MA								0			
	Norton Point, Martha's Vineyard, MA				1.2					0		0
	Cape Poge, Martha's Vineyard									2.0[19]		
Warm Waters Subregion	Bird I., Marion, MA	1.44	1.33	1.23	1.12	1.34	0.85	0.86	1.16	0.80	1.04	0.79[20]
	Ram I., Mattapoisett, MA	1.04	1.30	1.10	1.31	1.31	0.98	0.87	1.49	1.16	0.98	0.80[2]
	Penikese I., Gosnold, MA	0.73			0.11		1.08	1.12	0.10	1.29	1.10	0.33[2]
	Falkner I., CT[21]	1.15	0.98	0.67-1.14	0.81-0.94	0.91-1.09	0.62-0.67	0.92-1.11	1.00-1.07	1.02-1.09	0.89-0.96	1.06-1.17

[19] Crude estimate.
[20] Productivity estimate is mid-point between number fledges observed and the Nisbet et al. 1999 method.
[21] Dual productivity estimates based on two methodologies: First number is observed fledges, second number was derived from the Nisbet et al 1999 method.

	Great Gull I., NY[22]	1.10	1.4-1.8	1.2-1.4	0.80	1.16	1.0	1.25	1.36	1.44	1.48	0.75-0.80

[22] Broad estimates.

Appendix C

Cold water subregion estimated productivity 2009 to 2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Petit Manan Island, ME	0.33	0.00		0.25	0.00						
Seal I., ME		0.50		1.00							
Matinicus Rock, ME		0.00									
Eastern Egg Rock, ME	0.78	0.72	0.85	1.31	0.93	1.21	1.19	1.24	1.29	1.13	1.10
Pond Island, ME											0.50
Jenny Island, ME	1.50	1.25	1.42	1.21	0.73	0.80	0.88	0.54	0.86	0.68	1.10
Outer Green Island, ME		1.32						1.00		0.00	
Stratton Island, ME	1.31	0.98	1.24	1.32	1.27	0.99	1.38	1.00	1.03	1.25	1.28
Seavey Island, NH	0.93	1.27	1.16	0.86	1.12	0.91	0.93	0.94	0.91	0.82	1.02
Plymouth Beach, MA			1.00								
Minimoy Island MA			1.67	0.50						0.00	
S. Monomoy Island, MA		1.00	0.29	1.00	1.13	1.38	1.27	1.17	0.81	0.37	0.75
Little Beach, MA							0.00				
Norton Point, MA				1.20					0.00		0.00

Warm waters subregion estimated productivity 2009 to 2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bird I., Marion, MA	1.44	1.33	1.23	1.12	1.34	0.85	0.86	1.16	0.80	1.04	0.79
Ram I., Mattapoisett, MA	1.04	1.30	1.10	1.31	1.31	0.98	0.87	1.49	1.16	0.98	0.80
Penikese I., Gosnold, MA	0.73			0.11		1.08	1.12	0.10	1.29	1.10	0.33
Falkner I., CT	1.15	0.98	1.06	0.88	1.00	0.65	1.02	1.04	1.06	0.93	1.23
Great Gull I., NY	1.10	1.60	1.30	0.80	1.16	1.00	1.25	1.36	1.44	1.48	0.78
Annual Average Productivity/ Adjusted Productivity	1.09/ 1.17	1.30/ 1.43	1.17/ 1.23	0.84/ 0.97	1.20/ 1.23	0.91/ 0.94	1.02/ 1.05	1.03/ 1.32	1.15/ 1.23	1.11/ 1.22	0.78/ 0.79

Appendix D.

BBL bands issued and encounter counts reported to the BBL for the Northeast United States 2010 to 2018[23].

State	Year	Bandings Count	Encounters Count
Connecticut	2010	58	0
	2011	57	22
	2012	36	30
	2013	24	110
	2014	14	49
	2015	41	50
	2016	30	36
	2017	65	1
	2018	33	0
Total Reported to BBL		**358**	**298**
Maine	2010	198	1
	2011	198	1
	2012	209	1
	2013	231	2
	2014	208	4
	2015	243	3
	2016	211	30
	2017	234	14
	2018	218	1
Total Reported to BBL		**1950**	**57**
Massachusetts	2010	988	19
	2011	67	4
	2012	14	2
	2013	240	3
	2014	214	12
	2015	214	18
	2016	370	84
	2017	524	32
	2018	425	17
Total Reported to BBL		**3056**	**191**
New Hampshire	2010	64	0
	2011	23	0
	2012	41	0
	2013	23	0
	2014	61	3
	2015	71	0
	2016	121	0
	2017	109	2
	2018	63	42
Total Reported to BBL		**576**	**47**

State	Year	Bandings Count	Encounters Count
New Jersey	2013	0	1
	2016	0	2
	2017	0	5
	2018	0	3
Total Reported to BBL		**0**	**11**
New York	2010	1217	0
	2011	1188	0
	2012	914	2
	2013	890	4
	2014	819	0
	2015	907	1
	2016	1526	9
	2017	1663	31
	2018	1183	19
Total Reported to BBL		**10,307**	**66**
Rhode Island	2012	0	1
	2014	0	1
	2015	0	1
	2016	0	3
	2018	0	2
Total Reported to BBL		**0**	**8**
Total Northeast US		**16,247**	**678**

[23] It should be noted that most resighting occurs at the breeding colonies and staging sites and often is not reported to the BBL.