NEBC Conference Poster Presentations

It's all in the timing: Answering short term research questions while establishing a long-term phenology study

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Abstract: Phenology offers insights into species' response to climate change. Shifts in phenology can disrupt ecological processes including: exposure to spring frost, availability of leaves for herbivorous insects, increase risk of seed predation, plant-pollinator interactions and seed production. Nantucket Island, Massachusetts is host to unique species assemblages including coastal shrubland, heathland, and the globally rare sandplain grassland communities. Species-specific responses to climate changes could result in alterations to these rare habitats. In establishing a long-term phenological research program at the Linda Loring Nature Foundation, we focus on native shrubs characteristic of these plant communities. While we recognize the benefits of a long-term data-set, we begin by asking short-term research questions to 1) justify the expense and labor to our funding agencies, board of directors, and constituents, 2) offer educational opportunities to our community, and 3) provide a base for student research projects. To accomplish these goals, we established eight plots across our study site with multiple individuals of each of our 10 study species present. In addition to recording phenological observations 2-3 times per week, loggers record hourly temperature at each plot location. Initial questions include: What are the main phenophases of the 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? At the early stages of this phenology program, we have been able to identify the main phenophases of 10 of our common, native shrubs characteristic of the Nantucket coastal heathland communities. Among our plots, even slight variations in topography have resulted in temperature differences of up to 10°C. These temperature differences have had species-specific effects; some shrubs show more synchronous annual bud burst regardless of within-season temperature variation (*Morella caroliniensis*, for example). Other species, such as *Gaylusaccia baccata*, show asynchronous bud burst spanning a 10-day period with leaf-out highly correlated with minimum spring temperatures. These preliminary results provide a base for a long-term research program. Additional years of data will help illustrate potential plant species' responses to changing temperatures. Differential climate sensitivities have implications for the assemblages of shrub communities in these threatened systems with predicted warmer temperatures. If future communities leaf out and/or flower in novel assemblages, pollinator-mediated interactions may be altered and plant reproductive performance could be impacted.

The Conservator - A modern flora for Martha's Vineyard

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Abstract: In 2002 the Polly Hill Arboretum in West Tisbury, MA received their first herbarium collections and set out to document the flora of Martha's Vineyard. Today, working with Island land conservationists, the Arboretum houses nearly 3,000 specimens with plans to build a new education center and botany lab in September, 2015.

Nietzsche was right: Multiple cycles of drought training strengthens *Phaseolus vulgaris* L. tolerance to drought stress

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Abstract: Common beans (*Phaseolus vulgaris*), including kidney beans, are a major crop in Africa. However, drought is a large threat to bean crops, especially in developing countries. Greater than sixty percent of bean crops will be negatively affected by drought at some point in their development. An important question is: Can a novel approach to drought training plants using multiple controlled cycles of dehydration and recovery result in plants that have greater tolerance to extreme drought stress? In this study, it was hypothesized that multiple training cycles (ranging from 1 – 4 cycles) of moderate drought (soil moisture 20%) followed by rehydration recovery (soil moisture 50-60%) and maintenance (soil moisture 40-50%) will improve the red kidney bean (*Phaseolus vulgaris* L.) plant's ability to withstand subsequent extreme drought stress (soil moisture 10%). Four experimental groups of bean plants (groups B, C, D and E) were subjected to varying numbers of drought training cycles (1, 2, 3 and 4 cycles, respectively) followed by extreme drought stress, and then four dependent variables (height, leaf area, bean pod yield and stomatal density) were compared to those of a control group (group A). Each additional cycle of drought training was associated with increasingly greater values in all four variables. Average height for groups A, B, C, D and E were as follows: 37.2 cm, 41 cm, 43.2 cm, 43.6 cm, and 47.8 cm, respectively. Average total leaf area was: 390 cm^2, 450 cm^2, 511 cm^2, 525 cm^2 and 541 cm^2, respectively. Total bean pod yield was: 8, 10, 13, 13 and 17, respectively. Average stomatal density was: 433/cm^2, 661/cm^2, 689/cm^2, 1023/cm^2 and 1093/cm^2, respectively. A one-way analysis of variance (ANOVA) test comparing stomatal density among the five plant groups found $p < 0.0001$ and $F = 62.38$. Drought-trained bean plants showed substantial evidence of increased tolerance to drought stress. Plant height, leaf area, bean pod yield and stomatal density improved with each additional drought training cycle. These results may have potential implications for increasing crop yield in drought-stricken countries.

