Audubon CONNECTICUT

Important Bird Area Conservation Plan

Falkner Island Unit of the Stewart B. McKinney National Wildlife Refuge

Guilford, CT

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This conservation plan is a formal organization of ideas pertaining to Falkner Island contributed by individuals with expertise in conservation biology, tern conservation, and/or firsthand experience working on the island. The following recommendations are presented not as directives, but as ideas that have the greatest potential to enhance the ecological integrity and conservation value of Falkner Island – the 'crown jewel' of Connecticut's bird habitat. Many of the ideas within can be attributed to Sara Williams, former biologist at the Stewart B. McKinney National Wildlife Refuge, and Patrick Comins, Director of Bird Conservation for Audubon Connecticut. We would also like to acknowledge Kris Vagos, current biologist at Stewart B. McKinney National Wildlife Refuge, and Jeffrey Spendelow, biologist at the United States Geological Survey Patuxent Wildlife Research Center, for providing critical information and additional recommendations.

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EXECUTIVE SUMMARY

The Falkner Island Unit of the Stewart B. McKinney National Wildlife Refuge is a small crescent-shaped island located approximately three miles off the coast of Guilford, Connecticut. As the state's only vegetated marine island, Falkner Island presents unique habitat and supports a distinct avifauna, most notably, Connecticut's only remaining breeding colony of the federally endangered roseate tern (*Sterna dougallii*). The island also supports a common tern (*Sterna hirundo*) colony which represents 95% of the state's breeding population and large numbers of landbirds and shorebirds during spring and fall migration. In a regional context the roseate tern colony at Falkner Island is part of the federally endangered Northwest Atlantic population, and is the former long-term site of the Falkner Island Tern Project which made substantial contributions to our understanding of roseate tern biology and conservation.

Falkner Island has been recognized as a state Important Bird Area by Audubon Connecticut by satisfying the following criteria:

- *The site is important to endangered or threatened species in Connecticut.*
- *The site is important to species of high conservation priority in Connecticut.*
- *The site contains rare or unique habitats within the state/region or is an exceptional representative of a natural habitat and holds important species or species assemblages largely restricted to a distinctive habitat type.*
- *Gulls and Terns: The site regularly supports 100 or more terns or 500 or more gulls in a season.*
- *Landbirds: The site is an important migratory stopover or seasonal concentration site for migratory landbirds.*
- *Single-species Concentrations: The site regularly supports significant concentrations of a congregating species but may not meet the thresholds above. Such sites should support a higher proportion of a species statewide population (>1%, if known) than other similar areas.*

This conservation plan describes Audubon Connecticut's vision of conservation for Falkner Island by synthesizing available information, setting conservation goals, and recommending actions to approach these goals. Due to the relative importance of Falkner Island to terns, the focus of this plan is roseate tern conservation. To guide the development of this plan, the following primary goal was established.

Primary Goal

Address the factors that can limit roseate tern productivity, in relation to Falkner Island, as outlined by the Roseate Tern Recovery Plan (USFWS 1998): predation, food availability, storm events, and an imbalanced sex ratio.

Secondary Goals

A further examination of conservation threats and opportunities for research, public involvement, and ecological enhancement at Falkner Island resulted in the following secondary conservation goals:

A. Enhance and expand roseate tern nesting habitat

B. Manage native vegetation and control invasive species

C. Reduce the negative effects of the shoreline revetment

D. Enhance the North Spit through stabilization and expansion

E. Minimize human disturbance during the breeding season

F. Expand monitoring activities and publish data analyses

G. Pursue research opportunities to fill knowledge gaps

H. Foster stakeholdership and expand public involvement

The following is a summary of the recommended actions that address one or more of the outlined goals:

- Reduce or eliminate the negative effects of black-crowned night heron predation through predator control
- Enhance and increase tern nesting opportunities through habitat management
- Maintain the vegetation of the upland area as grasses and forbs, and control undesirable species
- Mitigate the negative effects of the shoreline revetment by filling crevices and installing additional shelves
- Stabilize and expand the North Spit to increase available nesting and loafing habitat
- Minimize human disturbance during the breeding season by refining activities
- Facilitate and engage in tern research
- Expand current breeding season monitoring activities and establish monitoring outside of the breeding season
- Analyze, share, and publish monitoring data
- Expand and refine educational activities and public outreach tools

INTRODUCTION

Colonial waterbirds have been recognized as symbols of avian conservation and as indicators of ecosystem health since the inception of the modern bird conservation movement in the late 1800's. This movement, a response to declining waterbird populations across North America, included the first efforts of the National Audubon Society (NAS) and the U.S. Fish and Wildlife Service (USFWS) to protect waterbird habitat on a national scale. The product of these efforts was an extensive network of refuges, much of which later became the National Wildlife Refuge system, and by the early 1900's it had protected habitat for many waterbird species. In more recent times, however, new stresses from the additive and synergistic effects of human disturbance (habitat loss, habitat fragmentation, contamination, and an increase in the populations of pest species) have driven many colonial waterbird species once again to the point of endangerment, necessitating more drastic conservation actions – intervention in the form of active management.

This Important Bird Area (IBA) conservation plan is written for the Falkner Island Unit of the Stewart B. McKinney National Wildlife Refuge (SBMNWR), an actively managed colonial waterbird breeding colony. The island supports Connecticut's only nesting colony of federally endangered roseate tern (*Sterna dougallii*) which represents approximately 3% of the Northwest Atlantic population. The island also supports the state's largest colony of common tern (*Sterna hirundo*), a state listed species of special concern. The Northwest Atlantic roseate tern population was listed as federally endangered in 1987 and has continued to decline since listing. Detailed life history information for roseate tern and common tern can be found in Appendix A.

This plan was designed to be consistent with two existing taxonomic plans, the USFWS Roseate Tern Recovery Plan (USFWS 1998) and the USFWS/NAS Regional Tern Management Plan (Kress and Hall 2000). Accordingly, the ultimate measure of success for this plan will be fulfilled if Falkner Island can be classified as one of the six large Northwest Atlantic roseate tern colonies by demonstrating an annual breeding population of greater than 200 pairs in congruence with an annual productivity of greater than 1.0 fledglings/pair for five consecutive years, as outlined by Recovery Criteria 2 of the Roseate Tern Recovery Plan (USFWS 1998). This criterion provides a quantitative and biologically relevant reference and allows for comparison to other colonies in the regional population. Reaching this benchmark may be difficult due to the fact that several of the factors that may affect this population may be beyond the control of the SBMNWR staff (herein, "Refuge Staff") and Audubon Connecticut's management efforts. However, site-specific factors affecting roseate terns at Falkner Island can be addressed through local management to effect positive change. This plan will address potential limiting factors and conservation threats by synthesizing information from published literature and experts into a discussion of recommended conservation actions, and refer readers to additional sources of information and funding opportunities. The goals outlined within seek to maintain or enhance the ecological integrity of Falkner Island while developing research opportunities, public outreach, and educational activities.

Conservation Planning and the Important Bird Areas Program

The IBA program was initiated by BirdLife in the 1980s and was since adopted by NAS and other conservation partners. It has identified millions of acres of habitat as part of a now global effort to identify and evaluate sites that are critical for birds, regardless of ownership. The IBA program has been used as a key component of many comprehensive conservation plans, including the North American Waterbird Management Plan, the U.S. Shorebird Conservation Plan, and numerous Partners in Flight plans. In 1995, NAS initiated an IBA program for the United States, resulting in the designation of more than 2600 IBAs encompassing over 360 million acres in 46 states. There are currently 27 Important Bird Areas in Connecticut, two of which are recognized as globally important.

Conservation plans are drafted for each IBA to describe: the key natural resources present at a particular site; the historic and current land uses of the site and its surroundings; current conservation activities; potential conservation threats; and opportunities to enhance ecological integrity and conservation value. This information is then used to inform the design of appropriate conservation actions and goals that suit each site. Finally, progress towards these goals and the effectiveness of any actions should be monitored and continuously re-evaluated in an evidence-based adaptive manner.

Designation as an Important Bird Area

National Audubon Society recognizes IBAs of state, continental, and global importance that meet criteria addressing the abundance, distribution, and habitat use of certain target species as they relate to a given site. Any site that satisfies the appropriate criteria qualifies for consideration as an IBA regardless of size, current level of conservation protection, or landownership. The criteria for Connecticut IBAs are presented in Appendix B.

The target species used to evaluate a site for the state designation process: are threatened or endangered at the state level; occupy a restricted geographic range; are concentrated within one general habitat type or biome; and/or form significant inter- or intraspecific congregations. These species are identified by examining priority lists relevant to the geographic location of a given site. For a Connecticut site these lists, in order of priority, include:

- The International Union for the Conservation of Nature (IUCN) List of Globally Threatened Species
- Partners in Flight Regional Priorities for Southern New England and Connecticut
- Audubon WatchList
- USFWS Birds of National and Continental Conservation Concern
- USFWS Birds of Regional Conservation Concern in the Northeast
- State Priority List: Connecticut Department of Energy & Environmental Protection (CT DEEP) Species of Conservation Concern

- State Conservation Plan: CT DEEP Comprehensive Wildlife Conservation Strategy

Falkner Island was designated as a Connecticut IBA by satisfying the state criteria in the following ways:

- Connecticut Criteria 1: Falkner Island supports Connecticut's only regular breeding colony of the state and federally endangered roseate tern.
- Connecticut Criteria 2: Falkner Island supports Connecticut's largest breeding colony of the state special concern common tern, and represents a nesting site for the state special concern American oystercatcher.
- Connecticut Criteria 3: Falkner Island is the only marine vegetated island in Connecticut.
- Connecticut Criteria 4b: Falkner Island has supported well over 100 terns every breeding season since 1954.
- Connecticut Criteria 4f: Falkner Island is an important stopover area for migratory landbirds; 120 species of landbirds have been banded on the island during the spring migration period since 1978.
- Connecticut Criteria 4g: Falkner Island supports nearly 100% of Connecticut's roseate tern breeding population and 95% of Connecticut's common tern breeding population.
- Connecticut Criteria 5: Research conducted on Falkner Island has contributed substantially to knowledge of roseate tern population dynamics and management.

Designation as a Long Island Sound Stewardship Site

In addition to being recognized as an IBA, Falkner Island was designated as an inaugural Long Island Sound Stewardship Site due to its significant ecologic value, potential for educational outreach, and unique contribution to the Long Island Sound ecosystem. The designation was a part of the Long Island Sound Stewardship Initiative, as authorized by the Long Island Sound Stewardship Act of 2006 (Public Law 109-359). The Long Island Sound Stewardship Act has expired as of December 2011, but pending legislation (the Long Island Sound Restoration and Stewardship Act [S.1080]) would provide reauthorization, thus appropriating $25 million annually to the Environmental Protection Agency to distribute as Long Island Sound Stewardship Grants for each year from 2014 – 2018.

SITE BACKGROUND

Site Description and Abiotic Features

Falkner Island (Figure 1) is located approximately three miles south of Guilford, CT, USA (41.211487˚, -72.655094˚) in Long Island Sound. The topography of the island resembles a plateau, as the terrain rises steeply on all sides from the beach to an upland area of grasses, shrubs, and early successional tree species. There are four islands located to the west: Goose Island, Stony Island, Three Quarters Rock, and North Rocks. Goose

Island (~ 0.5 acres at low tide) is the largest of the four; all are unvegetated and completely covered by water during spring and storm tides.

Figure 1. Falkner Island aerial image

Connecticut Environmental Conditions Online (CT ECO), Coastal Orthophotograph, 2010.

The total acreage of Falkner Island is about 4.5 acres at mean low tide and the land cover is approximately 65% barren and 35% vegetated (Center for Land Use Education & Research, University of Connecticut, 2006). The barren areas of the island consist of rocky beach habitat, a man-made shoreline revetment, and a large north facing sand bar known as the North Spit. The revetment, constructed in 2000 to halt erosion, extends along the entire east shore, the northern tip, and a portion of the southwestern shore. The upland area is approximately 2.8 acres in size and rises to a maximum elevation of 40 feet above sea level.

Land Ownership, Past and Current Use

The first humans to visit and use Falkner Island were the native Menunkatuck people, who used the area primarily for hunting. The town of Guilford purchased the island from the Menunkatuck tribe in 1639 and retained ownership until 1677 when it

was sold to private owners. Under private ownership, the island was used for agriculture (primarily wheat and clover) and grazing sheep until 1801, when the United States government purchased the island and erected a lighthouse. The island was managed by the United States Coast Guard (USCG) and inhabited by series of light keepers until a fire destroyed the keeper's house in 1976 after which an automated light system was installed, eliminating the need for full-time inhabitants.

