Roseate Tern

Sterna dougallii

Federal Listing	E
State Listing	E
Global Rank	G4
State Rank	S1
Regional Status	Very High

Photo by Len Medlock

Justification (Reason for Concern in NH)

Since records were first taken in 1870, the roseate tern has dwindled somewhat in the region (USFWS 1988). This population nested from Nova Scotia to Virginia in the late nineteenth century but has been lost from all south of Long Island's south shore. The roseate tern was listed under the Endangered Species Act in 1987. At the time of listing, there were approximately 3,000 pairs nesting on 21 islands (10 islands with over 10 pairs) in the Northeast. Since then, restoration efforts have had a limited effect; populations continue to fluctuate around 3,200 pairs. There was a 4% per year decline in population from 2000-2007, but it has stabilized since 2007 (Nisbet 2014). The long-term population trajectory has alternated between long periods of increasing numbers and shorter periods of decline (Nisbet and Spendelow 1999). There have been recent large declines in southern New England and Long Island. Most sites on Long Island's south shore have been lost, and a significant Long Island Sound colony is greatly reduced (USFWS 1998, Kress and Hall 2004). In contrast, the cold water Gulf of Maine roseate population has been steady during this period. The Seavey Island roseate tern colony grew from 1 pair in 2001 to a peak of 112 pairs in 2004 to 76 in 2014 (NHFG and NHA unpublished data). Thus, it is important to evaluate these smaller, cold-water populations for their potential to aid in recovery goals. About 90% of the entire northeastern population currently nests on 3 islands: Great Gull Island in NY, and Bird and Ram Islands in MA; leaving the entire population increasingly vulnerable. Preservation of populations adapted to variable climates is critical in a time of global climate change. The concentration of roseate terns in several large colonies, due to predation and loss of nesting sites, is the primary threat to the species (USFWS Roseate Tern Recovery Plan). Expanding gull populations have taken over many of the offshore islands that once supported terns, and other islands have been lost to erosion. Roseates were forced to nest at inshore islands where the habitat quality was lower and the risk of predation from multiple predators was higher. In the northeastern United States, eggs, chicks and adults are eaten by 11 avian, 10 mammalian, 1 reptile, and 2 ant species (Nisbet 1989). Additional limiting factors may include inadequate foraging resources, competition for nest sites, contaminant impacts, imbalanced sex ratio, and insufficient funds to adequately protect existing colonies. Inclement weather may also harm northeastern roseate tern populations. Little is known about factors affecting the population on its wintering grounds (Gochfeld et al. 1998). In managing for roseate terns the needs of other coastal island species including common tern, Arctic Tern, common eider, black guillemot and purple sandpiper are also addressed.

Distribution

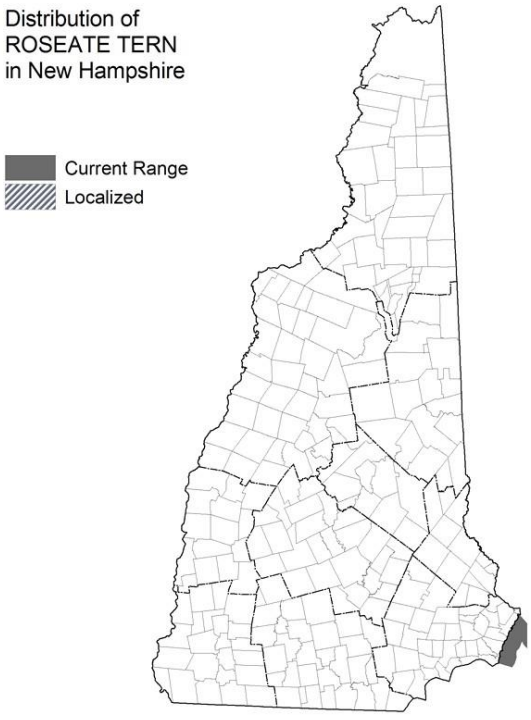
In New Hampshire, the only current nesting of roseate terns occurs at Seavey Island, Isles of Shoals. The island has been intensively managed for terns since 1997. One pair of roseate terns successfully nested on Seavey Island in 2001 and the population quickly grew to a peak of 112 pairs in 2004 and has since decreased to 76 pairs in 2014 (NHFG unpublished data).