A new population of *Triphora trianthophora* (Orchidaceae) in western Massachusetts

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Abstract: In August 2014, I discovered a new population of approximately 1200 flowering stems of the rare and endangered three-birds orchid, *Triphora trianthophora*, in Williamstown, Massachusetts. Plants were found in deep litter trapped in the pits of old tip-up mounds and an abandoned woods road running cross-slope through the population. The present forest composition and inferred land use history suggest a novel suite of disturbances which created the requisite habitat, and even possibly through which the orchid persevered. The poster will describe the novel stand composition, including important discrepancies with other known occurrences and the strong evidence of repeated and intensive natural and anthropogenic disturbances, namely wind-throw and timber harvest.

Are *Achillea millefolium* and *Hypercium perforatum* locally adapted to serpentine and granite outcrops on Deer Isle, Maine? A greenhouse study on ecotypic differentiation of two common herbaceous plants

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Abstract: Changing environmental conditions influence the survival and reproductive fitness of locally adapted species because their site-specific adaptations can lead to habitat specialization. Long-term selection on certain morphological and physiological traits associated with local habitat conditions can give rise to the evolution of ecotypes. This study explores the relative effects of lithology and genetic differences on reproductive fitness and timing of fall and spring phenology for *Achillea millefolium* (yarrow) and *Hypericum perforatum* (St. John's wort) populations found on serpentine and granite outcrops on Deer Isle, Maine. Seeds were collected from ten mother plants of similar age and health from comparable microhabitats at both sites. To test effects of substrate on reproductive fitness and ecotypic differentiation, a reciprocal transplant experiment is currently being conducted in a Conviron growth chamber using field-collected soils. Data on individual plant attributes such as germination, growth rates, above- and below-ground biomass, survival, phenology, and reproductive fitness are being collected. The experiment also investigates the edaphic-climatic influences on plant phenology (leaf drop in the fall, leaf-out and flowering in the spring-summer) of these populations at the two sites. Researchers and six citizen scientists tagged and monitored leaf drop and leaf color change in Fall 2014 and monitored leaf-out and flowering times in Spring 2015. Microchip temperature loggers (iButtons) were installed to record differences in temperature between the serpentine and granite outcrops. Outcomes of this study include evidence for possible local adaptation of *A. millefolium* and *H. perforatum* to granite and serpentine soils in a greenhouse setting and possible evidence of flowering time differences between these species at the serpentine and granite sites. Our findings are important to better understand the mechanisms that promote evolutionary change and assess how special edaphic floras may respond to future changes in climate.

Effects of multiple interactive global change factors on the introduced common reed, *Phragmites australis*

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Abstract: Multiple interacting global change factors such as elevated CO_2, nitrogen, and sea level rise modify the growth of plant species in different ways, and consequently, alter ecosystem function. These global change factors can induce species shifts and enhance the productivity of native or introduced species. An introduced lineage of the common reed, *Phragmites australis*, was introduced from Eurasia and invades wetland habitats spanning the North American Atlantic Coast. Both nitrogen pollution and elevated CO_2 are known to facilitate the spread of the invasive reed, however, little information exists on how these global change factors will interact with sea level rise. Our objective was to determine how nitrogen pollution, elevated atmospheric CO_2, and relative sea level interact to affect *P. australis* productivity in the current and near future environments. To evaluate this, a mesocosm experiment was conducted in a brackish estuary on the Rhode River of Chesapeake Bay, at the Smithsonian

Environmental Research Center's Global Change Environmental Research Wetland. Six marsh organs, each consisting of six different sea level treatments were distributed across six open top chambers with either ambient or elevated levels of CO_2. Half of the replicates received nitrogen treatment while half did not. Aboveground productivity was estimated each month between June 2010 and September 2010 with a destructive harvest in October. We report a differential response among a multitude of these interacting global change factors including significant treatment effects in the sea level rise by nitrogen by elevated CO_2 plots. Nitrogen pollution by ambient atmospheric CO_2 treatments increased aboveground productivity the greatest under high levels of inundation. The data supports a hierarchical response to global change factors, with sea level, nitrogen and CO_2, and suggests that steady increases in global change factors may aid *P. australis*' survival.

