**Nantucket Biodiversity Initiative’s**

**6th Biennial Research Conference**

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**Presentation Abstracts – alphabetical by Presenter**

**ROOSTING BEHAVIOR OF THE THREATENED NORTHERN LONG-EARED BAT ON MARTHA’S VINEYARD, AND ITS PRESENCE ON NANTUCKET**

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Martha’s Vineyard and Nantucket provide unique and potentially critical habitat to the Northern Long-eared Bat (*Myotis septentrionalis)* (NLEB). This species is listed as federally Threatened and state Endangered, due to massive declines associated with the spread of White-Nose Syndrome (WNS). In 1997-1998, before the spread of this fungal disease, large numbers of NLEB were documented on Martha’s Vineyard. Acoustic and mist-netting surveys in 2013-2014 demonstrated that post-WNS, the species was still present in greater abundance than elsewhere, suggesting that isolation from the mainland might be providing some protection to island populations. In summer and fall of 2015, we engaged in mist-netting and radio-tagging efforts to understand more about NLEB roosting behavior, maternity colonies, and overwintering on Martha’s Vineyard. We captured and tagged 9 lactating female NLEB in early summer, and 2 females in late summer. Tracking and emergence counts revealed small but active maternity colonies of 6-15 bats. NLEB selected trees (42%) and structures (58%) for maternity colony and daytime roost locations. In 2015, we also extended our efforts to Nantucket, deploying acoustic detectors on four Nantucket Conservation Foundation properties. Despite a lack of the heavily forested cover NLEB are thought to prefer, we documented this species at seven of eight detector locations. We also recorded the presence of migratory tree bats on the island. Further investigation of bat populations on Nantucket is warranted.

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**PRELIMINARY RESULTS OF TEN YEARS OF AMERICAN OYSTERCATCHER COLOR-BANDING AND MONITORING ON NANTUCKET**

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The American Oystercatcher (*Haematopus palliates*)is classified as a “Species of High Concern” in the U. S. Shorebird Conservation Plan (prepared by Manomet Center for Conservation Sciences in 2001) due to small overall population (11,000 individuals), loss of suitable habitat, and threats from predators and recreation use. Nantucket, Tuckernuck and Muskeget Islands collectively have the highest concentration of nesting oystercatchers in Massachusetts (52 of 203 pairs in 2011). Since 2005, the Nantucket Conservation Foundation has been a partner in the American Oystercatcher Working Group, a collaboration of over 40 organizations, agencies and research institutions involved with banding and re-sighting oystercatchers to learn about their movement and dispersal patterns. Color-band and/or re-sight projects are currently underway in most Atlantic and Gulf Coast States from Massachusetts to Texas. Color-bands contain a unique, field-readable code with a color combination specific to the state where the bird was banded. Birds are banded with the same code on both legs, allowing individuals to be identified and tracked in the field with binoculars or a spotting scope. With the assistance of many partners, 286 individual oystercatchers (121 adults and 165 chicks) were color-banded on Nantucket, Tuckernuck and Muskeget between 2005 and 2015. A total of 244 individuals banded or observed on Nantucket have been re-sighted at least once outside of Massachusetts, for a total of 1,715 re-sightings. This collaborative work has revealed interesting connections between Nantucket and the wintering sites of this species and identified important target areas for habitat protection and conservation.

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**DIET OF GREAT BLACK-BACKED AND HERRING GULLS, TUCKERNUCK AND MUSKEGET ISLANDS, MA**

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Both Great Black-backed and Herring Gulls colonized Massachusetts during the early 20th century, as their North American population dramatically increased and expanded southwards. Herring Gulls have declined by at least 50% after a peak before 1980, and Great Black-backeds have decreased proportionately less since a peak in the 1990s. Part of the precipitous decline of gulls, perhaps most of it, reflects changes in garbage dumping procedures and decline of New England fisheries. With virtually no data on gull diets collected in Massachusetts, we do not know how they are impacted by changes of fish stocks, nor how they impact fish. We studied Great Black-backed and Herring Gull diet on Tuckernuck and Muskeget Islands during the breeding season of 2015. We collected basic demographic data including clutch initiation date and size, hatching dates, and chick weights. 300 chicks of both species were banded and 75 chicks of both species sampled. We found a high frequency and proportion of squid (*Loligo pealei*) in both Great Black-backed and Herring diet. Great Black-backed diet was composed predominately of squid and fishes, while Herring diet had other sources, most notably blueberries. Great Black-backeds had high fledgling success, while Herrings were less successful and appeared to struggle, mostly on Muskeget Island.