Habitat

Roseate terns nest on small rocky or sandy islands, barrier beaches, salt marshes, and rarely on the mainland (USFWS 1989, Kress and Hall 2004). Most colonies are close to shallow-water foraging areas with sandy bottoms, bars, or shoals (Gochfeld et al. 1998). In the Northeast, roseate terns nest within common tern colonies (Nisbet 1989, USFWS 1998). Within these mixed colonies, roseate terns usually select habitat with dense vegetation or the protection of rocks and driftwood (Burger and Gochfeld 1988). They will also use artificial nest sites (e.g., boxes and half-buried tires) (Spendelow 1982). Roseate terns forage over shallow sandbars, shoals, inlets, or schools of predatory fish, often in mixed flocks with other terns (Safina 1990, Shealer and Burger 1993, 1995). Roseates feed on at least 15 species of small marine fish but prefer sand lance (*Ammodytes spp*.) (Gochfeld et al. 1998, Kress and Hall 2004). Feeding studies at New Hampshire's Seavey Island have documented sand lance (*Ammodytes spp*.), white hake (*Urophycis tenius*), and Atlantic herring (*Clupea harengus*) as key forage species (NHA and NHFG unpublished data 2006-2007). Foraging distance is variable (300 m^2 to 30 km^2) and depends on local prey availability. Roseate terns will travel farther than common terns to feed (Gochfeld et al. 1998, Kress and Hall 2004).

NH Wildlife Action Plan Habitats

- Coastal Islands
- Salt Marshes



Distribution Map

Current Species and Habitat Condition in New Hampshire

The only New Hampshire population of roseate terns occurs on Seavey Island, Isles of Shoals. This population has been intensively monitored since 2001 when the first pair nested. In 2004 a peak of 112 pairs nested and has declined from that level to 76 in 2014 (table 1). Productivity has averaged 1.00 chicks per pair between 2001 and 2014. This remains slightly below the northeastern average of more than 1.1 chicks per pair. Less than 1 chick per pair is considered low but can be seen in small or newly formed colonies (Nisbet 1989, Gochfeld et al. 1998). Roseate terns have not nested on any other islands at the Isles of Shoals since the late 1940s. The last known breeding on Lunging Island was in 1944 (Borror and Holmes 1990). Anecdotal evidence from Duck Island describes tern breeding in the "thousands". Both Lunging and Duck Island are potential breeding habitat but support large herring and great black-backed gull colonies.

The potential for roseate tern recolonization outside the Isles of Shoals is low. Inshore tern colonies contend with predation, disturbance, and the attendant disruptions of nesting habitats. Few inshore islands have the dense vegetation or rocky outcrops that roseates prefer to nest in. In addition, roseates only nest in common tern colonies of significant size. The largest common tern colony outside of Seavey Island rarely supports more than 12 pairs.

The objective for recovery in this species is to increase the Northeast nesting population to a minimum of 5,000 pairs with at least 6 large colonies (over 200 pairs) with high productivity (at least 1.0 fledged young per pair). A secondary objective is to expand the number of roseate tern breeding colonies to 30 or more sites. At present, there are only 4 sites larger than 200 pairs and they all experience fluctuating productivity. The concentration of nearly all the roseate (100%), Arctic (100%), and common turns (98%) at one site in New Hampshire puts tern populations at great risk.