In the 1970's, Falkner Island was the site of a satellite project of the Great Gull Island Project run by Helen Hays (American Museum of Natural History); and in 1977 Fred Sibley and Jeffrey Spendelow initiated the Falkner Island Tern Project which began as a tern banding program and expanded into a comprehensive research and monitoring effort. During this time the financial and logistic responsibilities of managing the island's natural resources was shared through a cooperative agreement among the USFWS, the Connecticut Audubon Society, the Connecticut chapter of the Nature Conservancy, and the Little Harbor Laboratory. In 1985 the island was transferred to its current owner, the USFWS, and became a part of Stewart B. McKinney National Wildlife Refuge headquartered in Westbrook, CT. Beginning in 1987 and continuing through the 1990's, Falkner Island was a study site of the Cooperative Long-term Roseate Tern Metapopulation Project (CLRTMP), a multi-state project to study the population dynamics and ecology of roseate terns in southern New England that resulted in numerous publications and revealed important aspects of roseate tern population biology.

Currently, the USFWS conducts all management and monitoring of the island's natural resources, while the USCG still owns and maintains the lighthouse and a 2500 square foot plot around its base. The USCG also holds ownership of the auxiliary structures on the island (including a generator house, boat house, cement jetty, and two cisterns), and authorizes the use and maintenance of these structures to the USFWS by permit. The United States Army Corps of Engineers (USACE) occasionally assists these two agencies in completing projects requiring construction and/or engineering expertise. The island is closed to the public, but guided visits are periodically scheduled by the Refuge Staff.

Figure 2. Profile of Falkner Island from the west

NATURAL RESOURCES

Vegetation

A comprehensive vegetation survey of the island (Andrus and Ortega 1999) documented 45 plant species which the authors categorized into plant association groups, described below. The complete list of plants is detailed in Table 1. Common mugwort (*Atremisia vulgaris*) was absent in the original floral survey but has since established itself on the island (Refuge Staff 2012).

- Dense low vegetation consisting predominantly of *Rubus*, wild grape, poison ivy, and forbs at the north end of the island
- Bramble and vine association consisting predominantly of *Rubus*, Oriental bittersweet, black swallowwort, and forbs at the south end of the island
- Shrub and vine association consisting predominantly of bayberry, wild grape, poison ivy, Oriental bittersweet along the southern perimeter of the island
- Sumac stand with an understory of bayberry and forbs in the northern and central regions of the island
- Mowed areas throughout the center regions of the island dominated by *Bromus tectorum*.

Table 1. Floral inventory of Falkner Island (Andrus and Ortega 1999); bolded species are known to be invasive

Shrubs and Trees

Myrica pennsylvanica	Bayberry
Rhus glabra	Smooth sumac
Rhus typhina	Staghorn sumac

Grasses (4 additional species unidentified)

Bromus tectorum	**Junegrass**
Elymus virginicus	Wild rye
Phleum pretense	Timothy grass
Phragmites australis	**Common reed**

Sedges and Rushes (2 additional species unidentified)

Juncus spp.	

Vines

Celastrus orbiculatus	**Oriental bittersweet**
Calystegia sepium	Hedge bindweed
Parthenocissus quinquefolia	Virginia creeper
Polygonum scandens	Climbing false buckwheat
Solanum dulcamara	**Bitterweet nightshade**
Toxicondendron radicans	Poison ivy
Vincetoxicum nigrum	**Black swallowwort**

Vitus sp.	Wild grape

Forbs

Achillea millefolium	Yarrow
Allium canadense	Wild garlic
Artemisia vulgaris	**Common mugwort**
Asclepias syriaca	Common milkweed
Atriplex prostrate	Triangle orache
Brassica nigra	Black mustard
Circium arvense	**Canada thistle**
Circium sp.	
Circium vulgare	Bull thistle
Datura stramonium	**Jimson weed**
Galium triflorum	Sweet-scented bedstraw
Glechoma hederacea	**Gill-over-the-ground**
Hemerocallis sp.	Day-lily
Lycopus americanus	Cut-leaved water-horehound
Ranunculus bulbosus	Bulbous buttercup
Rosa carolina	Carolina rose
Rubus sp.	
Rumex crispus	Curly dock
Sisyrinchium sp.	Blue-eyed grass
Stellaria media	Common chickweed
Taraxacum officinale	Common dandelion
Trifolium repens	White clover
Verbascum sp.	Mullein
Vicia sativa	Common vetch

Invertebrates

A comprehensive invertebrate survey has not been conducted, but Falkner Island may be an important stopover site for migratory butterflies and dragonflies that cross Long Island Sound. Species observed on or near the island include green darner (*Anax junius*), eastern tiger swallowtail (*Papilio glaucus*), monarch butterfly (*Danaus plexippus*), cabbagge white (*Pieris rapae*), and red admiral (*Vanessa atalanta*).

Reptiles & Amphibians

No reptile or amphibian species breed on Falkner Island, but there are five species of sea turtle that may occur in Long Island Sound during the summer months: leatherback sea turtle (*Dermochelys coriacea*), Atlantic green sea turtle (*Chelonia mydas*), Atlantic ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), and hawksbill sea turtle (E*retmochelys imbricata*). All of these species are listed as federally threatened or endangered.

Mammals

Falkner Island has no regular mammal inhabitants, but harbor seals (*Phoca vitulina concolor*) occasionally use the island as a haul out site. The island was one of several study sites for a project investigating the distribution of harbor seals in southern New England (Payne and Selzer 1989) that documented eleven seals during one of three survey visits in the spring of 1986. This study also identified American sand lance (*Ammodytes americanus*) as the dominant prey item of the harbor seal, which is also important forage for terns. Gray seals (*Halichoerus grypus*) also occur in Long Island Sound and have the potential to use Falkner Island for loafing as well. There has been no regular documentation of seal visits, but as New England seal populations increase (NOAA 2012), loafing activity may become more frequent at Falkner Island.

A population of feral European rabbits (*Oryctolagus cuniculus*) formerly existed on Falkner Island until 2008. The last comprehensive survey, conducted in 2001, estimated the population at 113 (± 36) individuals (Ortega and Andrus 2001). Rabbit activity disrupted nesting terns and intensified erosion, prompting the United States Department of Agriculture (USDA) to attempt a full eradication of the island's rabbit population in the summer of 2007. These control measures, combined with a subsequent harsh winter, eliminated the island's rabbit population.

Fish

The description of fish fauna will be limited to species occurring in the waters surrounding Falkner Island that are relevant to terns. The most common species of fish exploited by terns (including prey delivered to chicks) are: American sand lance (*Ammodytes americanus*), bay anchovy (*Anchoa mitchilli*), bluefish (*Pomatomus saltatrix*), American butterfish (*Peprilus triacanthus*), Atlantic herring (*Clupea harengus*), blueback herring (*Alosa aestivalus*), northern pipefish (*Syngnathus fuscus*), Atlantic mackerel (*Scomber scombrus*), round herring (*Etrumeus teres*), scup (*Stenotomus chrysops*), killifish (*Fundulus* spp.), and Atlantic menhaden (*Brevoortia tyrannus*) (Safina et al. 1990, Shealer 1995). Roseate terns are specialized predators of American sand lance which constitute 72.6% of prey delivered to chicks while common terns are less specialized and exploit the previously mentioned fish species more evenly (Safina et al. 1990). Adult bluefish, also present in Long Island Sound, pose potential competition at foraging areas (Safina 1990). A map of roseate tern feeding locations from Falkner Island is presented in Appendix C.

Historical Avian Species

Avian records of Falkner Island prior to the 1900's are sparse and inconsistent, but common terns likely nested on Falkner Island regularly throughout the last several centuries when prevailing land use permitted it. The colony was almost reduced to the point of extirpation in the late 1800's when hunting terns was still popular and legal, but rebounded in the early 1900's to over 1000 pairs. Around this time, the Northwest Atlantic roseate tern population numbered in the thousands and a colony located on Goose Island likely numbered in the hundreds. In 1954, the Goose Island roseate tern colony relocated itself to Falkner Island for reasons unclear, and has remained ever since. More recently, the researchers working on the island kept records of all bird sightings in

the vicinity of Falkner Island and Goose Island from 1978-2003; the complete species list is presented in Appendix D.

Current Avian Species

In recent years approximately 2,000 pairs of common terns and 45 pairs of roseate terns nest at Falkner Island each summer. In addition to terns, Falkner Island also provides nesting opportunities for several other species of conservation attention such as American oystercatcher (*Haematopus palliates*) and American black duck (*Anas rubripes)*; a complete list of regular nesting species is presented in Table 2. The state threatened least tern (*Sternula antillarum*) forages near the island in the summer, but does not currently nest on the island. Attracting breeding least terns (a beach nesting species) to the island could be given future consideration as this species is increasingly threatened by human disturbance and predation at mainland breeding sites, however, the potential for competition with roseate terns precludes this as a current recommendation.

Apart from its importance as a tern colony, Falkner Island is an important stopover site for migratory birds during spring and fall migration. During the 25-year span of the Falkner Island Tern Project (1978 to 2003), researchers conducted regular bird banding activities during spring migration resulting in 8,876 banded individuals of 120 species. The majority of these species have likely continued to use the island during migration; the complete list of individuals banded by year is presented in Appendix E. Avian use of Falkner Island during the winter season has not been extensively documented, but the island likely provides habitat for shorebirds and seaducks including purple sandpiper (*Calidris maritima*), long-tailed duck (*Clangula hyemalis*), harlequin duck (*Histrionicus histrionicus*), and brant (*Branta bernicla*). Gulls, particularly herring gull (*Larus argentatus*) and ring-billed gull (*Larus delawarensis*) use the island as a loafing site throughout the year and occasionally make nesting attempts during the breeding season. Black-crowned night heron (*Nycticorax nycticorax*) began making sporadic nighttime visits to the island in 1996 from an unknown mainland location to depredate tern eggs and chicks. Several species of raptors, including peregrine falcon (*Falco peregrinus*), occur infrequently during the breeding season and pose a minor predatory threat to the tern populations.

Table 2. Regular nesting avian species at Falkner Island

Common Name	Species	Conservation Status
Roseate tern	*Sterna dougallii*	Audubon WatchList (Yellow); USFWS (Endangered- Region 5); CT DEEP (Endangered)
Common tern	*Sterna hirundo*	Audubon WatchList (Green); CT DEEP (Special Concern)
American oystercatcher	*Haematopus palliates*	Audubon WatchList (Green); CT DEEP (Threatened)
American black duck	*Anas rubripes*	Audubon WatchList (Yellow)
Mallard	*Anas platyrhynchos*	Audubon WatchList (Green)
Canada goose	*Branta canadensis*	Audubon WatchList (Green)

Red-winged blackbird	*Agelaius phoeniceus*	Audubon WatchList (Green)
Willet	*Tinga semipalmata*	N/A
Barn swallow	*Hirundo rustica*	N/A
Song sparrow	*Melospiza melodia*	N/A

Interspecific Associations and Competition

The Falkner Island breeding population of roseate terns is greatly outnumbered by common terns. These two populations have coexisted at similar relative abundances for decades while experiencing various interspecific associations and competition. Roseate terns nest exclusively at common tern colonies, and this relationship is likely due to benefits garnered by roseate terns through enhanced predator awareness and defense that common terns provide. Common terns are more likely to alert a colony when predators are nearby, and more likely to actively discourage potential predators through mobbing behavior (Burger and Gochfeld 1988). Roseate terns also nest about 8 days later than common terns (USFWS 1998), hypothetically minimizing the risk that eggs or chicks are depredated (Burger et al. 1996) due to a greater number of concurrently active nests. Competition for nesting space has historically not been a management concern at the island; common terns nest on both the shoreline and upland area, while roseate terns exhibit a strong preference to the shoreline where ample space has been available. However, common terns have been nesting on the North Spit more frequently in recent years and may be limiting roseate tern nesting opportunities (Refuge Staff 2012).

These populations also compete for forage as demonstrated by overlapping diets, although roseate terns exhibit stronger prey preference and higher prey capture success rates than common terns (Safina et al. 1990). Roseate terns also appear to be more sensitive to competition with predatory adult bluefish, potentially eliminating their competitive advantage over common terns when all three species are feeding congruously (Safina 1990). In late summer, foraging competition with adult bluefish for baitfish can be intense enough to exclude both tern species from foraging areas (Safina 1990).