Research in Progress: Documenting the serpentine biota of Massachusetts

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Abstract: During the summer of 2015 we will conduct floristic and ecological surveys on several outcrops of serpentinite bedrock in western Massachusetts. Serpentinite outcrops and the soils weathered from them (both of which are commonly called "serpentine") present a number of unique edaphic challenges to the plants and other organisms that live on them, due to a low Ca:Mg ratio, deficits in other essential nutrients, high heavy metals, and poor soil development relative to neighboring lithologies. Although the biota of serpentine outcrops has been studied extensively in the western United States, and some research has been conducted on serpentine sites in Maine, Vermont, Newfoundland, and Quebec, we can find published data on only one serpentine outcrop in Massachusetts, in the northeastern portion of the state. Such research is urgently needed; because serpentinite bedrock is rare in the state and has not been studied floristically, it is currently considered to host a critically imperiled (S1) plant community. The research we are conducting will help to close this gap in our knowledge of the geoecology of northeastern North America by addressing the following major questions: (a) do individual Massachusetts serpentine outcrops support a biota distinct from that of nearby non-serpentine areas; (b) is there a recognizable "serpentine biota" in Massachusetts across multiple serpentine sites; (c) can changes in the diversity and density of species along a serpentine to non-serpentine gradient be correlated to features of soil chemistry; (d) do any plants on Massachusetts serpentine outcrops accumulate elevated quantities of nickel; and (e) does serpentine bedrock exert any influence on lichen secondary metabolites? In this poster, we present the progress we have made thus far in selecting field sites using bedrock geologic maps, aerial photography, and GIS. We also outline the methods that we will use to assess the diversity and rock/soil preferences of plants and lichens at these sites. We hope that presenting these methods at this early stage will encourage critiques that can improve the project before the intensive field season begins.

Do pollinators care about petal number? Comparing petal number variation in outcrossing and selfing species of *Phlox*

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Abstract: Many angiosperm lineages especially in the eudicots have become mostly fixed on pentamerism (five petals). Botanical field guides organized by petal number highlight this fact by devoting a large portion of the book to five-petaled flowers. Historically, the notion was that the reduction and fixation of petal number during the evolution of angiosperms was a result of adaptation to selection by pollinators.

However, this has been poorly tested and it is unclear whether there is strong selection on petal number or whether pollinators have an innate preference for five-petaled flowers. Species in the genus *Phlox* (Polemoniaceae), while primarily pentamerous, have low levels of natural variation in petal number. We quantified this variation in natural populations of *Phlox drummondii*, an outcrosser, and a close relative, *Phlox cuspidata*, which is primarily self-pollinated, setting fruits autogamously. We found no difference in the amount of variation for petal number between the two species. Given that the autogamous species did not appear to have more natural variation in petal number, despite a presumed release from selective forces enacted by pollinators, this suggests that selection by pollinators does not play a role in maintaining petal number constancy in *Phlox*. However, natural populations varied in the amount and direction of petal number variation. Here, we present results of a common environment greenhouse experiment to elucidate whether those differences between natural populations are maintained in a second generation indicating a genetic basis and divergence between populations. We also present the results of several generations of selection in *Phlox drummondii* on increased petal number, decreased petal number, and constancy in petal number in which we find that there is considerable heritable and selectable variation for increased and decreased petal number, but that selection for constancy in petal number seems to be difficult. Our work is the first in many years to attempt to address whether or not the ubiquitous nature of pentamery throughout the eudicot clade is maintained via selection by pollinators. In an era of declining pollinators and burgeoning research on the evolution of angiosperms, it is crucial to understand the link between pollinator preference and selection on floral form and function.

Patterns and changes in the nonnative flora of Worcester County, Massachusetts

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Abstract: The influence of non-native species on the integrity of local ecosystems is a major concern. Non-native species often impose high costs for management or eradication, and their introduction and establishment may cause major ecosystem disruption through increased competition with native species, altered nutrient cycles, and facilitation of pests and disease. Better data on the patterns and extent of establishment of non-native species will allow better assessment of the threats they pose to local ecosystems. Because many biological processes and effects of non-native species are site-specific, examination of patterns of invasion in different regions is important. Few comprehensive studies have been conducted on the changes in regional abundance of non-native plants in North America. The availability and reliability of historical and current data for the flora of Worcester County, Massachusetts, allowed a detailed investigation into the trends of non-native vascular plants in this region. Using data from floristic surveys conducted from 1930-1950 and 1980-2000, we found that non-native species richness was most strongly correlated with the percentage of land in residential use, and was also positively associated with human population density and extent of commercial and urban open land. Non-native species richness was negatively correlated with elevation and extent of natural vegetation (mostly forest). Established, non-native species comprised 21%-36% of all species present in the county's 60 townships. Most non-native species increased in frequency between the two sampling periods, although a few declined or disappeared. Increasing and decreasing species differed in several characteristics. Decreasing species were recorded earlier in the region, were more likely to be of European origin, and included more agricultural weeds and species of herbal and culinary use. Increasing species were more likely to be recent introductions, of Asian or North American origin, and associated with ornamental use. This research documents the influence of anthropogenic landscape modification in favoring the proliferation of non-native species. The data suggest that minimizing the residential footprint and increasing scrutiny of the invasive potential of ornamental plants are critical steps in combating the spread of non-native plants.