Population Management Status

The Seavey Island roseate, common and Arctic tern colony is managed intensively. Biologists live on the island throughout the breeding season, controlling predators, monitoring colony productivity, and implementing public outreach. Visitation is restricted from 1 May to 1 September to minimize disturbance. Managers encouraged roseate terns to recolonize Seavey Island by using tern attractants and controlling gull populations. Gull control at Seavey Island consisted of dogs (late April), pyrotechnics, regular circumnavigation of the island beginning 30 minutes before sunrise and continuing until 30 minutes after sunrise, and the placement of a large rock in any gull nest cups (NHA and NHFG unpublished reports 1997-2003). Tern attraction techniques included the placement of decoys in suitable habitat along with the broadcast of tern colony sounds (Kress 1983). Common terns nested at this site in the first year of restoration efforts (1997).

Gull predation continues, but is dealt with successfully. Resident tern biologists intervene throughout the breeding season, and specialist predatory gulls are removed from the island. During summer, tern biologists regulate visitation and guide educational visits from Shoals Marine Lab, Star Island, and various other conservation organizations.

Regulatory Protection (for explanations, see Appendix I)

- Endangered Species Conservation Act (RSA 212-A)
- Migratory Bird Treaty Act (1918)

Quality of Habitat

Seavey Island provides the best habitat for roseate terns in New Hampshire. The quality of foraging habitat and prey availability on Seavey Island is largely unknown. Duck Island and Lunging Island still have good potential for tern nesting, though the presence of gulls makes colonization problematic.

Smuttynose Island once supported one of the largest gull concentrations at the Isles of Shoals, and the presence of raccoons and gulls makes this site unsuitable for tern nesting. A large gull colony exists on Appledore Island, where a research station is operated from April to October. However, rats, muskrats, raccoons, and human disturbance make this island unsuitable for terns.

Habitat Protection Status

Seavey Island was deeded to the State of New Hampshire after the White Island Light was automated in 1987. White and Seavey Islands have been managed by the Department of Resources and Economic Development (DRED) Parks and Recreation Division as part of Odiorne State Park since 1993. A Memorandum of Agreement on tern restoration exists between DRED – Parks Division and the NHFG. Seavey Island is managed by NHFG as an endangered species nesting area and is afforded both state and federal protection under endangered species law.
The Coastal Islands National Wildlife Refuge purchased Duck Island in July 2003. This island will be managed for its wildlife resources, protected as a seabird colony, posted for closure during the breeding season, and evaluated for habitat management and restoration (B. Benedict, USFWS, personal communication). Privately owned Lunging Island is not protected beyond current shoreline and wetland regulations. Smuttynose Island is privately owned but was protected in August of 2001 by a conservation easement held by the Coastal Islands National Wildlife Refuge. This conservation easement allows the refuge to manage the site for wildlife resources (B. Benedict, USFWS, personal communication). Islands in the Piscataqua River, and Great and Little Bays are not suitable for roseate terns because of their proximity to the mainland.

Habitat Management Status

Seavey Island is managed for terns through the NHFG and NHA Tern Restoration partnership. Restoration efforts from 1997 to 2004 have focused on intensive management to eliminate gull nesting and to control predation, and have allowed re-colonization by common terns. There has been a shift in the Seavey Island vegetation from yarrow and seaside goldenrod to tall dense grasses. Although the height of the grass makes the habitat more suitable for roseate terns, the density can cause problems for movement of both adults and chicks as the season progresses.
In 2005, approximately 100 feet of boardwalk were laid through the grassy area to give more structure and opening to the nesting habitat, and to allow biologists access to this part of the island. Other islands identified in 'Relative Quality of Habitat' as having the potential for tern recolonization need to have baseline habitat assessments. If determined to be suitable for restoration efforts, a habitat restoration plan would need to be developed and implemented.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Mortality from predator overpopulation (Threat Rank: High)