Roseate Tern Population and Productivity

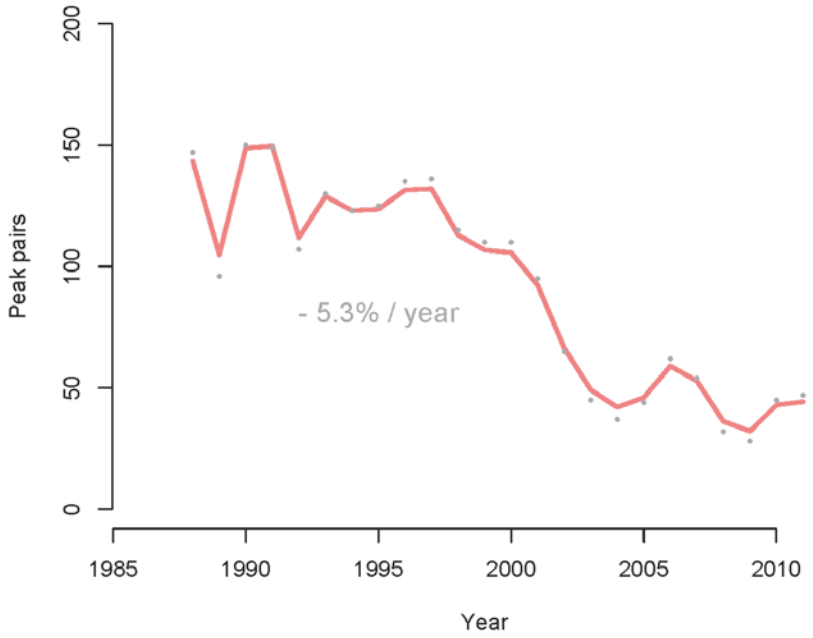
The roseate tern colony has been monitored each breeding season since the initiation of the Falkner Island Tern Project in 1978. Each breeding season, full-time live-in staff members conduct regular bird surveys and nest checks. Annual estimates of total pairs, peak period pairs, and productivity from 1978-2012 (when available) are presented in Table 3. A trend analysis of colony population is presented in Figure 3. Peak period pairs (assessed during the height of breeding season during first hatch) is used in this analysis as it provides a more meaningful estimate of annual colony population than total pairs (USFWS 1998). Readers interested in the details of any analyses may contact the authors.

Table 3. Roseate tern breeding season population and productivity estimates at Falkner Island, 1978-2012 (1978-2003 Falkner Island Tern Project, Jeffrey Spendelow USGS; 2004-2012 Stewart B. McKinney National Wildlife Refuge Staff).

Year	Total Pairs[1]	Peak Pairs[2]	Productivity[3]
1978	210*		0.96
1979	180		1.02
1980	100		1.01
1981	185		1.3
1982	135	~120	1.13
1983	140	~130	1.46
1984	205		1.26
1985	235		1.24
1986	175		1.19
1987	165		0.98
1988	190	147	1.08
1989	165	96	0.82
1990	170	150	0.84
1991	180	149	0.88
1992	130	107	0.79
1993	160	130	1.18
1994	140	123	1.33
1995	130	125	0.94
1996	150	135	0.5
1997	150	136	0.65
1998	120	115	0.74
1999	110	110	0.7
2000	115	110	0.75
2001	100	95	0.72
2002	70	65	0.18
2003	46	45	.26
2004	37	37	.38-.68
2005	53	44	.52 – .82
2006	62	62	.34
2007	54	54	.54
2008	32	32	1.06
2009	41	28	1.15
2010	45	45	.98
2011	47	47	1.43
2012	36	36	.81 – .94

[1]Estimated total nesting pairs for a given breeding season; [2]Estimated peak period nesting pairs for a given breeding season; [3]Estimated as fledglings per pair; *New estimate by J. Spendelow differs from FITP report

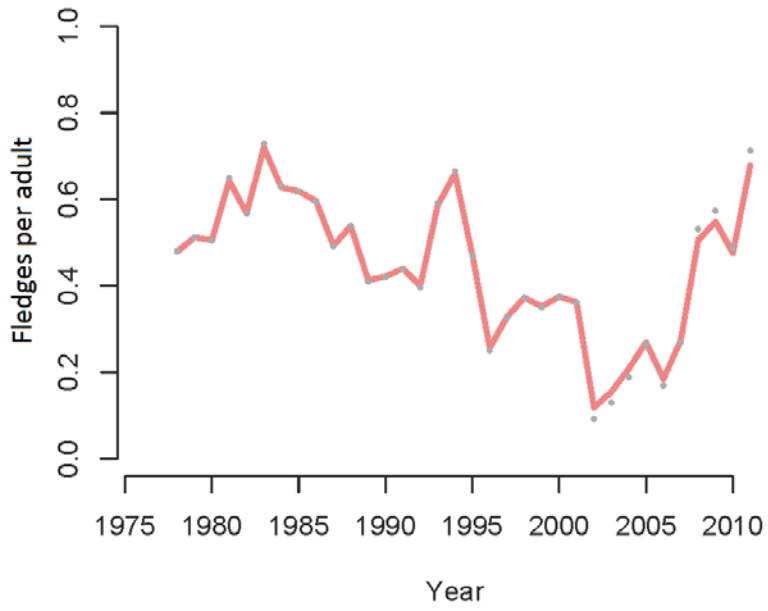
Figure 3. Population trend of roseate terns at Falkner Island, 1988-2011. Gray points represent annual estimates of peak period pairs; the red line represents a population trend fitted by an autoregressive model in a Bayesian mode of analysis. Our results show a declining trend (-5.3% pairs/year).



The Falkner Island roseate tern colony has exhibited a declining population trend over the last 25 years and this colony may not be self-sustaining, but rather, a sink population sourced by the colonies of Bird Island, MA and/or Great Gull Island, NY (Spendelow 1991). Natal site fidelity is relatively high for roseate terns fledged at Falkner Island (Spendelow 1991), but low productivity (<1.0 fledglings per pair annual average) and a recruitment rate of approximately 20% (USFWS 1998) has made the replacement of breeders exiting the local population each year (due to senescence, mortality, or emigration) improbable. Overall, the sum of Falkner-reared birds breeding for the first time (at age 3) and breeding immigrants have not outnumbered the number of birds exiting the local population, resulting in a net loss and a long-term local population decline.

The Refuge Staff conducts daily surveys to identify all roseate tern nests and then follows the progress of each by recording the presence of eggs and/or nestlings. Each nestling is weighed and color banded, then continuously re-sighted; those that survive to day 15 are presumed to have survived to fledging (Refuge Staff 2012), and estimates of productivity are calculated as fledglings per pair (Table 3). A trend analysis of colony productivity from 1978-2011 is presented in Figure 4. This analysis was unable to produce a reliable trend for the entire times series, likely due to the recent rise in observed productivity, which the analysis suggests is not anomalous.

Figure 4. Productivity trend of roseate terns at Falkner Island, 1978-2011. Gray points represent annual estimates of productivity (as fledges per adult) drawn from Table 3; the red line represents the productivity trend fitted by a hierarchical regression model in a Bayesian mode of analysis. Annual estimates of productivity were transformed from fledglings per pair to fledglings per adult to ensure an accurate assessment of trend, which can be skewed by the smaller sample sizes of recent years.



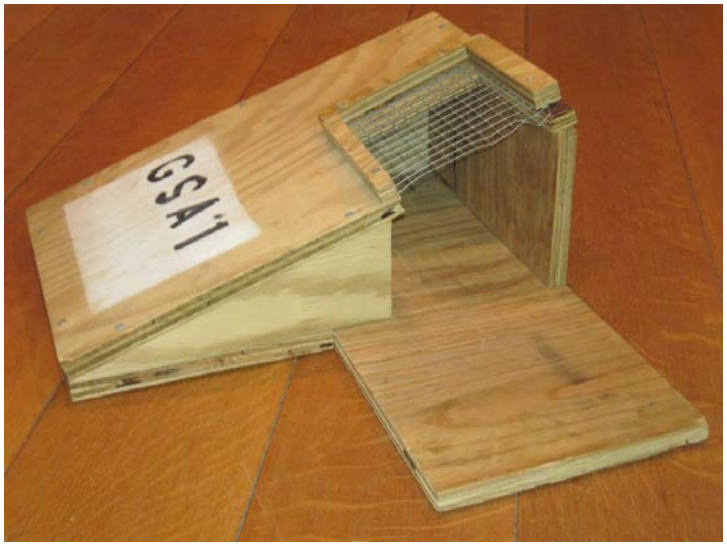
The ultimate cause of low productivity exhibited from 1978-1995 is not entirely clear, but low survival rate of B-chicks (the second chick hatched in the brood) (Nisbet et al. 1995) and low fledging success due to limited chick provisioning performance by adult males (Shealer 1995), are likely contributing factors. Low productivity exhibited throughout much of the last 15 years is primarily attributed to predation from black-crowned night herons (Spendelow 2002) and high chick mortality rates attributed to the impacts of habitat modification – the construction of the shoreline revetment (Spendelow and Rogers 2007). A recent positive trend in productivity is likely due to the efforts of the Refuge Staff to mitigate these negative effects by improving nesting habitat and conducting predator control.

Roseate Tern Nesting Habitat

Roseate terns nest in six subcolonies at three general locations on Falkner Island: the North Spit, the eastern shore of the island, and the southern shore of the island. Approximately two-thirds of all roseate tern nests are located on the North Spit. Common terns nest on the upland and along the shoreline, and have been nesting on the North Spit more frequently in recent years. A typical roseate tern nest is an open scrape on gravel substrate or among sparse vegetation, but at Falkner Island the majority of nests are located within artificial nesting structures. Nests *not* found within these structures are open scrapes located amongst driftwood piles, on the revetment, or on open ground

elsewhere. In the early 1980s the Falkner Island Tern Project began distributing artificial nesting structures at sub-colony locations in an effort to improve productivity by protecting eggs and chicks from predation and the elements. A variety of designs were initially offered including wire boxes, tires, and wooden nest boxes, most of which improved nesting success (Spendelow 1996). As these nesting structures aged or were lost, they were gradually replaced by a now standard design, the "Series 500" (Figure 5). Presently, virtually all of the artificial nesting structures on the island are wooden nest boxes, and in November 2011, volunteers from the US Coast Guard Academy, Connecticut College, and the Science and Technology Magnet High School of Southeastern Connecticut assembled 200 new Series 500 nest boxes that were brought to the island prior to the 2012 breeding season.