Vascular plants observed since 2006 during botany club investigations at retired cranberry bogs, Coonamessett River, Falmouth, Massachusetts

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Abstract: Successional changes in the vegetative community on recently retired cranberry bogs are being investigated by Botanical Club of Cape Cod and the Islands (BCCCI) members. Site visits were initiated in 2006 and have continued on a regular basis through spring 2015. Our searches have been carried out on Town of Falmouth conservation land prior to the planned restoration of the stream channel and adjacent cranberry beds on the lower Coonamessett River. Species diversity on the retired beds is being managed through the removal of invasive species, primarily an aggressive introduced exotic gray willow (*Salix atrocinerea*). We expect that specimens of native shrubs including leatherleaf, inkberry, winterberry, northern arrowwood, black elderberry, and chokeberry, with American holly, tupelo, and selected red maple trees, will be salvaged and relocated within the site and serve as planting sources for the restoration. Seeds in the seed bank will reestablish the herbaceous cover. Our investigations provide a baseline inventory for directing the restoration efforts. To date, we have observed about 170 higher vascular plant taxa in the river channel and reservoir pond, on banks and the cranberry platform, and in the immediate surrounding upland. Approximately 80% are native to Barnstable County, 75% are herbaceous, and 20% are woody shrubs and trees. Four permanent photo stations were established in 2013 to photo-document changes in the vegetation.

Comparison of several relocation techniques and success rates for Wild Lupine (*Lupinus perennis*) and Birds Foot Violet (*Viola pedata*) in Nashua, NH.

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Abstract: Sandplain habitats in New Hampshire are a relatively uncommon natural community, and as such, several plant species associated with these environs are listed as rare species in the State. Extensive populations of two of these species, wild lupine (*Lupinus perennis*) (5,000± plants) and bird's foot violet (*Viola pedata*) (10,000± plants), were located partially within an area of proposed impact associated with the reconstruction of the runway at Boire Field, a small airport in Nashua, NH. Little has been published on the success rates of various transplantation methods for either species; therefore, as part of our ecological surveys and permitting for this project, we implemented several relocation techniques of these species, part of a comprehensive mitigation package. Our primary means of relocation was direct transplantation, relocating 3,562 violet ramets and 957 lupine genets to suitable habitat outside of the construction zones. These transplants were monitored for three growing seasons with a combined success rate for these two species of 76.2% (62.7-103.4%) for the violet and 108.4% for the lupine. In addition to direct transplantation of individual plants, we also saved and re-used topsoil from impacted populations of bird's foot violet as top cover and evaluated the degree of successful regrowth in these areas from latent root and seed stock.

Mycoremediation in the face of anthropogenic environmental damage

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Abstract: Mine tailings, a major source of concern in conservation biology, produce chemical imbalances and generate toxic edaphic and hydrologic conditions, disrupting the establishment and survival of local organisms. Ecologically and economically sound, mycoremediation offers unique prospects for addressing widespread ecological damage in mine settings. Mushrooms are bioremediators: They break down recalcitrant chemical contaminants, sequester heavy metals, bind toxic metals in the soil, and stimulate microbial metabolism and decomposition, thus promoting vital ecosystem processes in degraded ecosystems. By investigating the potential benefits of *Pleurotus ostreatus* (oyster mushroom) for modifying contaminated soil from the Callahan Mine, a superfund site in Brooksville, Maine, we are exploring the unique intersection of fungi and conservation biology. We propose amending Callahan Mine soil with mycelium and organic matter to observe the impact of these additions on plant survivability and vigor as a measure of ecosystem health.

The New England Vascular Plants Project: 200,000 specimens digitized and counting

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Abstract: The New England Vascular Plants Project is a multi-institutional collaborative project seeking to digitize all New England herbarium records and specimens. The Harvard University Herbaria (HUH) houses the largest collection of New England specimens in the region, with an estimated 500,000 specimens, and has spearheaded digitization efforts with a unique workflow and methodology. Efforts at the HUH have been divided into three stages. During the pre-capture phase, completed in 2013 by a two-person team, specimen folders were outfitted with customized QR codes to maximize data input efficiency. During the primary digitization phase, specimens are imaged and data is captured for essential fields including collector, collection date, and locality. Secondary digitization will focus on further data capture using the images and focusing on habitat, phenology, and enhanced georeferencing. Two conveyor belt imaging stations have been installed at the HUH, and have been in continuous use since November of 2013. Currently, the databasing team is comprised of four full-time and one part-time staff member. To date, nearly 200,000 herbarium specimens and collection records have been imaged and databased, nearly 80% of which belong to the New England Botanical Club. The preliminary data has already been used to develop lines of research dealing with a number of botanical and ecological topics, including changes in range and distribution of New England flora, georeferenced non-native plant invasions, and shifts in phenological timing.