Herring gulls and great black-backed gulls are major predators on terns and other small seabirds. The protection of all seabirds, changes in human land use along coastal islands, the fishing industry, and the use of open landfills caused gull populations to exponentially increase in the twentieth century. Gulls prey on tern eggs and chicks and displace them from prime nesting habitats (Foss 1994). Gulls were partly to blame for the extirpation of roseate terns from New Hampshire, but initiation of active

gull control on Seavey Island has allowed for the recolonization of this species.
Nearshore tern colonies are vulnerable to predators such as rats, raccoons, skunk, and fox. Increased development and human use of coastal areas has allowed for an abundance of potential tern predators (USFWS 1998, Kress and Hall 2004). Great horned owl and black-crowned night heron will fly many kilometers to feed on tern chicks and adults. Other avian predators seen at Seavey Island include peregrine falcon, northern harrier, snowy owl, and cattle egret. With 100% of the roseate terns in New Hampshire nesting at Seavey Island this species is vulnerable to predation.

More effective control of municipal and fishing wastes is helping to control gull populations. However, the New Hampshire seacoast still has a large open landfill located in Rochester, about 46 kilometers from the Isles of Shoals. This landfill supports large numbers of gulls during the winter. The Isles of Shoals remains an active fishing area, and there is evidence that discarded lobster bait and other fishing wastes subsidize local gull populations (Goodale 2000). Lack of gull control has been shown to sharply increase predation and disturbance of nesting terns (Donehower 2003). Although non-lethal gull control has successfully removed nesting gulls from Seavey Island, gull predation continues at this site and is particularly intense during the fledging period.
Nocturnal predators such as the great horned owl and black-crowned night herons prey on terns and may cause colony desertion (Nisbet 1999). A great horned owl killed significant numbers of roseate adults in the 2 largest roseate colonies in Buzzard's Bay, Massachusetts. Black-crowned night heron predation has been documented on Stratton Island, Maine and on Falkner Island, Connecticut. The Stratton Island colony grew from 1 pair in 1995 to 127 pairs in 2001 after black-crowned night herons were controlled. The Falkner Island population fell from 135 pairs in 1997 to 37 pairs in 2004 after black-crowned night heron appeared.
Since 2000, mink have invaded 5 common and roseate tern colonies, resulting in dramatic loss of common and roseate terns and the abandonment of tern colonies from Ship Island, Stratton Island, and Jenny Island. Mink killed every roseate chick on Brothers Island (Canada) in 2 consecutive years. Boats have brought predators (rats and raccoons) to Star, Smuttynose, and Appledore Islands in the Isles of Shoal, causing widespread nesting failure.

Species impacts from competition (with gulls for nesting islands) (Threat Rank: High)

Gulls displace terns from prime nesting habitats (Foss 1994). Gulls continue to nest on all the other islands at the Isles of Shoals, making them unsuitable for terns.

Duck and Lunging Islands were noted to support high numbers of breeding terns in the mid-1800 and 1900s (Jackson 1947, Borror and Holmes 1990), but Lunging Island was abandoned because of displacement by herring gulls (Drury 1973, Erwin 1979). The presence of open landfills and lobster and other fishery waste have also contributed to growing gull populations in seacoast NH (Goodale 2000) and other coastal areas (Kadlec and Drury 1968, Drury 1973, Nisbet 1978, Oro et al. 1995, Chapdelaine and Rail 1997). The near extirpation of terns caused by the gathering of birds for the feather trade provided gulls with more nesting habitat leading to an increase in large gulls (herring (*Larus argentatus*) and great black-backed gulls (*Larus marinus*) (Brown and Nettleship 1984, Buckley and Buckley 1984) which prey on tern eggs and young (Nisbet 2002).

Species impacts from oil spills (Threat Rank: High)

Portsmouth Harbor services large passenger and container ships presenting the possibility of an oil spill occurring near the Isles of Shoals where common terns nest or within the Piscataqua River where they forage. Roseate terns could also be affected by oil spills during migration or on their wintering grounds.