Figure 5. Series 500 nesting structure



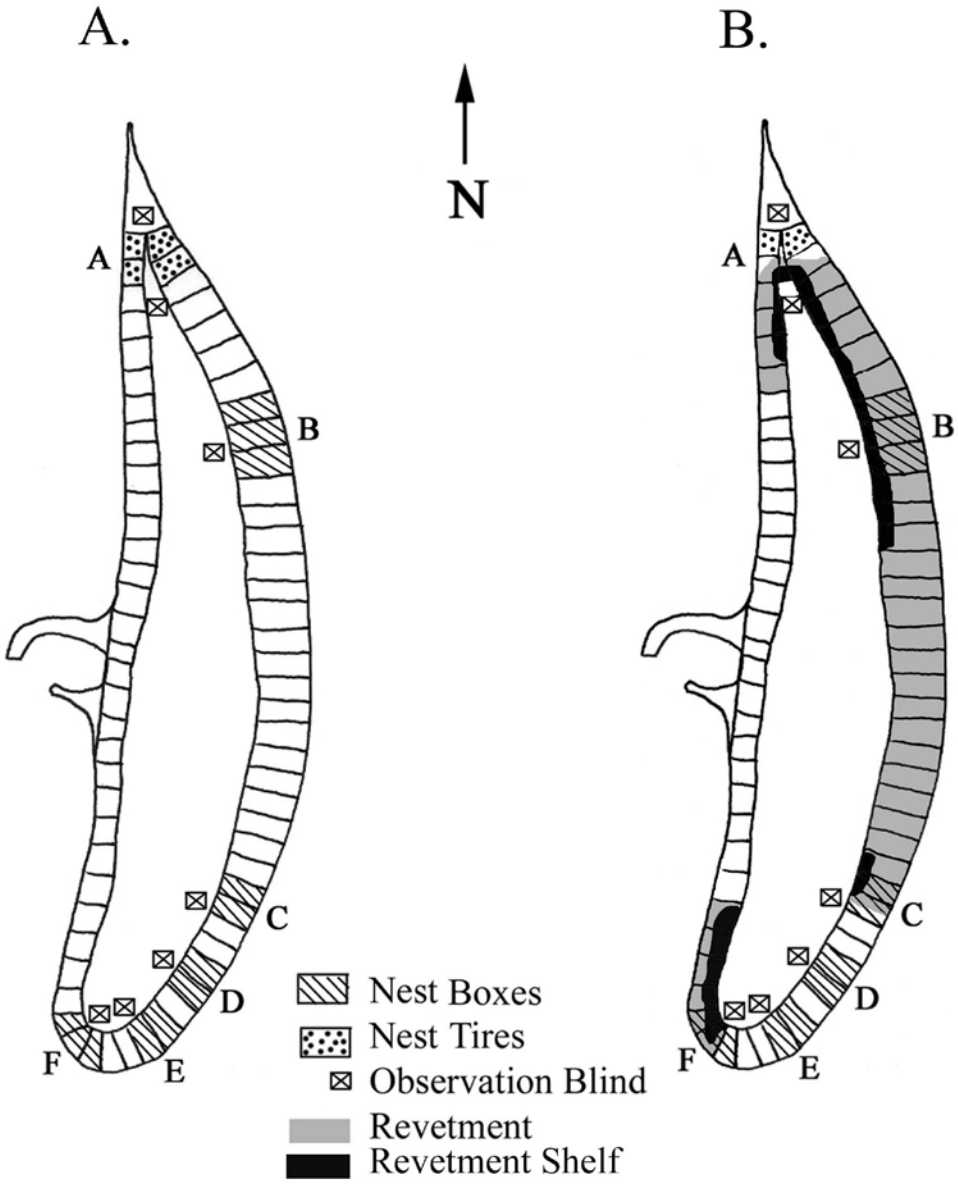
Shoreline Protection Project

In September 2000, a revetment comprised of large boulders was installed at the base of the Falkner Island's steep banks along the entire eastern shore, northern shore, and a portion of the southwestern shore (Figure 6) to halt erosion that threatened the lighthouse and tern nesting habitat. In cooperation with the USACE, the USFWS chose a plan that aimed to limit erosion and not negatively impact the roseate tern colony (Spendelow and Kuter 2001). The size and spacing of the boulders comprising the revetment were chosen to create additional "rock house" nesting sites thought to provide superior egg protection and improve hiding opportunities for chicks. The majority of the revetment surface was left as open boulder, while several sections were covered with a concrete shelf. This shelf provides further bank stabilization and offers additional elevated nesting space that is less vulnerable to flooding.

This project succeeded in stabilizing the banks of the island, but the drastic modification of nesting habitat at three of the six subcolonies produced unintended results for roseate terns. The "rock house" nesting sites did not provide adequate protection as depredation of eggs continued and many chicks became lost or trapped within the deep crevices of the revetment, resulting in low productivity for the 2001 breeding season

(Spendelow and Rogers 2007). Project managers concluded that the main revetment had a negative impact on roseate tern productivity and recommended that the crevices be filed to a maximum depth of six inches to prevent chick entrapment (Spendelow and Rogers 2007). The Refuge Staff continues work to reduce the negative effects of the revetment by filling crevices and depositing gravel material on the shelves to mimic the roseate tern's preferred natural nesting substrate.

Figure 6. Map of roseate tern subcolony locations before (A) and after (B) the installation of the revetment in 2001. The inner polygon represents the vegetated upland area, and the segmented shoreline divisions represent the grid system used for documenting nests. Figure used with permission from Corey Grinnell (Grinnell 2010).



CONSERVATION GOALS AND RECOMMENDED ACTIONS

Primary Goal and Recommended Actions

The primary goal of this plan is to address the factors that can limit roseate tern productivity in the Northwest Atlantic tern population, as they relate to Falkner Island, and suggest relevant management activities when feasible. Predation, food availability, storm events, and an imbalanced sex ratio are the factors identified in the Roseate Tern Recovery Plan (USFWS 1998).

Predation and Predator Control

In 1996, black-crowned night herons began visiting Falkner Island and depredating roseate tern eggs and chicks; the result was a drastic decline in productivity. Prior to 1996 the colony exhibited an average of 1.0 fledglings/pair, and in 1996 productivity was reduced to 0.5 fledglings/pair. Black-crowned night herons typically visit the island at night, but daytime visits may cause additional impacts to roseate tern productivity by disrupting the provisioning of chicks during feeding hours (Spendelow 2002). Lethal control is an effective method reducing tern egg and chick loss to black-crown night heron predation, thus improving colony productivity (Spendelow 2002). Alternative solutions that have been unsuccessful at other tern colonies include strobe lights, mesh enclosures, bow nets, and taste aversion techniques (Kress 2000).

A predator control program was initiated at Falkner Island in 1997 in which daily surveillance is used to identify herons that exhibit predatory behavior and then eliminate them by firearm. Predatory individuals are intercepted as they approach or retreat from the island to minimize disturbance to terns. Although productivity improved, herons continued to depredate an average of 49 eggs and chicks per year, resulting in an average yearly productivity of .57 fledglings/pair from 1997-2002 (Spendelow 2002). In 2007, the predator control strategy was refined and re-emphasized by the Refuge Staff, and became highly successful in limiting predation as demonstrated by the absence of predation on tern eggs and chicks over the last several years (Refuge Staff 2012). Furthermore, despite daily surveillance, no black-crowned night herons needed to be eliminated in 2011 or 2012. The continuation of the predator control program is warranted to protect roseate tern eggs and chicks from predation and we recommend that it continue until an adequate alternative solution is developed. Each predator visit and subsequent staff action should be documented to help determine the efficacy of these methods and trends in predator behavior.

Several gull species regularly congregate on nearby Goose Island and infrequently make nesting attempts at Falkner Island. Gulls are occasional egg predators, and should be dissuaded from loafing or nesting on Falkner Island throughout the breeding season using non-lethal harassment, and any nests should be destroyed. Gulls that exhibit predatory tendencies may require lethal control. Nuisance species such as Canada geese also have the potential to impact tern productivity by disrupting nesting activity. The most probable locations for geese loafing and/or nesting attempts are the sumac stand, the southern end, and the western bank of the island. Canada geese should be deterred from the island using non-lethal harassment and any nests should be destroyed, preferably before egg laying. When necessary, eggs should be dispatched using the Humane Society's protocol for egg addling.

Prey Limitation

The role of prey availability as a potential limiting factor for roseate tern productivity is not well understood (USFWS 1998). Safina et al. (1988) demonstrated that more chicks survived to fledging in a year of greater prey abundance, but more evidence is needed to determine a causal relationship between a perceived lack of forage and documented low productivity. However, legislation or management designed to improve the fisheries of Long Island Sound would likely have a positive effect on waterbird populations. Audubon Connecticut, site administrators, and stakeholders should support future research and monitoring of finfish abundance, and evaluate proposed fisheries management decisions and provide input to decision makers regarding how those decisions might affect the tern colonies at Falkner Island.

Storm Events and Sea Level Rise

The Intergovernmental Panel on Climate Change (IPCC) projects a mean sea level rise of at least 18 cm by the year 2100 due to global climate change (IPCC 2007). For Falkner Island, a rise in sea level could reduce the amount of available roseate tern nesting habitat, particularly on the North Spit, and exacerbate erosion. Hurricanes and tropical storms also pose a threat, with the potential to drastically reduce colony productivity for a given breeding season and/or alter the availability of nesting habitat on the island. In October 2012, strong currents and high water caused by Hurricane Sandy reduced the North Spit to one-third of its previous size, and going forward, storm events are expected to increase in frequency and intensity (IPCC 2007). From a local perspective, the best way to mitigate the negative effects of storm events and sea level rise are to provide ample nesting habitat throughout the island, and continue to improve nesting habitat on the revetment shelves and upland area which are less vulnerable to high water and storm damage than the natural shoreline.

Imbalanced Sex Ratio

Research at several Northwest Atlantic roseate tern colonies has revealed an imbalanced sex ratio skewed towards females (Szczys et al. 2001, USFWS 1998). The cause of this imbalance is unknown, but it can result in nesting attempts by female pairs and trios that exhibit lower nesting success than a typical male-female pair (USFWS 1998); thus a lack of males may be limiting colony productivity. Further demographic information must be collected to re-evaluate the magnitude of this potential limiting factor and suggestions for monitoring techniques to improve the understanding of this issue are presented in the *Monitoring and Data Analysis* section.

Secondary Goals and Recommended Actions

Secondary conservation goals designed for Falkner Island represent opportunities for ecological enhancement, public involvement, and research. These goals are accompanied by actions recommended to accomplish each. A summary table of recommended actions and suggested actors is provided in Appendix F.

A. Enhance and expand roseate tern nesting habitat

At Falkner Island, nesting habitat preferred by roseate terns occurs along the shoreline and on the North Spit. Increasing the availability and suitability of nesting habitat can be accomplished by creating natural nesting habitat (gravel substrate) or by

providing artificial nesting structures, a strategy proven successful for roseate terns (Dunlop et al. 1991, Eades 1970, Norman 1987, Spendelow 1982, 1996). Opportunities to create nesting habitat on the North Spit and on the revetment will be discussed in later sections.

Existing nesting structures should be inspected prior to each breeding season and unsound structures should be repaired or replaced with Series 500 structures, and all structures should be distributed at priority areas by early May. The CT DEEP could be a key partner in box building efforts as they can likely provide wood materials at minimal or no cost from their sawmill operation. The following additional guidelines should be considered when distributing nest boxes:

- Nest boxes should be oriented with the open side facing the nearest observation blind to facilitate behavioral observations. If possible, nest boxes should also be faced away from revetment crevices to reduce the likelihood a chick becomes trapped upon leaving the nest.
- Nest boxes should be camouflaged and/or hidden among debris when possible to reduce the likelihood boxes are targeted by predators.
- Nest boxes should be high enough above the high tide line to ensure that nests are not flooded during storm events and high tides.
- The majority of nest boxes should be located on the North Spit as it is consistently the largest sub-colony.
- The best substrate for nest boxes is gravel.

B. Manage native vegetation and control invasive species

The suitability of tern nesting habitat at Falkner Island is threatened by plant succession and the spread of invasive plant species, and regular vegetation management is required to maintain suitable nesting habitat for common terns on the upland area. Common terns can nest among light vegetation (a mix of grasses and forbs) or on rocky substrate (sand/gravel/cobble), while roseate terns prefer rocky substrate. Nesting among light vegetation provides cover for terns, but dense vegetation interferes with chick/parent interactions (Spendelow 1982). Invasive species (such as Oriental bittersweet) pose an additional threat, as these species can displace native plants that provide more suitable nesting habitat. Unchecked growth on the upland area may also indirectly affect roseate terns as common terns may seek nesting sites elsewhere on the island, and recent observations have shown that common terns have been nesting on the shoreline areas more frequently and potentially excluding roseate terns (Refuge Staff 2012). Invasive species may also degrade existing rocky habitat preferred by roseate terns by spreading to unvegetated portions of the island; *Phragmites australis* and Oriental bittersweet have become established among the rocks of the upper shoreline and further spread is likely without control.

To address these issues we recommend that the upland area be maintained as grasses and forbs by employing a biannual mowing schedule. Mowing and/or trimming activities should occur in the spring, prior to tern arrival, and again in mid-autumn after fall migration. The sumac stand that currently covers approximately one-third of the

upland area should be thinned and reduced in extent, and the resulting cleared area should be perpetually maintained as grasses and forbs. Undesirable invasive plants, particularly Oriental bittersweet, should be targeted for removal throughout the island. The most effective methods of removal, in sites where herbicides are undesirable (such as Falkner Island), include cutting or uprooting individual plants using hand tools. Flame torching is additional method that may be used to remove *Phragmites australis* and other species, when conditions permit. Although labor intensive, a Spring and/or Autumn work crew of interns could make great progress towards an island-wide suppression of undesirable plants using these methods. Additionally, partners and volunteers could participate in "work days" attended by Faulkner's Light Brigade members, Audubon Connecticut members, and the CT DEEP to help accomplish the Refuge Staff's vegetation management goals.

C. Reduce the negative effects of the shoreline revetment

The 2001 construction of a shoreline revetment initially caused a drastic reduction in roseate tern productivity due to chick entrapment and predation among the large crevices. The original design called for some sections of the revetment to remain as exposed boulders (Figure 7), and other sections to be covered with concrete (forming a shelf). Expanding the extent of these shelves over a greater portion of the revetment is recommended to reduce the abundance of large crevices, and the shelves should be overlaid with gravel to mimic the natural substrate preferred by nesting roseate terns. The sections of the revetment that remain exposed should have crevices filled with gravel material to reduce crevice depth to a maximum of 6 inches to prevent chick entrapment and unsuccessful nesting attempts (Spendelow and Rogers 2007).