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**The Integration of Town Collected Water Quality Data and Habitat Assessments to Aid the Larval Release Program from the Brant Point Shellfish HatcherY**

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The Town of Nantucket Natural Resources Department

Over the past decade many strategies have been implemented to better conserve and enhance Nantucket’s native shellfish populations. Due to increased environmental pressure, limited funding and space constraints the Town of Nantucket Natural Resources Department implemented a larval release strategy for the enhancement of the native population of Nantucket Bay Scallops (*Argopecten irradians irradians*). Adult scallops are conditioned in the Brant Point Shellfish Hatchery and spawned in a controlled setting. Over the next 10-12 days the larvae are closely monitored and screened to produce competent larvae eligible for release. Larvae are released into areas deemed suitable by a combination of habitat assessment, water quality data and historic site information. To aid in this effort comprehensive Eelgrass mapping has been underway in 2015 and water quality analysis has been conducted over the last decade. Since the program’s inception in 2010 approximately 500 million bay scallop larvae have been released into Nantucket and Madaket Harbors. The success of this program has allowed for the renovation of the Brant Point Shellfish Hatchery in efforts to further enhance the larval release program for Nantucket Bay Scallops and expand additional enhancement initiatives to include other species of native shellfish as set forth by the Town of Nantucket’s Shellfish Management Plan.

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**COOPERATIVE UPDATE OF THE VASCULAR FLORA OF NANTUCKET**

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Nearly 20 years ago, in 1996, Sorrie and Dunwiddie published “The Vascular and Non-Vascular Flora of Nantucket, Tuckernuck, and Muskeget Islands”. In that 20 years the nomenclature and taxonomy of the New England Flora has been overhauled. Additionally, during this time the ranges of plant species has been changing, with a great many non-native species expanding into new territories. In response to this floristic flux a cooperative initiative to update the vascular portion of the Nantucket flora has begun. Preliminary surveys were conducted this past summer. Five previously unreported non-native vascular plant species were found to be establishing on Nantucket including: *Pyrus calleryana*, *Dysphania pumilio*, *Zelkova serrata*, *Lonicera maackii,* and *Kummerowia striata*. Furthermore, plans are afoot to update the nomenclature of vascular plant species list, and possibly develop online botanical keys specific to the island.

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**IT’S ALL IN THE TIMING: ANSWERING SHORT TERM RESEARCH QUESTIONS WHILE ESTABLISHING A LONG-TERM PHENOLOGY STUDY**

***Sarah Treanor Bois***

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Phenology offers insights into species’ response to climate change and shifts in phenology can disrupt ecological processes. Nantucket is host to unique assemblages of coastal shrubland, heathland, and sandplain grassland communities. Species-specific responses to climate changes could result in alterations to these threatened habitats. In establishing a long-term phenological research program, we focus on common shrubs characteristic of these native plant communities. We begin by asking short-term research questions: What are the main phenophases of common, woody shrubs of the coastal heathland community? How do small differences in temperature (imposed by topography) affect the timing of these phenophases among plots and years? How do these differences vary among species? We established eight plots across our study site with multiple individuals of each of 10 study species present. Phenological observations were recorded twice a week along with hourly temperature at each plot.