Seabirds are particularly susceptible to both internal and external oil exposure after oil spills at sea (Leighton 1993), and their foraging habits, preening behavior, and resting requirements lead to frequent contact with surface oil (Haney et al. 2014). Mortality occurs as a consequence of spills of petroleum oils. Birds are affected by oil in the following ways: external contamination of feathers, contamination of eggs which are lethal to the embryo in very small doses, and ingestion of oil while preening. Oils on feathers is the single most devastating effect of oil on birds as the feathers lose their water repellency, insulation, and flight capabilities. Death results from combinations of hypothermia, starvation, and drowning (Leighton 1993).

Disturbance from restoration and maintenance of lighthouse and associated buildings (Threat Rank: Medium)

Species impacts from sea level rise and altered food chains (Threat Rank: Medium)

Climate change will likely warm sea surface temperatures and oceanic circulation, leading to changes in nutrient cycling and marine productivity (Tyrell 2005). Many other activities threaten coastal marine habitat in the Gulf of Maine (for a review, see Tyrell (2005). There is some indication that primary productivity patterns in the GOM have shifted in both magnitude and phenology (NEFSC 2013) which would have harmful effects on all trophic levels in the system. Mills et al. (2013) reported that 2012 was the largest, most intense warming event in the Northwest Atlantic in 30 years and was distinctly evident in the GOM where the 2012 sea surface temperature (SST) anomaly was 2°C above the 1982–2011 average, and over a degree warmer than the next highest anomaly. This level of warming is close to the mean SST change projected to occur near the end of the century (Meehl et al. 2007). These changes presumably have important impacts on the foraging ecology and ultimately success of terns nesting at White and Seavey Islands. Given roseate terns have a more specialized diet; they could be more vulnerable to altered food chains.

In 2011 on Petit Manan Island, Maine, common terns delivered 40% butterfish (*Poronotus triacanthus*) to their chicks versus 10% herring, one of the preferred prey species; butterfish is a deep bodied fish difficult for chicks to consume. This pattern has been observed recently at other regional breeding sites and is reversed from typical years when herring was the dominate fish in chick diets (Steeves 2011). In 2012 when water-temperature was the warmest on record in the Gulf of Maine in the last 30 years (Mills et al. 2013), Atlantic puffins (*Fratercula arctica*) at Petit Manan Island fed their chicks significantly larger butterfish than in previous years, perhaps signaling a response to an earlier phenology of ecosystem processes, and subsequently, more advanced spring butterfish growth (National Audubon Society 2012).

Habitat conversion and species disturbance from wind tower and turbine development (Threat Rank: Medium)

Habitat may be converted around the Isles of Shoals for a potential wind turbine site. The construction would disturb terns nesting on White and Seavey Island and may cause movement issues around the turbines. Wind turbines located in their migratory routes could also pose a threat.

Wind farms can be fatal to birds through direct contact with towers or blades (Drewitt and Langston 2006, Arnett at al. 2008). Breeding site selection can also be affected (Pearce-Higgins et al. 2009, Douglas et al. 2011), as well as flight routes (Desholm and Kahlert 2005, Larsen and Guillemette 2007), and foraging behavior (Larsen and Madsen 2000). Offshore wind farms can affect sedimentation patterns and prey species composition (Percival 2001) and may act as a barrier to seasonal and local migrations (Exo et al. 2003). Currently no wind development projects are proposed for the Isles of Shoals where common terns nest; however Cape Wind is attempting to build a wind farm off the coast

of Cape Cod, Massachusetts.

Species impacts from reduced prey availability due to overfishing (Threat Rank: Medium)

According to the United Nations Food and Agriculture Organization, more than 70% of the worldwide marine fish stocks are either fully exploited or depleted (FAO Report 2004). In the North Atlantic, the American Fisheries Society has identified 82 species at risk of extinction including Atlantic salmon, Atlantic halibut, and a number of species of sharks, skates, sturgeons, and groupers. Fishing can change the abundance of exploited species and degrade marine habitat (e.g., trawling) (Collie et al. 1997).
Point and non-point source runoff from agricultural and developed coastal areas can negatively impact estuarine and sub-tidal areas that support food webs in coastal and offshore waters.