Digitizing the Brown University Herbarium collections

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Abstract: The Brown University Herbarium dates to 1869 when local businessman Stephen Thayer Olney donated his plant collection to the University. The herbarium includes Olney's extensive collection of *Carex*, in addition to a survey of Rhode Island flora from the 19th century. It is also rich in plants from the western and southern parts of North America from the golden age of natural history exploration. There are also specimens from Mexico, Cuba, Colombia, South Africa, India, New Zealand, Australia, and various countries in Europe. The collection now includes around 100,000 specimens of plants, fungi, mosses, lichens, and algae. Funding from the National Science Foundation has made it possible to start digitizing the herbarium, and a team of Brown undergraduate students has recorded data from around 26,000 specimens over the past year and half. This dataset will be combined with records from other herbaria in New England and can be used to tract the effects of climate change on plant phenology and other physiological processes. Herbarium specimens also provide data for studies related to plant evolutionary history, plant distributions, and the spread of invasive species.

Bud development: Comparing pentamerous to hexamerous flowers in *Phlox drummondii*

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Abstract: The stage of maturation and development of flower buds determines the orientation of petals, sepals, stamens, and carpels. Although flowers of species *Phlox drummondii* are pentamerous (five-petaled), there are occasional cases of hexamerous (six-petaled) flowers. These flowers are moderately rare, but they are not random; they have a partial genetic basis. We studied how the development of six-petaled flowers differs from five-petaled flowers to gain a better understanding of the nature of these anomalies. We aimed to compare the sizes and diameters of five and six-petaled flower buds early in development, and we also wanted to compare the floral meristem size within plants that produce many six-petaled flowers to plants that are strictly (or mostly) pentamerous. After two rounds of selection for higher petal number, most plants had a 20-40% relative frequency for six-petaled flowers. However, of the buds we collected, only a few were six-petaled, and we did not gather sufficient evidence to fully understand whether meristem size contributed to the development of six-petaled flowers. Although no conclusions can be made, the few hexamerous buds provide valuable information. There are no notable differences in sizes of these buds when compared to pentamerous buds. Bud position and age seem to have a greater impact on size than merism. For example, terminal buds are always larger than other buds in the inflorescence regardless of the number of petals. We also looked at buds of many sizes to determine the stages in which flower organs emerge and how these flower organs develop. Our observations show that sepals emerge with spiral phyllotaxy in *Phlox drummondii*; each sepal develops at a different time, which causes asymmetry in the early bud stages. In addition, we learned that within developing buds of *Phlox drummondii*, the stamens and sepals emerge first from the meristem cells, and petals and carpels form after. Sepals can be clearly identified under the microscope, but petals appear as small stubs until later in development. Our work has led to a better understanding of bud development and meristem differentiation in *Phlox drummondii*. Further research on hexamerous buds may support or reject our original hypothesis regarding six-petaled flowers, but we know that meristem differentiation for six petals occurs at a very early stage. These findings are critical to the understanding of how buds emerge in both normal and abnormal flowers.

Morphological and molecular identification of a new species of *Truncospora* (Polyporales, Basidiomycota) in North America

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Abstract: A new polypore, *Truncospora microspora*, is described based on a combination of molecular and morphological data. The phylogenetic analysis shows that four specimens from Wisconsin, USA form a monophyletic group based on molecular data of nuclear internal transcribed spacer regions (nucITS). The translation elongation factor 1-α coding gene (tef1-α) sequence data further confirmed that the new taxon forms a monophyletic lineage (100% BS, 96% BP, 1.00 BPP) and groups with *T. ohiensis* and *T. arizonica*. *Truncospora microspora* is characterized by an annual habit, pileate basidiocarps with a white pileus and pore surface, a dimitic hyphal system with slightly dextrinoid to non-dextrinoid, strongly cyanophilous skeletal hyphae and ellipsoid, truncate, slightly thick-walled, strongly dextrinoid basidiospores (9–11 x 6–7.5 µm).