Figure 7. Shoreline revetment

D. Enhance the North Spit through stabilization and expansion

The success of the revetment in halting erosion of the shoreline may have had the unintended effect of accelerating erosion of the North Spit since it is no longer being

replenished by the naturally eroding till from the southern shoreline. This large sand bar provides loafing and nesting habitat for terns and is the site of roughly half of roseate tern nests, thus it may be necessary to regularly replenish the North Spit with sand and gravel to maintain a constant size and shape. Additionally, the drastic reduction of this area caused by Hurricane Sandy reinforces the need for active management here, especially if total nesting attempts are drastically lower in subsequent breeding seasons (2013 and beyond). The loss of nesting habitat here is further confounded by competition for nesting space, which has intensified in recent years, as it appears that common terns are excluding roseate terns from this area (Refuge Staff 2012) further warranting stabilization and/or expansion.

Maintaining suitable beach habitat at the North Spit by depositing material would likely require significant resources and the use of heavy equipment, but may be warranted if nesting space becomes critically low. A minimum width of 10 meters (at its widest point) should be maintained to provide adequate nesting space for the current population, but expanding this area would increase nesting opportunities. Stabilizing structures or creative land formation may be necessary to help ensure long term stability and should reduce the amount of annual attention and resources needed to maintain the desired shape and size. A potential low cost source of fill is dredging spoils which may be available from the dock area on the west side of the island. Dredging spoils must be screened for toxic material, and due to the high content of silt and clay, may need to be supplemented and/or overlay with gravel. If dredging spoils are deemed unsuitable, alternative sources of material should be brought from the mainland. The USACE would be a likely partner in the design and execution of a North Spit enhancement project, and all efforts should be documented to accurately understand the effect had on terns and to inform habitat modification projects at other sites.

E. Minimize human disturbance during the breeding season

Public access to the island is prohibited, but the Refuge Staff makes regular visits to the island throughout the year and, in the summer months, full-time interns live on the island to conduct tern monitoring and predator control. Researcher disturbance does not appear to have a measurable effect on the productivity of roseate terns; a Falkner Island study showed no strong correlation between roseate tern trapping effort and productivity (Zingo 1998), and terns seem to be tolerant of researchers moving about a colony and checking nests (Nisbet 2000). However, investigator activity should be periodically audited and optimized in an effort to limit disturbance to terns during the breeding season. Research activities can be made less conspicuous by improving observation blinds and by optimizing the timing and route of nest checks and re-sighting efforts. Activities should cease when ambient temperatures are extreme, during inclement weather, or when winds are in excess of 25 mph to ensure that eggs and chicks experience minimal exposure when adults are flushed. Additionally, the use of exterior lights at night is discouraged, the generator house (research headquarters) should be outfitted with window blinds, and shoreline recreation should be limited.

F. Expand monitoring activities and publish data analyses

Breeding season monitoring activities conducted by the Refuge Staff include: re-sighting banded terns, identifying nests, banding tern nestlings, and recording the status

of eggs and chicks through daily checks of active nests. Gulls are censused regularly at the North Spit and predator surveillance occurs somewhat continuously. The most critical monitoring procedures are those that contribute to estimates of roseate tern productivity. The Refuge Staff has developed standard protocols for these procedures, but should reference the protocols described by Nisbet et al. (1990) when reviewing and refining methods. Opportunities to expand the scope of breeding season monitoring by incorporating new techniques should be considered when feasible. Cheek swabs could be performed on roseate tern nestlings at the time of banding so that each may be sexed via DNA analysis (Handel 2006). This would provide a local sex ratio of nestlings and fledglings and, with the continued use of color bands, would allow for sex-specific re-sighting of adults as males and females are indistinguishable by passive observation. All roseate tern nests should be georeferenced to reveal spatial relationships and track changes in clustering and location over time. A trapping program for adult roseate terns could also be reinstated to band unbanded individuals and sex adults via DNA analysis or morphometric methods (Palestis 2012). These data would contribute to a better understanding of inter-colony movement and regional demographics.

Monitoring data and subsequent analyses should be formally summarized and published as technical reports or submitted to locally relevant scientific publications. Results that have broad ecological or roseate tern conservation implications should be submitted to peer-reviewed journals. Additional summary statistics such as total eggs, nestling weights, hatching success, fledgling success, nest box occupancy, and nest success can be presented to further elucidate the status of colony-wide reproductive success. After each breeding season, annual population and productivity estimates should be combined with the existing long-term dataset and reanalyzed to assess colony trends. Nisbet et al. (1990 & 1999) present various methods for estimating annual productivity and should continue to be the main reference regarding such calculations, as many options are available. A key consideration when estimating annual productivity or interpreting past productivity estimates based on chick survival, is the age (in days) at which fledgling survival is presumed. Research and monitoring efforts not related to roseate terns should be given lower priority and designed in a way that minimizes disturbance. Suggestions related to secondary monitoring efforts are listed below:

- **Common terns** – It is not practical to monitor every active common tern nest on a daily basis, instead 5-10% of the total nests should be monitored closely by randomly selecting quadrants from the existing 30 meter grid system to establish productivity plots. The selection of plots could also be stratified by habitat type to evaluate the relative quality of nesting habitat available on the island. A comprehensive nest census should occur in mid-June before most chicks have hatched, by systematically searching the island and documenting all nests and their contents.
- **Monitoring of potential predators and nuisance species –** All species that have the potential to negatively affect terns should be monitored. Gulls should be censused daily, and the presence and activity of Canada geese, seals, raptors, and owls should be documented whenever present.
- **Vegetation surveys** – Vegetation surveys should be used to document species composition, stem density, percent cover, and basal area within 1 m^2 plots. These

plots can be temporary or permanently referenced, and the information collected can be used to describe nest sites, track successional changes, and evaluate the effects of vegetation management. The characteristics of tern nest sites located among vegetation can be compared to each nest's hatching and fledgling success to inform future vegetation management. These surveys should be conducted soon after nesting activity has completed.

- **Shorebirds** – The occurrence and abundance of shorebird species at Falkner Island should be documented during the breeding and non-breeding seasons whenever possible. A shorebird census could be added to the weekly tasks during the breeding season, and an International Shorebird Survey should be conducted during each non-breeding season.
- **Other nesters** – Nesting attempts by non-tern bird species should be documented when possible by recording evidence of breeding such as paired adults, carrying of nesting material, nests, eggs, provisioning, or juveniles.

G. Pursue research opportunities to fill knowledge gaps

The research carried out at Falkner Island has informed conservation decisions across the entire Northwest Atlantic roseate tern population. The island continues to present a unique opportunity for research, apart from regular annual monitoring, that can inform future conservation decisions throughout the region. Important research would contribute to an updated explanation of what factors may be limiting this population and produce more accurate parameters for an improved viability analysis to re-evaluate extinction probability. Here, we present a list of loosely formulated research questions that could form the basis of future research projects undertaken by university students or any combination of stakeholders, and facilitated by the Refuge Staff.

- Is forage scarce for Falkner Island terns? Has diet composition or distance to foraging grounds changes since prior assessments? Have the dynamics of interspecific competition changed? And are roseate terns negatively affected?
- What is the sex ratio of the Falkner Island roseate tern population at each life stage? What is the prevalence of nesting female pairs and trios?
- At what age are juvenile roseate terns most vulnerable to predation? Which additional management techniques are most effective in reducing predation risk?
- Where are the black-crowned night herons that visit the island nesting and what is their breeding chronology? What is the abundance of the local population? Are island visits a typical behavior among this population?
- Given the recent decline in black-crowned night heron predation of terns, has lethal control been successful in removing predatory individuals from the local population, or have other factors contributed more significantly?
- Are common terns excluding roseate terns from preferred nesting sites? Will roseate terns nest on the upland area if plots of gravel substrate are provided?

H. Foster stakeholdership and expand public involvement

Effective advocacy and stewardship are essential components of IBA conservation plans to ensure the long-term success of conservation actions. The most effective tool available for accomplishing these objectives is a Site Support Group (SSG). An SSG is a group of local stakeholders that work with the landowner towards the development and implementation of conservation and educational activities. These activities include fundraising, citizen science, habitat management, public education, research, and outreach. While most IBAs require the development of an SSG, Falkner Island is unique among Connecticut State IBAs in that is has the full-time attention of the Refuge Staff *and* a preexisting volunteer based support group – the Faulkner's Light Brigade (FLB), thus the development of a unique SSG is not necessary.

The FLB is a membership based organization that exists to preserve the historical integrity of the lighthouse and ensure the long term existence of the island itself. They offer assistance to the Refuge Staff and their numerous activities include: fundraising, administering volunteer events, purchasing equipment, sponsoring the annual open house, repairing docks and service boats, installing an island weather station and webcam, maintaining a blog that describes island activity, performing maintenance of island structures, and maintaining signage at the Guilford marina. Any members of the general public interested in participating in the conservation and preservation of Falkner Island should contact the FLB.

In addition to local volunteers, relevant conservation organizations, agencies, and experts can collaborate with the Refuge Staff to help accomplish goals. Stakeholder input and contributions are important components of the IBA program, and a list of potential stakeholders for Falkner Island is presented in Appendix G. Audubon Connecticut will facilitate communication among stakeholders and the Refuge Staff, and help coordinate the sharing of data and resources, as these stakeholders can: act on funding opportunities, provide technical expertise, assist in data collection, conduct data analysis, and co-author publications.

Falkner Island is a valuable educational resource and public outreach tool. The annual open house hosted by the FLB and the Refuge Staff allows members of the public to visit the island by boat and experience the island firsthand. However, limited access to the island during the rest of the year forces a majority of these activities to occur on the mainland. The Refuge Staff offers a wide variety of educational programs for children and adults at its headquarters in Westbrook, CT and the FLB has demonstrated a strong commitment to public outreach through lectures, newsletters, an online blog, weather station, and webcam. Suggestions to expand educational activities and outreach are presented below.

- **Signage** – Falkner Island and its terns are clearly visible from many popular shore points. Permanent signs that describe the life history of terns and the ecological significance of the island are an effective communication tool and should be erected at nearby public locations along the Connecticut shoreline. Similar signs have been posted at the Guilford Marina by the FLB and at Hammonasset Beach State Park by the CT DEEP, but additional locations should be considered. Signs that have become weathered or outdated should be replaced.

- **Presentations** – Public presentations are also an effective way of informing local residents of the activities occurring at Falkner Island and the importance of conservation efforts. Presentations can be used to introduce Falkner Island to interested citizens and school groups, or to update stakeholders and informed citizens of island activities. FLB has coordinated many interesting lectures and presentations regarding the history of the island and other stakeholders should consider presenting content relevant to tern biology and conservation.
- **Classroom curricula** – Incorporating materials related to Falkner Island into classroom curricula is an excellent way of conveying the value of environmental conservation to children and teenagers while teaching local history and principles of biology. The history of the island lends itself well to middle school history lessons; Helander (1988) tells the complete history of the island that includes many historical figures. The *scientific* value of the island lends itself well to high school students, who could undertake project that involves real data from island research and monitoring to learn simple data analysis.

FUNDING OPPORTUNITIES

Numerous funding opportunities exist to supplement the resources committed by the USFWS. Audubon Connecticut and other stakeholders should consider committing funds directly to specific projects, and each group may also apply for external funding for research or management projects aligned with this conservation plan. Collaborative grant sponsorship among key stakeholders should always be considered and may increase the likelihood of success.

Long Island Sound Stewardship Act

The Long Island Sound Stewardship Act may allocate up to $25 million annually to conservation activities along the sound including, land acquisition, conservation easements, habitat restoration, protection of natural areas, and projects to improve public access to the sound. The Long Island Sound Stewardship Initiative and the Long Island Sound Study will direct the allocation of these funds by identifying and protecting sites of ecological and recreational importance through a grants program.

LIS Futures Fund

The Long Island Sound Futures Fund is a grant program related to the Long Island Sound Study, administered by the National Fish and Wildlife Foundation (and many partnering organizations), with the mission of restoring and protecting the health and living resources of Long Island Sound. The Futures Fund offers both large grants ($10,000 - $75,000) and small grants ($1,000 - $5,000).

Long Island Sound License Plate Program

The Connecticut Department of Energy & Environmental Protection offers funding for select projects through the Long Island Sound License Plate Program. To qualify for eligibility, a project must fall under one of the following categories: outreach and education, public access, habitat restoration, or research.

The Sounds Conservancy Grant Program

The Quebec-Labrador Foundation/Atlantic Center for the Environment is a non-profit organization dedicated to conservation and education activities in Eastern Canada and the New England maritime region. This organization created the Sounds Conservancy Grant Program, which supports conservation and education projects that benefit the six sounds of southern New England.