Changes in prey availability affect the growth and survival of chicks and the condition of adults (Safina et al. 1988, Nisbet et al. 1995). Prey availability may also impact the size and distribution of colony sites (Nisbet 1999). However, the correlation of reduced prey availability and common and roseate tern productivity has not been firmly established. Other seabirds, including terns, have shown very significant impacts from changes in prey availability. In Britain, breeding failure and diminished adult survival in Arctic terns was linked to changes in fish prey availability due to commercial fisheries activities (Suddaby and Ratcliffe 1997 in Kress and Hall 2004).
In 2004, disappearance of sand eels devastated Scottish seabird colonies; 1,200 guillemot nests on the isle of Shetland failed completely, 24,000 Arctic tern nests were almost entirely empty, and the world's largest colony of great skuas produced only a few chicks. Scientists believe that the sand eels are disappearing because the cold-water plankton that these fish depend on no longer flourishes in these coastal areas. The North Sea has warmed 3.6°F over the last 20 years, shifting the phytoplankton blooms northward or earlier in the season (Schulman 2005).

Disturbance from recreation and tourism (Threat Rank: Medium)

Nearly one-third of the population in the United States (over 75 million people) and Canada (over 9 million people) live within a day's drive of the Gulf of Maine. Vast areas of coastal and offshore marine habitat have been lost or degraded in the last three centuries. The northeastern roseate tern population is restricted to a small number of islands and many historic nesting islands been lost to occupation by gulls. Degradation and disturbance in these areas would all have a negative impact on roseate tern success. Little is known of critical habitat (foraging, staging, and wintering) for roseate terns. Nisbet (2002) cites the need for increased research into winter habitat where it is believed the highest mortality occurs.

Critical habitats for common terns and roseate terns should be identified and protected. Seavey Island is important because most of New Hampshire's common terns and all of its roseate terns nest there. Yet scientists do not know basic information such as the location of foraging or staging areas. The 2 known staging areas in the Northeast are in highly developed areas of the coast and may be vulnerable (Casco Bay, Maine and South Beach, Massachusetts).

List of Lower Ranking Threats:

Species impacts from mercury toxicity

Species impacts from various diseases (cholera, botulism, salmonella) Mortality

from unregulated take on winter grounds

Habitat degradation from aquaculture contamination

Habitat conversion due to development

Actions to benefit this Species or Habitat in NH

Continue intensive monitoring of roseate terns on Seavey Island

Objective:
Continue intensive monitoring of roseate terns on Seavey Island

General Strategy:
Continue to monitor productivity. Use established methods as outlined by the Roseate Tern Recovery Plan to determine productivity on a yearly basis. Characterize roseate tern breeding habitat on Seavey Island. Determine the habitat parameters in preferred nesting habitat. Evaluate the need for vegetation management to maintain and/or increase roseate habitat on Seavey Island. Identify and characterize preferred foraging habitat/sites. Evaluate vulnerability of principal foraging sites to human related over-use issues. Assess available foraging resources by conducting foraging studies. Establish protocol to study the relationship of prey availability and productivity. Identify prey availability during the courtship and egg-laying stage to determine impacts on clutch size. Identify inter-annual and inter-colony variation in prey and the potential effects on productivity. Develop understanding of how foraging effort affects reproduction.

Political Location:
Statewide

Watershed Location:
Statewide

Conduct monitoring of roseate terns in New Hampshire

Objective:
Conduct monitoring and research of roseate terns in New Hampshire.