At the early stages of this project, we have identified the main phenophases of our 10 study species. Among our plots, even slight variations in topography have resulted in temperature differences of up to 10°C leading to species-specific effects; some shrubs had more synchronous annual bud burst regardless of within-season temperature variation. Other species had asynchronous bud burst spanning a 10 day period with leaf-out correlated with minimum spring temperatures. Differential climate sensitivities have implications for the assemblages of shrub communities in these threatened systems with predicted warmer temperatures. Additional years of data will help illustrate potential plant species’ responses to changing temperatures.

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**GALLS AND LEAF MINES OF NANTUCKET, YEAR FIVE**

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Nantucket’s gall-inducing and leaf-mining insect fauna was largely ignored in past assessments of the island’s biodiversity. To address this knowledge gap, we conducted intensive 3- to 7-day surveys for galls and leaf mines throughout the island and on Tuckernuck in September 2011, May and August 2012, June 2013, July 2014, and August 2015. Incidental observations and collections were made throughout the spring and summer of 2012, in November 2013, and in May 2014. Each of the first four main survey windows included visits to the 10 ha biodiversity plots at Squam Swamp, Coskata Woods, and Madequecham Valley, with explorations of various other sites as time permitted. Subsequent visits focused on exploring new locations, targeting previously missed host plants, and following up on previous observations of unidentified insects. Each type of gall or leaf mine was photographed, and when possible samples were collected in an attempt to rear adults. Collected and reared specimens have been sent to specialists around the world for examination. Each visit to Nantucket has yielded many new species for the island and a few new to science. We have also documented new host records for some species and discovered the immature stages of a few species previously known only from adults. Well over 200 gallmakers, leafminers, and associated hymenopteran parasitoids have now been found on Nantucket, most of them during our study.

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**MYCORRHIZAE OF THE SAND DUNES – NANTUCKET APPROACHES**

***Douglas E. Eveleigh***

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Sand dunes form protective barriers whose practical importance is amplified during storms. During the latter, dunes are subject to periodic wash outs. The establishment and restoration of sand dunes is of ecologic interest and practical importance. Revegetation by planting sand dune grass, *Ammophila breviligulata*, has been practiced at Dionis and Smith Point beaches, Nantucket. Comparison is made to the natural Folgers marsh barrier beach. In dune revegetation, fungal mycorrhizae, which cloak the roots of the grass, are essential acting symbiotically as “grass root hairs” to enhance nutrient and water uptake. Can better mycorrhizal strains improve development of the grass? This question is complex, one central restriction being that these mycorrhizae are absolute symbionts of the dune grass. The Cape American grass clones for revegetation were originally selected from Cape Cod, then propagated in farms in New Jersey (Smith Point dune) and in Delaware (Dionis dune). The Smith Point dune established 1985 using oceanic sand, lacked mycorrhizae. Revegetation plugs of dune grass with roots attached for Smith Point were purchased from a NJ farm and the Dionis plugs from Delaware. This study records optimization of recovery of mycorrhizal spores and comparative spore counts made by microscopic observation of *Gigaspora* and *Glomus* species from the three dunes. Spore surface sterilization followed by “clean” germination permits genomic study through DNA analysis based on recovery from germ tube nuclei. Clean spore germination also permits their pure culture on aseptically germinated grass clones. Studies with Siobhan McGurk, Janet Dillingham and Dorothy Klein.

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**THE IMPACT OF THE SECOND SEASONAL SPAWN ON THE NANTUCKET POPULATION OF THE NORTHERN BAY SCALLOP.**

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Nantucket has one of the last remaining commercial fisheries of the bay scallop*, Argopecten irradians,* which is based largely on natural settlement. Though previously thought to spawn only once in early summer at age one, individuals of the northern subspecies often spawn again in the late summer or fall. The resulting scallops are given the name “nubs” by Nantucketers. The second spawn allows nubs to survive and reproduce through a second summer, unlike the classic early-spawned scallops, which usually die before the second-summer spawning period begins. We formulated a mathematical model based upon five years of field and laboratory research in Nantucket Harbor, simulating both constant and variable environmental conditions. Under variable conditions, the presence of a second spawn increased the population growth rate almost 60% over that of a singly early-spawning life history. These results suggest that bay scallops use the second spawn as a “bet-hedging” strategy: by spreading reproduction over more than one spawning period in a season, the scallop increases its chances for success. This strategy appears to have sustained the Nantucket bay scallop population in spite of sometimes severe annual fluctuations, which have led to collapse in other locations. It is hoped that this model can serve as a predictor for the commercial harvest, and thus serve as an important management tool.