MEASURES OF SUCCESS AND FINAL REMARKS

The intent of this plan is to formally describe Audubon Connecticut's vision of management at Falkner Island by setting conservation goals and suggesting recommendations to approach these goals. The Refuge Staff does not have the available resources to complete all of the activities outlined within thus, without external collaboration, partial completion is expected. The level of success achieved by this conservation plan can be measured in terms of immediate successes, and ultimate successes. Immediate successes will be reached by simply implementing the recommendations for which existing time and funding resources can be reasonably allocated given that the suggested activities likely agree with the current goals of each organization and stakeholder involved. Ultimate success will be achieved by fulfilling the outlined conservation goals, and by fulfilling the roseate tern population and productivity criteria ($\geq$ 200 annual pairs, in congruence with $\geq$ 1.0 fledged fledges/pair for five consecutive years) outlined by Criteria 2 of the Roseate Tern Recovery Plan (USFWS 1998) to qualify Falkner Island as one of the six large Northwest Atlantic colonies. As stated previously, this benchmark may be difficult to attain due to external factors beyond the control of the Refuge Staff and Audubon Connecticut, but this criteria ensures a dedicated pursuit of roseate tern conservation and reinforces Audubon Connecticut's interest in the persistence of Connecticut's only federally endangered species. Failure to meet these criteria or fulfill other conservation goals will not be interpreted as failure by the Refuge Staff; rather, these goals have been set to encourage a level of heightened attention to the conservation issues at Falkner Island by all stakeholders. Progress will be monitored by the Audubon Connecticut IBA Program and an annual assessment of activities related to this plan will be conducted wherein the validity and feasibility of each goal and corresponding recommendations will be re-evaluated in an adaptive manner.

A 2007 population viability analysis of the Northwest Atlantic roseate tern population predicted a 95% probability of quasi-extinction in 50 years (Arnold 2007). Site-specific management aimed at improving colony productivity at Falkner Island is currently the best available conservation strategy to mitigate the negative effects of limiting factors that are poorly understood and/or difficult to address; and the expansion of research and monitoring efforts will improve our understanding of the issues affecting this population. Falkner Island is a unique feature of Connecticut's landscape that holds exceptional value at a local and regional scale; despite this plan's strong focus on terns, the value of the island for other birds and as a tool for public outreach and education should not be overlooked. Future collaboration among stakeholders and a dedication to the conservation activities outlined in this plan will help ensure Falkner Island's continued conservation value and ecological importance.

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Appendix A. Summary of life history information for common tern and roseate tern (Gochfeld 1998, Nisbet 2002, *respectively*)

Roseate Tern

Status and geographic range - There are two distinct breeding populations of the roseate tern in North America: the Northwest Atlantic population and the Caribbean Population. The Atlantic population was designated as a federally endangered species on November 2, 1987. Currently, this population breeds from Long Island north to Quebec, almost always on small marine islands and almost always among common tern colonies. From 1988 to 1997, 94% of the Northwest Atlantic breeding population (approximately 3,500 pairs) was concentrated on only five large colonies within this geographic range, one of which was Falkner Island. The wintering range of this species is not well-known, but roseate terns have been sighted as far south as Brazil during the non-breeding season. It is thought that one-year old birds spend their first breeding season on the wintering grounds.

Breeding biology – Roseate terns return to breeding colonies in the Northwest Atlantic in late April through May; pair formation begins soon after arrival. Egg laying can begin as early as mid-May and is usually finished by late-June, although some birds continue to lay throughout the summer. The majority of nests have a clutch size of two eggs, a few exceptional clutches have three or four, and the rest have a clutch size of a single egg. During the incubation period, about 23 days, the eggs are incubated by both sexes. Chicks hatch asynchronously and consequently the fledging period for the larger chick is usually about 25 to 29 days, with the second chick fledging up to 6 days later. While at many colonies almost all of the first chicks will survive, the survival of second chicks is much more variable, from 20 to 70% survival. Juvenile roseate terns are fed by both parents for as long as six weeks after fledging. Fledglings and adults gather at staging areas in August and early September, departing for their wintering grounds by late August through September.

Common tern

Status and geographic range – The Atlantic coast population of the common tern breeds from northern Canada to South Carolina. In Connecticut, about 95% of the population this species of state special concern breeds on Falkner Island. This population winters from South Carolina to Brazil.

Breeding biology – Common terns return to breeding colonies in April and May, and will start laying eggs in early May and June, about eight days before roseate terns. The common tern clutch size, usually 2-4 eggs, is larger than that of the roseate tern. Both parents incubate the eggs (for about 28 days) and feed the young after fledging. Common terns linger within their breeding distribution longer than roseate terns, often until mid-October.

Appendix B. Audubon Connecticut criteria for State Important Bird Areas

Connecticut Important Bird Area Criteria

1. Sites important to endangered or threatened species in Connecticut.
2. Sites important to species of high conservation priority in Connecticut. (Including WatchList species, species considered of high priority for our region by Partners in Flight, State Special Concern Species and species for which Connecticut supports a significant percentage of the global or continental population.)
3. Sites that contain rare or unique habitats within the state/region or an exceptional representative of a natural habitat and that hold important species or species assemblages largely restricted to a distinctive habitat type.
4. Sites where significant numbers of birds concentrate for breeding, during migration, or in winter, including:

   (4a) Waterfowl: The site regularly supports 500 or more waterfowl in winter and/or 1,000 or more waterfowl in migration (staging).

   (4b) Gulls and Terns: The site regularly supports 100 or more terns or 500 or more gulls in a season.

   (4c) Shorebirds: The site regularly supports 500 or more shorebirds (over a short period) at any time of the year.

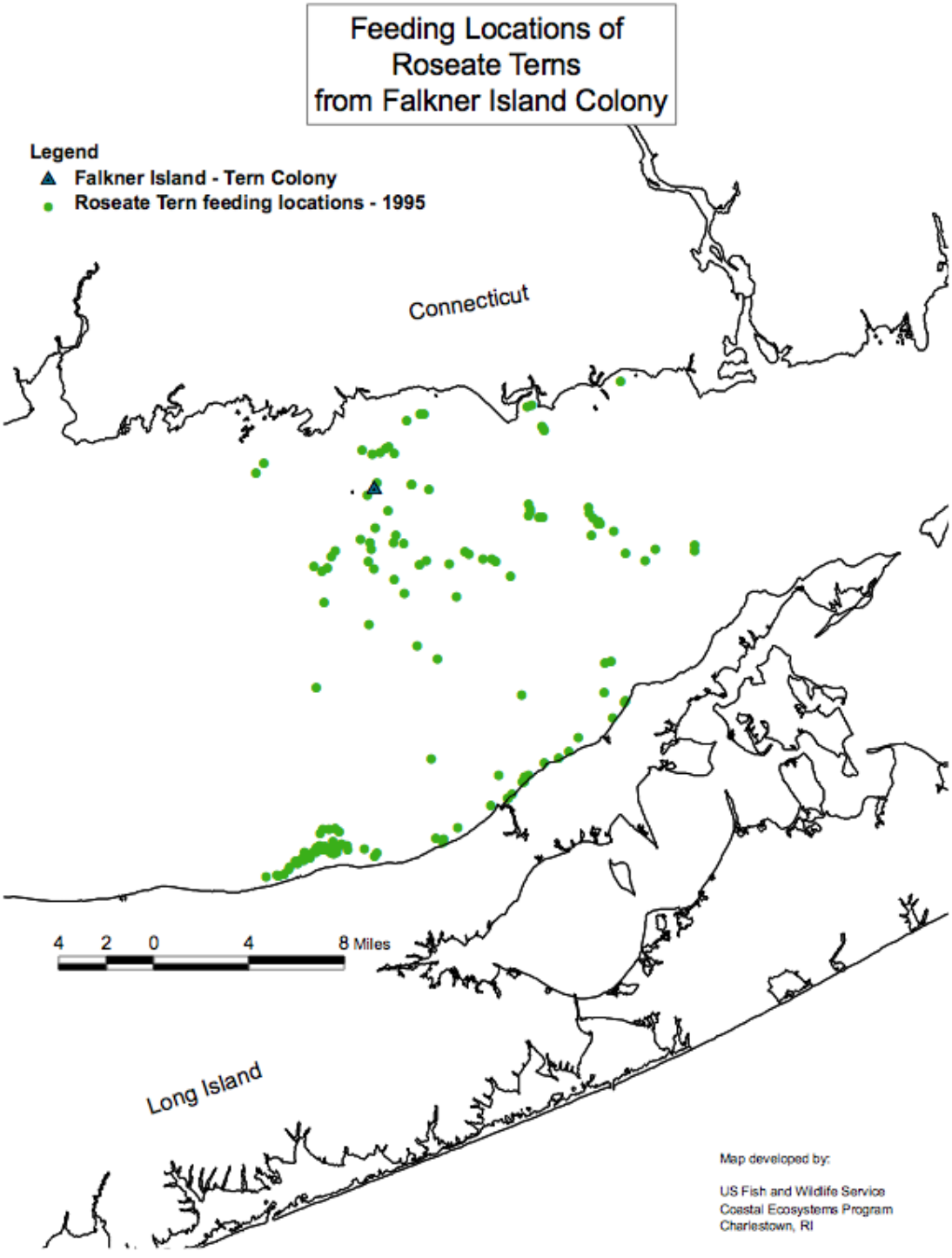
   (4d) Wading Birds: The site regularly supports 25 or more breeding pairs of wading birds or 100 or more individuals feeding or in migration.

   (4e) Raptors: The site is a “bottleneck” or migration corridor for >5,000 migratory raptors (seasonal total).

   (4f) Landbirds: The site is an important migratory stopover or seasonal concentration site for migratory landbirds.

   (4g) Single-species Concentrations: The site regularly supports significant concentrations of a congregating species but may not meet the thresholds above. Such sites should support a higher proportion of a species statewide population (>1%, if known) than other similar areas.
5. The site is important for long-term research and/or monitoring projects that contribute substantially to ornithology, bird conservation, and/or education.

Appendix C. Feeding locations of roseate terns from the Falkner Island Colony, 1995 (USFWS Coastal Ecosystem Program)



Appendix D. List of bird species observed at Falkner Island and Goose Island, 1978-2003

List of bird species in the vicinity of Falkner Island (FI) and Goose Island (GI) from late April to early September, 1978-present (last revised 02/2003)

Species seen or heard	Netted/ Banded	Breeding Site	Comments
Whimbrel			
Ruddy Turnstone	*		
Red Knot			
Sanderling			
Rufous-necked Stint			24 July 2002
Little Stint			28 July 2000
Semipalmated Sandpiper			
Least Sandpiper	*		
White-rumped Sandpiper			
Baird's Sandpiper			
Pectoral Sandpiper			1998
Purple Sandpiper			
Dunlin			
Short-billed Dowitcher			
American Woodcock	*		
Laughing Gull			
Bonaparte's Gull			
Ring-billed Gull			
Herring Gull	GI	FI/GI	nesting discouraged at FI
Great Black-backed Gull	GI	FI/GI	nesting discouraged at FI
Caspian Tern			9 July 1998
Royal Tern			1995
Roseate Tern	*	FI	
Common Tern	*	FI	
Forster's Tern			
Least Tern			
Bridled Tern			1992 1st documented CT record
Black Tern			
Black Skimmer			
Rock Dove			
Mourning Dove	*		
Black-billed Cuckoo	*		
Yellow-billed Cuckoo	*		
Snowy Owl			seen November to March
Long-eared Owl			
Short-eared Owl			
Common Nighthawk			5 Sept. 2002
Chuck-will's-widow			specimen collected
Chimney Swift			1995
Ruby-throated Hummingbird	*		netted, but not banded
Belted Kingfisher	*		
Downy Woodpecker	*		
Northern Flicker	*		
Eastern Wood-Pewee	*		
Yellow-bellied Flycatcher	*		
Acadian Flycatcher	*		
Alder Flycatcher	*		
Willow Flycatcher	*		
Least Flycatcher	*		
Eastern Phoebe	*		

List of bird species in the vicinity of Falkner Island (FI) and Goose Island (GI) from late April to early September, 1978-present (last revised 02/2003)