General Strategy:
Distribution research should include the following: Continue intensive monitoring of roseate terns on Seavey Island and characterize breeding habitat; evaluate other islands at the Isles of Shoals for suitable tern habitat, especially historic sites (Lunging and Duck Islands); identify priority habitats and potential restoration sites; document significant foraging and staging areas; understand movement patterns of the roseate tern within the Gulf of Maine using the marked known aged population; evaluate annual interchange of birds between GOM and “warm water” group; research migration routes; and research winter habitat use and distribution. Conduct habitat assessments at the other historical Isles of Shoals islands. Assess potential impacts of an oil spill near Seavey Island. • Identify important staging areas for Gulf of Maine roseate terns and the proportion of the population aggregating at staging/roosting areas. Conduct staging area counts through re-sighting of banded GOM birds, and determine the proportion of the population aggregating at staging/roosting areas. Build baseline information of the use of staging sites by NH and ME roseate terns. Determine if pre-migratory staging areas are a vulnerable population bottleneck.

Political Location:
Statewide

Watershed Location:
Statewide

References, Data Sources and Authors

Data Sources

Basic natural history information in this profile was largely gathered from the literature. Information on habitat and distribution was gathered from scientific literature, recovery conservation plans, technical field reports, published literature, NHA and NHFG Seavey Island data, New Hampshire Bird Records data, Gulf of Maine Seabird Working Group (GOMSWG) and Roseate Tern Recovery Team (RTRT) discussion and minutes. Information on habitat and distribution was gathered from scientific literature, recovery conservation plans, technical field reports, published literature, NHA and NHFG data, GOMSWG, and Roseate Tern Recovery Team (RTRT) discussion and minutes.

Data Quality

Roseate terns have been closely monitored in the region for more than 20 years. The Seavey Island roseate tern population has been intensively studied since recolonization in 2001. In New Hampshire, a census is conducted at all current and recently occupied tern-nesting sites during June. Roseate tern foraging habitat is largely unknown in New Hampshire. In 2004, a brief study suggested that some foraging occurs near Seavey Island, but critical foraging areas remain undocumented. Few data exist on staging areas for roseate terns before or after the breeding period, or on migration and wintering habitat. Seavey Island has been monitored intensively since 1997. Census and productivity numbers have been determined since roseate terns began nesting in 2001. Chick provisioning data were collected in 2005 and 2006. Baseline habitat data for roseate tern nesting sites were also collected in 2004. It will be important to expand on these data to determine the habitat parameters in preferred nesting areas.

2015 Authors:

Jessica Carloni, NHFG

2005 Authors:

Diane De Luca, NHA

Literature

Borror, A.C., and D.W. Holmes. 1990. Breeding Birds of the Isles of Shoals. Shoals Marine Laboratory, New York, New York, USA.

Brody, Samuel D. 1998. Evaluating the role of site selection criteria for Marine Protected Areas in the Gulf of Maine. Gulf of Maine Council on the Marine Environment.

Burger, J., and M. Gochfeld. 1988. Nest site selection: comparison of Roseate and Common Terns in a Long Island, New York colony. Bird Behavior 7: 59-66.

Chardine, J.W. 1990. Newfoundland: Crossroads for Marine Birds and Shipping in the North Atlantic. Proceedings: The Effects of Oil on Wildlife. Newfoundland.

Clement, J., and M. Janowicz (Editors). 2003. Aquaculture Physical Remediation: Workshop Proceedings. Gulf of Maine Council on the Marine Environment, www.gulfofmaine.org.

Collie, J.S., G.A. Escanero, and P.C. Valentine. 1997. Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series 155: 159-172.

Donehower, C. 2003. Predation rate and predatory behavior of large gulls on Eastern Egg Rock. Unpublished Report. National Audubon Society.

Drury, W.H.1973. Population changes in New England seabirds. Bird-Banding 44: 267-313.

Foss, C. Editor. 1994. Atlas of the Breeding Birds in New Hampshire. New Hampshire Audubon, Dover, New Hampshire, USA.