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**IS *MICROTUS BREWERI* A SEPARATE SPECIES?**

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The genus *Microtus* is composed of more than 60 rodent species widely distributed at mid latitudes in the northern hemisphere. *Microtus breweri*, the beach vole, found only on Muskeget Island, Nantucket, MA was identified as a separate species over 100 years ago by S.F. Baird. A series of investigations about the morphology, behavior, and physiology by Robert Tamarin’s group at Boston University in the 1970’s and 80’s suggested that *M*. *breweri* was indeed a separate species. However, the Natural Heritage program of Massachusetts believes that *M. breweri* is only a subspecies of *Microtus pennsylvanicus*, the meadow vole of Nantucket Island and mainland Massachusetts. *M. breweri* has not special protection from the state’s Natural Heritage program. To resolve this difference of opinion we trapped voles on Muskeget Island in June of 2015 and collected liver tissue for genetic analysis (All specimen were deposited in the Museum of Comparative Zoology at Harvard University). Following standard procedures (DNeasy Blood and Tissue Kit, PCR Purification Kit, Eton Bioscience for sequencing) 480bp cytochrome b sequences were obtained from 2 individuals from Nantucket and 10 from Muskeget. Comparison of our sequences with sequences of *M. pennsylvanicus* from GenBank suggests that there is insufficient genetic differentiation to warrant identifying the voles of Muskeget Island as separate species. Additional genetic data using next generation sequencing methods and additional rodent samples from Tuckernuck, Nantucket and coastal regions of Massachusetts will be needed resolve the species status of Muskeget’s voles.

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**HOW DO CROSS-ECOSYSTEM INTERACTIONS AFFECT NANTUCKET SALT MARSH CREEK BANK COMMUNITY STRUCTURE AND ECOSYSTEM FUNCTIONING?**

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 New England salt marshes are some of the most productive and important coastal ecosystems but they are currently under threat from human activities in adjacent terrestrial and marine habitats (e.g. eutrophication from terrestrial runoff and the removal of top predators). Recent experiments indicate that predators are likely key interactors along salt marsh creek banks but the identity and relative importance of common cross ecosystem predators are unknown and likely vary from marsh to marsh. Surveys in 2014 indicate that salt marshes of Nantucket host a diverse suite of predators including marine (e.g. green crabs, blue crabs, American eels, mummichogs) and terrestrial species, (e.g. shorebird predators such as Great Egrets, gulls, American Oystercatchers, Greater Yellowlegs, Willets, and Whimbrels). I used a combination of surveys, tethering experiments, and a manipulative field experiment to answer the following questions: (1) What are the most common predators of creek bank invertebrates in Nantucket salt marshes? and (2) What is the relative importance of shorebird and marine predators on the community structure and ecosystem functioning of Nantucket marshes? Preliminary results indicate that marine predators such as green crabs and blue crabs are likely keystone predators of marsh crabs, where bird predation is periodic. Ecosystem functions such as decomposition rate, net primary production, sedimentation rate, and recruitment also likely respond to predator manipulations. Determining the frequency and importance of cross ecosystem predators on creek bank processes will help understand how Nantucket salt marshes function and provision ecosystem services like erosion protection and nursery habitat availability.