Species seen or heard	Netted/ Banded	Breeding Site	Comments
Red-throated Loon			
Common Loon			
Horned Grebe			
Red-necked Grebe			30 April 1997
?Cory's Shearwater			28 June 2001
Manx Shearwater			20 June 1996
Northern Gannet			seen in November 2000
Great Cormorant			April 1996
Double-crested Cormorant	GI	GI	nesting since 1982
Magnificent Frigatebird			
Least Bittern			28 May 2001
Great Blue Heron			
Great Egret			
Snowy Egret			
Little Blue Heron			
Cattle Egret			18 May 1993
Green-backed Heron			
Black-crowned Night-Heron			
Glossy Ibis			
Mute Swan			
Brant			
Canada Goose		FI	nesting since 1993
American Black Duck		FI	nesting at least since 1981
Mallard		FI	nesting at least since 1982
Greater Scaup			
Common Eider			
Harlequin Duck			seen in winter
Oldsquaw			
Black Scoter			
Surf Scoter			
White-winged Scoter			
Bufflehead			
Red-breasted Merganser			
Turkey Vulture			
Osprey			
Northern Harrier			
Sharp-shinned Hawk	*		
Cooper's Hawk			
Red-tailed Hawk			12 May 2000
American Kestrel			
Merlin	*		
Peregrine			
Black-bellied Plover			
Semipalmated Plover			
Killdeer			
American Oystercatcher	*	FI	nesting since 1991
Greater Yellowlegs			
Lesser Yellowlegs			
Willet			
Spotted Sandpiper	*	FI	nested 1978-1987, 1994

(Last revised 02/2003)

Species seen or heard	Netted/ Banded	Breeding Site	Comments
Pine Warbler	*		
Prairie Warbler	*		
Palm Warbler	*		
Bay-breasted Warbler	*		
Blackpoll Warbler	*		
Black-and-white Warbler	*		
American Redstart	*		
Prothonotary Warbler	*		
Worm-eating Warbler	*		
Ovenbird	*		
Northern Waterthrush	*		
Louisiana Waterthrush	*		
Kentucky Warbler	*		31 May 1999
Connecticut Warbler	*		
Mourning Warbler	*		
Common Yellowthroat	*		
Hooded Warbler	*		
Wilson's Warbler	*		
Canada Warbler	*		
Yellow-breasted Chat	*		
Scarlet Tanager	*		
Northern Cardinal	*		
Rose-breasted Grosbeak	*		
Blue Grosbeak	*		1994
Indigo Bunting	*		
Dickcissel	*		
Rufous-sided Towhee	*		
Chipping Sparrow	*		
Field Sparrow	*		
Savannah Sparrow	*		
Sharp-tailed Sparrow	*		
Seaside Sparrow	*		
Song Sparrow	*	FI	nesting since 1980
Lincoln's Sparrow	*		
Swamp Sparrow	*		
White-throated Sparrow	*		
White-crowned Sparrow	*		
Dark-eyed Junco	*		
Bobolink	*		
Red-winged Blackbird	*	FI	nesting at least since 1981
Eastern Meadowlark			
Common Grackle	*	FI	nested in 1995
Brown-headed Cowbird	*		
Orchard Oriole	*		1994
Northern Oriole	*		
Purple Finch	*		
House Finch	*		
American Goldfinch	*		
House Sparrow	*		

List of bird species in the vicinity of Falkner Island (FI) and Goose Island (GI) from late April to early September, 1978-present (last revised 02/2003)

Species seen or heard	Netted/ Banded	Breeding Site	Comments
Great Crested Flycatcher	*		
Eastern Kingbird	*		
Tree Swallow	*		
Bank Swallow			
Barn Swallow	*	FI	nesting at least since 1981
Blue Jay	*		
American Crow			
Fish Crow			
Black-capped Chickadee	*		
Red-breasted Nuthatch	*		
White-breasted Nuthatch	*		
Brown Creeper	*		
Carolina Wren	*		
House Wren	*		
Winter Wren			
Sedge Wren	*		
Marsh Wren	*		
Golden-crowned Kinglet	*		
Ruby-crowned Kinglet	*		
Blue-gray Gnatcatcher	*		
Veery	*		
Gray-cheeked Thrush	*		
Swainson's Thrush	*		
Hermit Thrush	*		
Wood Thrush	*		
American Robin	*		
Gray Catbird	*		
Northern Mockingbird	*		
Brown Thrasher	*		
Cedar Waxwing	*		
European Starling	*	FI	formerly nesting
White-eyed Vireo	*		
Solitary Vireo	*		
Yellow-throated Vireo	*		28 May 2001
Warbling Vireo	*		
Philadelphia Vireo	*		
Red-eyed Vireo	*		
Blue-winged Warbler	*		
Golden-winged Warbler	*		
Tennessee Warbler	*		
Nasville Warbler	*		
Northern Parula	*		
Yellow Warbler	*		
Chestnut-sided Warbler	*		
Magnolia Warbler	*		
Cape May Warbler	*		
Black-throated Blue Warbler	*		
Yellow-rumped Warbler	*		
Black-throated Green Warbler	*		
Blackburnian Warbler	*		

Appendix E. List of birds banded during spring migration at Falkner Island, 1978-2003; in order of AOU number

# new banded in	1978	1979	1980	1981	1982	1983	1984
AMWO 2280							
LESA 2420					1		
SPSA 2630	1	1	3	7	1	4	1
RUTU 2830							
AMOY 2860							
MODO 3160			1				
SSHA 3320							
MERL 3570			1				
YBCU 3870			1		1		
BBCU 3880							
BEKI 3900							
DOWO 3940				1			
YSFL 4120							
EAKI 4440					1		
GCFL 4520			1	1		1	
EAPH 4560					1		
EAWP 4610			2	1	4		
YBFL 4630				5	4	3	
ACFL 4650				2			
TRFL 4669	1		2	6	11	2	
LEFL 4670			10	4			1
BLJA 4770	3	3	28	2			
EUST 4930		19	24	12	9		1
BOBO 4940			1	1			
BHCO 4950				1			
RWBL 4980	9	5	29	4	6	3	3
ORCR 5060							
BAOR 5070	1		3	1	2	1	
COGR 5110		1					
PUFI 5170							
HOFI 5190							
AMGO 5290		2	2		1		
SAVS 5420	1	16	5				
STSP 5490				1			
SESP 5500	1		3				
WCSP 5540							
WTSP 5580	1	91	78		2		
CHSP 5600							
FISP 5630	1	1	2				
SCJU 5670		1					1

# new banded in	1985	1986	1987	1988	1989	1990	1991
AMWO 2280						1	
LESA 2420							
SPSA 2630						1	
RUTU 2830						1	
AMOY 2860							
MODO 3160							
SSHA 3320			2				
MERL 3570							
YBCU 3870				1		1	
BBCU 3880			1	1			
BEKI 3900						1	
DOWO 3940							
YSFL 4120				4			
EAKI 4440							
GCFL 4520					1	3	
EAPH 4560			1	1			
EAWP 4610			1		1	9	
YBFL 4630			2		3	5	
ACFL 4650							
TRFL 4669			4	2	5	11	
LEFL 4670			4	2	5	38	2
BLJA 4770					10		
EUST 4930				3	2		
BOBO 4940			1			2	
BHCO 4950					3	1	
RWBL 4980	5		6	6	10	12	3
ORCR 5060							
BAOR 5070			2			6	
COGR 5110				1	3	5	
PUFI 5170							
HOFI 5190							
AMGO 5290			14			1	
SAVS 5420			2		1		
STSP 5490			1			3	
SESP 5500			2				
WCSP 5540				1		2	
WTSP 5580			14		4	17	7
CHSP 5600					1		
FISP 5630							
SCJU 5670							

# new banded in	1992	1993	1994	1995	1996	1997	1998
AMWO 2280							
LESA 2420							
SPSA 2630			2	3	3		1
RUTU 2830							
AMOY 2860		2					
MODO 3160			1		1		
SSHA 3320							
MERL 3570							
YBCU 3870			1	1			
BBCU 3880				1	1	2	
BEKI 3900	1		1				
DOWO 3940	1			5	2	1	
YSFL 4120		2	1	1	1		1
EAKI 4440	1					1	2
GCFL 4520	3	1	2		1	1	
EAPH 4560	2	1	2	6		4	1
EAWP 4610	3		6	4	4	2	4
YBFL 4630	2	1	4	4	9	6	5
ACFL 4650				1			
TRFL 4669	6	5	22	8	15	19	15
LEFL 4670	5	8	16	10	27	10	14
BLJA 4770					1		
EUST 4930	1			4			
BOBO 4940						1	
BHCO 4950		2	8	1	2	3	5
RWBL 4980	9	15	38	55	35	20	29
ORCR 5060			1				1
BAOR 5070		1	2	5	6	3	2
COGR 5110	1	3	1	14	14	2	13
PUFI 5170				2			
HOFI 5190	1		1	1		1	1
AMGO 5290			4	8	7	3	4
SAVS 5420		6		3	3		
STSP 5490	1						
SESP 5500				1			1
WCSP 5540			1		2		
WTSP 5580	1	10	2	10	2	8	18
CHSP 5600		1	1	4		2	2
FISP 5630	2		1	1	2	1	
SCJU 5670							1

# new banded in	1999	2000	2001	2002	2003	TOTAL:
AMWO 2280						1
LESA 2420						1
SPSA 2630						28
RUTU 2830						1
AMOY 2860		1				3
MODO 3160						3
SSHA 3320						2
MERL 3570						1
YBCU 3870	1					7
BBCU 3880					1	7
BEKI 3900	1					4
DOWO 3940	2					12
YSFL 4120	2	3	2	1		18
EAKI 4440			1		3	9
GCFL 4520				1	2	18
EAPH 4560	4	2	1	7		33
EAWP 4610	7		3	14	1	66
YBFL 4630	4	2	4	7		70
ACFL 4650						3
TRFL 4669	6	4	11	9	5	169
LEFL 4670	4		5	11	4	180
BLJA 4770						47
EUST 4930			1			76
BOBO 4940					1	7
BHCO 4950	3		1		1	31
RWBL 4980	25	25	35	11	22	420
ORCR 5060		1			1	4
BAOR 5070	1	1		2		39
COGR 5110	1	6	1	1	25	92
PUFI 5170		2				4
HOFI 5190						5
AMGO 5290	1		3	4	5	59
SAVS 5420	3	4	21	2	1	68
STSP 5490	1			1		8
SESP 5500						8
WCSP 5540				1		7
WTSP 5580		11	153	30	17	476
CHSP 5600		1	5	2		19
FISP 5630	1		2	1		15
SCJU 5670	3	1				7

# new banded in	1978	1979	1980	1981	1982	1983	1984
SOSP 5810	1	2	6	1	2		4
LISP 5830			9		4		
SWSP 5840	10	74	52	1	4		
EATO 5870	17	52	65	1	7		
NOCA 5930			1	1			
RBGR 5950			1	3	1		
BLGR 5970							
INBU 5980			1	1	1		1
DICK 6040							
SCTA 6080							1
BARS 6130	10	23	31	16	20	18	4
TRES 6140	1						
CEDW 6190				2			
REVI 6240		5	3	3	3	9	
PHVI 6260							
WAVI 6270						1	
YTVI 6280							
SOVI 6290			1				
WEVI 6310	1		1				
BAWW 6360	1		5				
PROW 6370							
WEWA 6390							
BWWA 6410							1
GWWA 6420				1			
NAWA 6450							
TEWA 6470			1				
NOPA 6480			4	1	1		
CMWA 6500			1				
YWAR 6520	1	10	10	27	6	1	4
BTBW 6540			3		1		
MYMA 6550		6	5		1		
MGWA 6570	1		17	7	9	6	
CSWA 6590			3	1		1	
BBWA 6600						3	
BLPW 6610	1		2	5	5	3	
BLBW 6620					1	1	
BTNW 6670	1					1	
PIWA 6710							
WPWA 6720							
YPWA 6729			1				

# new banded in	1985	1986	1987	1988	1989	1990	1991
SOSP 5810			9	4	3	14	1
LISP 5830			4	1		6	
SWSP 5840			3		3	24	5
EATO 5870	1		7		3	8	2
NOCA 5930							
RBGR 5950			2			4	
BLGR 5970							
INBU 5980			1	1		1	
DICK 6040							
SCTA 6080			2			2	
BARS 6130		15	6	4	9	5	33
TRES 6140							
CEDW 6190							
REVI 6240			4	1	2	5	
PHVI 6260						2	
WAVI 6270							
YTVI 6280							
SOVI 6290			1			1	
WEVI 6310							
BAWW 6360			3	1	6	8	
PROW 6370					1		
WEWA 6390					1		
BWWA 6410			4		1	3	1
GWWA 6420							
NAWA 6450							
TEWA 6470						1	
NOPA 6480	1				1	7	
CMWA 6500			1				
YWAR 6520	4		7	16	17	26	3
BTBW 6540						1	
MYMA 6550			2		2	3	
MGWA 6570	6		33	4	1	41	
CSWA 6590			3		1	7	
BBWA 6600						1	
BLPW 6610			3	1	3	2	
BLBW 6620			1	1		2	
BTNW 6670							
PIWA 6710							
WPWA 6720							
YPWA 6729							1