Foss, C. Editor. 1994. Atlas of the Breeding Birds in New Hampshire. New Hampshire Audubon, Dover, New Hampshire, USA.

Gochfeld, M., J. Burger, and I.C.T. Nisbet. 1998. Roseate Tern (*Sterna dougallii*). In The Birds of North America. No. 370 (A. Poole and F. Gill, eds.). The Birds of North America Inc. Philadelphia, Pennsylvania, USA.

Goodale, W. 2000. The importance of lobster bait in Penobscot Bay gull diet. Unpublished Report. College of the Atlantic.

Gulf of Maine Council Habitat Restoration Subcommittee. 2004. The Gulf of Maine Habitat Restoration Strategy. Gulf of Maine Council on the Marine Environment.

Gulf of Maine Council on the Marine Environment. 2002. Action Plan 2001-2006. Gulf of Maine Council on the Marine Environment.

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 of Field Ornithology 70:455-464.

Kress, S.W. 1983. The use of decoys, sound recordings, and gull control for re-establishing a tern colony in Maine. Colonial Waterbirds 6:185-196.

Kress, S.W., and C.S. Hall. 2004. Tern Management Handbook – Coastal Northeastern United States and Atlantic Canada. U.S. Department of Interior, Fish and Wildlife Service, Hadley, Massachusetts, USA.

New Hampshire Office of State Planning Coastal Program. 1996. A vision for the New Hampshire coast. National Oceanic and Atmospheric Administration. 61pp.

Nisbet, I.C.T. 2000. Disturbance, habituation and management of Waterbird colonies. Waterbirds 23:

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, Ian C., Michael Gochfeld and Joanna Burger. 2014. Roseate Tern (*Sterna dougallii*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/370.

Pierce, V. 1991. Pathology of Wildlife following a #2 Fuel Oil Spill. The Effects of Oil on Wildlife: Research, Rehabilitation, and General Concerns. BRRC, TSBR, IWR.

Safina, C., R.H. Wagner, D.A. Witting, and K.J. Smith. 1990. Prey delivered to Roseate and Common Tern chicks; composition and temporal variability. Journal of Field Ornithology 61: 331-338.

Shealer, D.A., and J. Burger. 1993. Effects of interference competition on the foraging activity of tropical Roseate Terns. The Condor 95: 322-329.

Shealer, D.A., and J. Burger. 1995. Comparative foraging success between adult and one-year-old Roseate and Sandwich Terns. Colonial Waterbirds 18: 93-99.

Shealer, D.A., and S.W. Kress. 1994. Postbreeding movements and prey selection of roseate terns at Stratton Island, Maine. Journal of Field Ornithology 65: 349-362.

Spendelow, J.A. 1982. An analysis of the temporal variation, and the effects of habitat modification on, the reproductive success of Roseate Terns. Colonial Waterbirds 5:19-31.

Spendelow, J.A., J.D. Nichols, I.C.T. Nisbet, H. Hays, G.D. Cormons, J. Burger, C. Safina, J.E. Hines and M. Gochfeld. 1995. Estimating annual survival and movement rates of adults within a metapopulation of Roseate Terns. Ecology 76: 2415-2428.

Tripp, B., M. Ernst and D. Keeley (Editors) 2004. Establishing research priorities in the Gulf of Maine. Final Report. GOMC-RARGOM Theme Meeting.

Tyrell, M.C. 2005. Gulf of Maine Habitat Primer. Gulf of Maine Council on the Marine Environment, www.gulfofmaine.org. 54 pages.

USFWS. 1989. Recovery Plan for Roseate Tern (*Sterna dougallii*). Northeast Population. Newton Corner, Massachusetts, USA.

USFWS. 1998. Roseate Tern Recovery Plan – Northeastern Population, First Update. Hadley, Massachusetts, USA.

USFWS. 2010. Caribbean Roseate Tern and North Atlantic Roseate Tern (*Sterna dougallii dougallii*). 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Boquerón and Concord.