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**UNUSAL PATTERNS OF ANT DIVERSITY ON TUCKERNUCK AND MUSKEGET**

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Ellison (2012) found unexpectedly high ant diversity on Nantucket Island (area 125 km2)– 59 species comprising about 50% of the species and 70% of the genera known in all of New England. Tuckernuck (3.6 km2) and Muskeget (1.2 km2), while much smaller in size, might also be expected to have relatively high species diversity for their areas. Using island biogeography theory, we predicted 16 to 33 species for Tuckernuck Island and 11 to 29 species for Muskget Island. We tested these predictions by sampling ants with pitfall traps, baits, hand collections and litter samples along ten transects on Tuckernuck and five transects on Muskeget. A total of 42 people-days of fieldwork were spread across four field trips in June, July, August and September of 2013. Among 3,935 specimens collected on Tuckernuck, we found 38 species, five species more than predicted. Five species found were not reported in Ellison’s synthesis of Nantucket’s ants. Among 16,621 specimens collected on Muskeget, we identified seven species, four species fewer than our predicted range. We conclude that area alone is insufficient to predict ant diversity on Nantucket, Tuckernuck and Muskeget. The higher than predicted diversity of ants for Tuckernuck may be due to a super saturation of species. The lower than predicted diversity of ants for Muskeget is likely because it is over-washed by the ocean and is moving at the rate of ½ mile a century creating a reduced number of habitats and its higher disturbance rates when compared to Nantucket and Tuckernuck.

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**USING GROUND PENETRATING RADAR TO MAP BURIED TRUNKS OF PROSTRATE-GROWING EASTERN RED CEDAR TREENS ON COSKATA/COATUE WILDLIFE REFUGE**

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We used Ground Penetrating Radar (GPR) transects, which is not disruptive to trees and substrate, to provide evidence of underground stems and roots of low-growing Eastern Red Cedars on the Coatue/Coskata Wildlife Refuge, located on Nantucket Island. This coastal Maritime Juniper Woodland/Shrubland, a critically imperiled natural community (S1), is the largest found in New England. These trees described as dwarf cedars, are better described as large, prostrate-growing trees buried by sand with exposed, upright-growing branches in this dynamic, coastal habitat. GPR using 200 MHz antennas was collected with traces every 0.05 to 0.25 meters to create profile images showing diffractions in the sand substrate. Interpretations of several profile images showed diffractions that are likely from trunks, branches or roots. Above ground tree dimensions were measured with one tree 16m long x 6m wide and only 1.75m tall. Exposed roots were observed growing north-northwest, toward shore, and above ground portions growing south-southeast, away from prevailing winds. Core samples of some branches were taken to determine ages of branches, and whether it was stem or root material, which differs morphologically. Ring counts from core samples taken on exposed trunks of the larger trees indicate ages of 60+ years, with severe stress signals in the rings.

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**VERTEBRATE SCAVENGERS ON NANTUCKET: A PILOT STUDY USING BAITED CAMERA TRAPS**

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Carrion resources and the scavenger community that feed on carrion in the United States are not well studied.  Both carrion availability and the abundance of mammalian scavengers have changed drastically in the last 150 years due to extinctions of exceedingly common species, such as the passenger pigeon, and a decrease in the abundance of large predators such as cougars.  These changes may have particular importance for conservation efforts concerning rare or endangered scavenger species as well as for understanding how non-native scavenger species may take advantage of this changed landscape.  Nantucket is a particularly interesting case study because the endangered American burying beetle (*Nicrophorus americanus*) has been reintroduced to the island and there are no typical mammalian scavenger species like raccoons and possums.  *N. americanus* depends on carcasses of small vertebrates for reproduction and is a direct competitor with mammal scavengers.  To understand what animals utilized carrion on Nantucket, we set 18 baited camera traps at nine sites over the course of four weeks during the summer of 2015.  Eastern towhees, white-tailed deer, and mice were the seen the most frequently.  Rats and other bird species could be locally very abundant.  Bait (small mice) lasted just over 3 days on average.