# new banded in	1992	1993	1994	1995	1996	1997	1998
SOSP 5810	18	8	5	11	3		13
LISP 5830		1	1	1	8	1	1
SWSP 5840	2	4	5	5	12	4	24
EATO 5870		3	4	12	1	3	6
NOCA 5930		1		1		1	
RBGR 5950			2			1	2
BLGR 5970			1				
INBU 5980			1	2	1		1
DICK 6040				1			
SCTA 6080		1		1			2
BARS 6130	2	17	59	29	11	12	43
TRES 6140							
CEDW 6190	2		1	1			
REVI 6240	4	3	5	14	5	6	14
PHVI 6260				1			
WAVI 6270							
YTVI 6280							
SOVI 6290				1		1	
WEVI 6310							1
BAWW 6360	2	4	6	14	8	5	26
PROW 6370							
WEWA 6390			3			1	1
BWWA 6410		2	3	3	2		1
GWWA 6420							
NAWA 6450				1		1	1
TEWA 6470							
NOPA 6480	2	3	2	10	1	3	4
CMWA 6500							
YWAR 6520	21	37	63	34	70	29	50
BTBW 6540		1	3	3	4	4	
MYMA 6550		1	9	7		4	7
MGWA 6570	10	20	14	32	30	74	39
CSWA 6590	3	3	5	7	1	4	5
BBWA 6600		1		1	1	1	2
BLPW 6610	2	5	6	10	4	4	15
BLBW 6620		1	2	1	2	2	
BTNW 6670		1		2			1
PIWA 6710			1				
WPWA 6720		1		1			
YPWA 6729						1	2

# new banded in	1999	2000	2001	2002	2003	TOTAL:
SOSP 5810	13	11	13	14	12	168
LISP 5830			6	2		45
SWSP 5840	2	4	52	11	1	302
EATO 5870	3	6	24	3	4	232
NOCA 5930		1	2		1	9
RBGR 5950		1	2	1		20
BLGR 5970						1
INBU 5980			2		1	15
DICK 6040						1
SCTA 6080			2			11
BARS 6130	43	31	16	23	2	482
TRES 6140						1
CEDW 6190				1	2	9
REVI 6240	8		14	8	1	117
PHVI 6260				1	1	5
WAVI 6270						1
YTVI 6280			1			1
SOVI 6290						5
WEVI 6310			1			4
BAWW 6360	4	1	14	7	2	117
PROW 6370						1
WEWA 6390	1		1			8
BWWA 6410			3		1	25
GWWA 6420			1			2
NAWA 6450						3
TEWA 6470				1		3
NOPA 6480	1	2	3	5	1	52
CMWA 6500						2
YWAR 6520	27	14	20	23	21	541
BTBW 6540		5	7	4		36
MYMA 6550	2	34	21	9	2	115
MGWA 6570	14	36	23	25	6	448
CSWA 6590	2	3	1	3		53
BBWA 6600						10
BLPW 6610	3	2	4	16	6	102
BLBW 6620		2	1	1		18
BTNW 6670	2			2		10
PIWA 6710						1
WPWA 6720		1				3
YPWA 6729	1	19	4		1	30

# new banded in	1978	1979	1980	1981	1982	1983	1984
PRAW 6730	1		3				
OVEN 6740	1	8	10	4	2		1
NOWA 6750	1	7	4	7	3		
LOWA 6760							
KEWA 6770							
CONW 6780						1	
MOWA 6790			3	3	2	1	
COYE 6810	13	274	188	46	39	3	
YBCH 6830							
HOWA 6840							
WIWA 6850			2				
CAWA 6860			5		2	2	
AMRE 6870		14	5	6	5	10	1
HOSP 6882			1				
NOMO 7030			2		1		
GRCA 7040	12	54	47	4	9	5	
BRTH 7050	1	7	7		2		1
CARW 7180						1	
HOWR 7210			3	1	1		
SEWR 7240							
MAWR 7250							
BRCR 7260				1			
WBNU 7270							
RBNU 7280							
BCCH 7350							
GCKI 7480							
RCKI 7490		4	14				
BGGN 7510			3		1		
WOTH 7550	1	2	5		4		
VEER 7560		5	4	1	1	4	
GCTH 7570	1			1		1	
SWTH 7580	1	3	1	3	10	2	
HETH 7590		7	5				
AMRO 7610			1				1
TOTAL:	96	697	732	197	192	88	26

# new banded in	1985	1986	1987	1988	1989	1990	1991
PRAW 6730						2	
OVEN 6740			8		4	14	1
NOWA 6750	1		6	17	23	17	6
LOWA 6760				1			
KEWA 6770							
CONW 6780							
MOWA 6790				2		1	
COYE 6810	9		38	2	23	133	3
YBCH 6830							
HOWA 6840						1	
WIWA 6850			2		1	3	
CAWA 6860			8	3	3	17	
AMRE 6870	3		12	3	5	19	1
HOSP 6882					1		
NOMO 7030					1	2	
GRCA 7040	2		4	2	7	41	1
BRTH 7050						1	
CARW 7180			1		1	3	2
HOWR 7210					2	1	
SEWR 7240							
MAWR 7250			1	1			
BRCR 7260							
WBNU 7270							
RBNU 7280						2	
BCCH 7350							2
GCKI 7480							
RCKI 7490			1		3	9	3
BGGN 7510					2		
WOTH 7550				1	4	10	
VEER 7560			4			11	
GCTH 7570			1			1	
SWTH 7580	1		13			18	
HETH 7590						2	5
AMRO 7610			1	2		1	1
TOTAL:	33	15	253	90	183	603	83

# new banded in	1992	1993	1994	1995	1996	1997	1998
PRAW 6730		1			1		
OVEN 6740	4	8	4	7	7	14	9
NOWA 6750	30	32	27	19	43	13	38
LOWA 6760			1	1	2	1	
KEWA 6770							
CONW 6780							
MOWA 6790	1	1		2	1	2	
COYE 6810	109	125	107	160	108	53	113
YBCH 6830					1	2	1
HOWA 6840		1	2	1			
WIWA 6850		2	2		2	1	
CAWA 6860		3	5	5	10	6	10
AMRE 6870	9	31	32	36	41	50	62
HOSP 6882							1
NOMO 7030			3	4	1	1	1
GRCA 7040	8	17	21	40	17	13	29
BRTH 7050			1		2		4
CARW 7180	4	5		2			2
HOWR 7210	1	2	2	3	3		2
SEWR 7240		1					
MAWR 7250							1
BRCR 7260							
WBNU 7270				1			
RBNU 7280		2		3		1	
BCCH 7350			1				
GCKI 7480							
RCKI 7490		5	3	3		2	16
BGGN 7510			4	1			
WOTH 7550			2	3	1	1	2
VEER 7560		1	2	3	7	1	
GCTH 7570							1
SWTH 7580			1	3	5	3	1
HETH 7590		1				1	
AMRO 7610	1	1	1	4	7	1	3
TOTAL:	275	415	540	660	561	418	677

# new banded in	1999	2000	2001	2002	2003	TOTAL:
PRAW 6730		1	2			11
OVEN 6740	3	4	18	9	1	141
NOWA 6750	25	6	5	17	2	349
LOWA 6760	1					7
KEWA 6770	1					1
CONW 6780				1		2
MOWA 6790		1	1		2	23
COYE 6810	86	32	104	45	17	1830
YBCH 6830			1		1	6
HOWA 6840		1				6
WIWA 6850			1	1	2	19
CAWA 6860	2	1	1	3	2	88
AMRE 6870	18	9	13	14	6	405
HOSP 6882						3
NOMO 7030	1		11	4	2	34
GRCA 7040	7	6	47	29	19	441
BRTH 7050	1	1				28
CARW 7180	1	2		4	2	30
HOWR 7210	1	1	1	3	1	28
SEWR 7240						1
MAWR 7250						3
BRCR 7260						1
WBNU 7270		1				2
RBNU 7280	1	1		1		11
BCCH 7350						3
GCKI 7480			1			1
RCKI 7490	2	8	7	5		85
BGGN 7510	1			1	1	14
WOTH 7550			1	7	1	45
VEER 7560	1		4	9		58
GCTH 7570			1			7
SWTH 7580	1	1	9	2		78
HETH 7590		13	10		2	46
AMRO 7610		1	2	1	3	32
TOTAL:	349	327	727	421	218	8876

Appendix F. Summary of recommended actions and actors

Goal(s)	Recommended Actions	Actor(s)
Enhance and expand roseate tern nesting habitat	Distribute "Series 500" nest boxes, manage vegetation, distribute gravel substrate, and modify the revetment.	Refuge Staff and volunteers
Manage native vegetation and control invasive species	Employ a bi-annual mowing schedule to maintain the majority of the upland area as grasses and forbs. Remove undesirable plants using methods that do not require herbicide.	Refuge Staff, volunteers, and other capable organizations
Reduce the negative effects of the shoreline revetment	Fill revetment crevices with gravel material, to a maximum depth of 6 inches. Install additional concrete shelves where necessary, and cover with gravel material.	Refuge Staff and USACE
Enhance the North Spit through stabilization and expansion	Build up the North Spit by depositing material. Install structures to reduce its gradual erosion.	USACE and Refuge Staff
Minimize human disturbance during the breeding season	Optimize the timing and routes of daily activity. Avoid activity when conditions are not ideal, and improve observation blinds.	Refuge Staff and volunteers
Expand monitoring activities and publish data analyses	Perform cheek swabs on roseate tern nestlings; band adult terns; utilize vegetation survey plots; survey non-terns species; publish monitoring results and analyses.	Refuge Staff, Audubon Connecticut, CT DEEP, public volunteers, university faculty and students
Pursue research opportunities to fill knowledge gaps	Conduct research that will inform conservation and management of roseate terns.	University faculty and students, Refuge Staff
Foster stakeholdership and expand public education and outreach	Develop classroom curricula, conduct public presentations, and expand mainland signage.	Audubon Connecticut, CT DEEP

Minimize the negative effects of black-crowned night heron predation on roseate tern eggs and chicks	Continue the predator control program.	Refuge Staff

Appendix G. Potential stakeholders

I. Stakeholders: Government agencies

Agency	**Attn:**	**Contact Information**
U.S. Fish and Wildlife Service Stewart B. McKinney National Wildlife Refuge	Richard Potvin, Refuge Manager	richard_potvin@fws.gov
U.S. Coast Guard Station New London	Lt. Thomas M. Stokes, Commanding Officer	860-442-4471
U.S. Fish and Wildlife Service New England Field Office	Susi von Oettingen, Roseate Tern Recovery Team Leader	susi_vonoettingen@fws.gov
U.S. Geological Service, Patuxent Wildlife Research Center	Jeffrey Spendelow, Biologist	jeff_spendelow@usgs.gov
U.S. Army Corps of Engineers, New England District	William Scully, Project Manager	978-318-8111
Connecticut Department of Energy & Environmental Protection, Wildlife Division	Jenny Dickson, Wildlife Biologist	jenny.dickson@ct.gov
Town of Guilford, Conservation Commission	Shelley Green, Chairperson	860-458-1257

II. Stakeholders: Non-profit organizations

Organization	**Attn:**	**Contact Information**
Audubon Connecticut	Patrick Comins, Director of Bird Conservation; Corrine Folsom-O'Keefe, IBA Program Coordinator	pcomins@audubon.org cfolsom-okeefe@audubon.org
Menunkatuck Audubon Society	Suzanne Botta, President	president@menunkatuck.org
Potapaug Audubon Society	Barbara Barron, President	potapaugaudubon@gmail.com
Connecticut Audubon Society	Milan Bull, Senior Director of Science and Conservation	mbull@ctaudubon.org

Faulkner's Light Brigade	Jeff Heinrich, Chairman	info@faulknerslight.org
Little Harbor Laboratory	Sally Richards	sallyw@cshore.com
The Nature Conservancy, Connecticut Chapter	Nathan Frohling, Director of Connecticut Coastal and Marine Initiatives	203-226-4991 (ext. 116)
American Bird Conservancy	David Pashley, Vice President of US Conservation Partnerships	dpashley@abcbirds.org
Connecticut Ornithological Association	Tina Green, President	petermgreen@hotmail.com

III. Stakeholders: Academic and educational institutions

Institution	**Attn:**	**Contact Information**
Sound School	Paula Daddio	pjdaddyp@comcast.net
American Museum of Natural History Great Gull Project	Helen Hays	hays@amnh.org
University of Connecticut Ornithology Research Group	Margaret Rubega, State Ornithologist	margaret.rubega@uconn.edu
Connecticut College	Robert Askins	robert.askins@conncoll.edu