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**IDENTIFICATION OF THE BENTHIC CYANOBACTERIUM HYDROCOLEUM LYNGBYACEUA ON THE NANTUCKET ISLAND**

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A benthic, epiphytic cyanobacterium has been recently reported as invasive in temperate coastal beaches of the Nantucket Island, Massachusetts, USA, during late summer. Microscopic and molecular analyses were applied to identify the cyanobacterium and describe its phylogenetic position, and to characterize the microbial communities associated with it. The morphological observations in parallel with 16S rRNA and nifH gene community results suggest that the cyanobacterium is closely related to Hydrocoleum sp. (Oscillatoriales, Phormidiaceae), with the closest previously described relative Hydrocoleum lyngbyaceum, and appears to represent a unique strain. The genus is a ubiquitous benthic cyanobacterium in tropical and subtropical waters and coral reefs, where it is at times considered a nuisance, while these observations in North Atlantic temperate waters may represent an expansion of its habitat range. Amplicon sequencing targeting the nifH gene confirmed that the cyanobacterium is capable of fixing N2, and also hosts a relatively diverse community of nifH-gene containing bacteria typifying microbial mat diazotroph communities growing in association with it. Hydrocoleum was recently reported to be a potential producer of homoanatoxin-a, a neurotoxin, but genes for production of these toxins were not detected in the communities investigated in this study. Increasing sea surface temperatures in the North Atlantic Ocean may have contributed to expansion of Hydrocoleum sp. habitat range.

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**HARROWING & SEED ADDITION TO FACILITATE RESTORATION OF OVERGROWN SHRUBLAND TO SANDPLAIN GRASSLAND AND COASTAL HEATHLAND**

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Conservation of globally rare sandplain grassland and coastal heathland has been a top priority on Nantucket and nearby coastal areas. These communities provide crucial habitat for rare species, with much higher biodiversity than later-successional shrublands. Efforts on Nantucket have primarily focused on maintaining existing sandplain habitats with brush-cutting and fire. At the Middle Moors, efforts were also made to convert overgrown scrub oak shrubland back into sandplain grassland and coastal heathland. Repeated annual brush-cutting (1998-present) reduced shrub height, yet did not produce the desired shift to a grass/forb dominated system. Further research indicated that the soil seed bank lacked key grassland species, and that woody vegetation rapidly re-colonized small areas of soil disturbance. As the next step of grassland/heathland restoration, we examined native seed addition in combination with large-scale soil disturbance. This research examined the effectiveness of harrowing a three-acre block, with an adjacent un-harrowed control area (each area contained both seeded and unseeded vegetation plots). Diverse native species germinated from the seed bank following harrowing, and woody regrowth was slowed. Target grassland species appeared only in seeded plots, underscoring the lack of available seed bank in soils. Un-harrowed plots had very low germination of seeded species. Establishment of three rare species within the harrowed area demonstrated the usefulness of large-scale soil disturbance in triggering germination of rare species with high seed longevity. Analysis of vegetation composition following treatment indicated that harrowing + seeding accelerated the trend toward local “reference” sandplain grassland and heathland vegetation more than harrowing alone.

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**A SURVEY OF QUEEN ANNE’S LACE ON NANTUCKET AND AN ASSESSMENT OF ITS EFFECT ON NATIVE POLLINATION**

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Queen Anne’s Lace (*Daucus carota*, QAL) is a non-native plant species that was introduced to North America from Europe during the early colonial period, and its presence on Nantucket has been documented since at least the nineteenth century. Research in other plant systems have investigated whether native pollination was affected by the presence of a non-native, and the results have been mixed. Depending on the system a native may be negatively affected, may not be affected or may be positively affected. As yet, there has been no survey of QAL on Nantucket, and no study known to the authors has investigated the effect of QAL on a native species. In June and July 2015 a survey of QAL populations was performed on properties owned and managed by the Nantucket Conservation Foundation, Linda Loring Foundation and Nantucket Islands Land Bank, as well as other, public properties. Following this, a pollinator observation study was performed on QAL and a native species, Toothed White-top Aster (*Sericocarpus asteroides*, TWTA). Pollinators were observed for three hours per day and five days each for the 2 species individually and both species cohabitating together. Queen Anne’s Lace was found to be abundant across the island, with an average density of 12.2 plants/m2 and a high density of 109.4 plants/m2. While both plant species are generalist pollinated, QAL attracted 15 insect families and TWTA attracted only 8, the majority of each were flies and bees.

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**IS *LASIUS CF. NIGER* A NEW INVASIVE SPECIES OF ANT IN NEW ENGLAND?**

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Ellison et al.’s (2012) guide “Ants of New England” lists *Lasius cf. niger* as a distinct species from *Lasius neoniger* and as a non-native species in New England. It had only been identified by one sample collected by Pat Kearns at UMass Boston and identified by Stefan Cover at Harvard’s MCZ. However,in 2013 we found large numbers of *L. cf. niger,* especially in sand dune habitats, on both Tuckernuck and Muskeget islands in Nantucket sound. We hypothesized that either *L. cf. niger* is a new invasive ant of the Massachusetts or that it has been previously misidentified as *L. neoniger*. In 5 dune habitats on Nantucket Island we found that *L*. *cf. niger* was the most abundant species at every site. Additional hand sampling on the mainland coast found some sites with *L. neoniger* and some with *L. cf. niger*. Reexamination of specimens from previous collections on Nantucket indicates that ants identified as *L. neoniger* are correct. Additional morphological and genetic studies over broader geographic areas are needed to clarify the taxonomic status and rank of *L. cf. niger* and *L. neoniger* to ensure the stability of these sensitive dune habitats.

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**How do the Garter Snakes of Nantucket Compare to other Populations in Massachusetts: Ecology and Variability**

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*Thamnophis sirtalis* (Common Garter Snake) is ubiquitous throughout New England and inhabits a variety of habitat systems. We have used artificial cover objects to study snake communities from two islands in Nantucket Co. as well as Wachusett Mountain, Worcester Co. in central MA. We have developed standardized sampling techniques that can be implemented by students, interns, and volunteers. These long-term sampling stations have provided data on population trends and how environmental conditions affect our sampling. I am also working with colleagues at Bristol County Agricultural High School where some snakes are maintained in captivity to study their behavior and growth in standardized conditions. This research has resulted in documenting population-specific color pattern differences, life-history plasticity (size, age at maturity), sex ratios, habitat use, diet, growth, reproduction, and thermal biology. Data collected so far have shown that female snakes are significantly smaller on the islands of Nantucket and Tuckernuck compared to those from Wachusett Mountain, snakes from mainland populations are more likely to have continuous stripes compared to island snakes, which have broken stripes or stripes interrupted by dark blotches, and there is a strong female bias within the population on Nantucket compared to those at Wachusett Mountain.

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**CLIMATE AND CHANGING WINTER DISTRBUTION OF ALCIDS IN THE NORTHWEST ATLANTIC**

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Population level impacts upon seabirds from changing climate are increasingly evident, and include effects on phenology, migration, dispersal, annual survivorship and reproduction.  Most population data on seabirds derive from nesting colonies; documented climate impacts on winter ecology are scarce.  We studied interannual variability in winter abundance of six species of alcids (Charadriiformes, Alcidae) from a 59-year time series of data collected in Massachusetts 1954-2011.  We used counts of birds taken during fall and winter from coastal vantage points. Counts were made by amateur birders, but coverage was consistent in timing and location.  We found significant association between winter abundance of all six species of alcids and climate, indexed by NAO, at two temporal scales.  The two temporal scales were 1.)  Significant linear trends at the 59-year scale of the time series; and 2.)   Shorter term fluctuations corresponding to the 5-8 year periodicity of NAO.  Thus, variation in winter abundance of all six species of alcids was significantly related to the combined short-term and longer-term components of variation in NAO.  Two low-Arctic species (Atlantic Puffin and Black Guillemot) peaked during NAO positive years, while two high Arctic species (Dovekie and Thick-billed Murre) peaked during NAO negative years.  For Common Murree and Razorbills, southward shifts in winter distribution have been accompanied by southward expansion of breeding range, and increase within the core of the range.  The proximate mechanism governing these changes is unclear, but, as for most other species of seabirds whose distribution have changed with climate, seems likely to be through their prey.

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