Sanford Farm and Ram Pasture Property Monitoring:

Comparing the effects of long-term annual mowing and prescribed fire management techniques on the presence of desirable Sandplain Grassland and Sandplain Heathland plants at Sanford Farm and Ram Pasture

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Introduction

In 2012, the Nantucket Conservation Foundation (NCF) Science and Stewardship Staff began implementing the Property Conservation Management Plan approved by the NCF Board in 2011 for the Sanford Farm, Ram Pasture and the Woods properties.

Portions of these properties have been historically managed through a combination of grazing and farming prior to NCF acquisition, and more recently with prescribed fire and mowing conducted by NCF. The cumulative effect of these land use practices over time has promoted the establishment and maintenance of rare Sandplain grassland and heathland habitats. Areas of these properties that have not been managed within the last several decades have succeeded to dense coastal shrublands.

One of the Ecological Stresses identified by the Property Conservation Management Plan (Ecological Stress 2) emphasizes the ecological impacts of altering or decreasing management activities in these areas:

> *The cessation of agricultural activities (primarily sheep grazing and dairy farming) that took place in many areas of the Sanford Farm, Ram Pasture and the Woods properties prior to Foundation ownership has promoted the establishment and increased cover of woody, mid-successional shrub species such as huckleberry, scrub oak, high bush blueberry, northern arrowwood, and bayberry. This increase in shrubs has resulted in a decrease in open, early successional Sandplain grassland habitat in upland portions of the property that have not been treated with regular management such as prescribed fire and/or mowing. A number of plant species of conservation concern (see Appendix 7) are associated with these rare habitats, and increases in shrub cover have reduced available habitat for these species. Furthermore, many of the species found in Nantucket's shrublands, including huckleberry, scrub oak and bayberry, contain high concentrations of volatile oils in their leaves and stems. Increased cover of these highly flammable shrubs has resulted in increased wildfire and associated public safety risks. Management recommendations for both achieving Sandplain grassland restoration and management goals and mitigating wildland fire public safety risks on Foundation-owned properties are currently under development.* ***This ecological stress ranked as "high."***

One step towards addressing this issue is to examine current management activities on these properties and assess how effective these practices are at maintaining and promoting early successional plant communities. Management Objective 5 in the Conservation Management Plan outlined the following actions to guide this assessment:

Management Objective 5:

Continue to develop, implement, and monitor the effectiveness of management strategies aimed at restoring and perpetuating early successional Sandplain grassland and heathland habitats on the property in order to maintain and preferably increase populations of species of conservation concern.

Develop a vegetation and/or photo monitoring protocol to detect community-level changes in functional groups (collections of similar species, such as grasses, shrubs, trees, etc.) and monitor trends in key species that occur in response to management. Incorporate methods and results from similar efforts currently underway on other Foundation properties. Ensure that the methodology employed is time-efficient and replicable over multiple years. Collect data every 3-5 years and evaluate results in order to determine if sandplain communities are being maintained.

To address this Management Objective, the Science and Stewardship Department established vegetation monitoring transects within Sandplain grassland and heathland habitats at Sanford Farm and Ram Pasture in 2012.

Since NCF acquired the property in 1985, open areas in Sanford Farm and in Ram Pasture have been consistently managed using dormant season mowing, prescribed fire and a combination of these practices. However, each of these two areas have been managed in distinctly different ways.

The Foundation utilizes prescribed fire and dormant season mowing to promote Sandplain grassland and heathland vegetation communities. Open areas in Sanford Farm have been managed using annual dormant season mowing since 1985 (27 years) with occasional prescribed fire in 1987 – 1995 (Figure 1). The majority of Ram Pasture has only been managed through prescribed fire with mowing occurring rarely in a few small areas (Figure 2). Overall, the most recent and consistent management on these properties has been prescribed fire in Ram Pasture and annual dormant season mowing in Sanford Farm.

Detailed records of the past management conducted on these two properties provide an ideal opportunity to compare the long-term influence of dormant season mowing and prescribed fire on vegetation community composition. Therefore, transects were established in Sanford Farm and Ram Pasture to allow for the direct comparison of present vegetation community composition within two areas with distinctly different management regimes. This comparison will help NCF Science and Properties Maintenance staff gain a better understanding of the ecological implications of using predominantly annual mowing vs. prescribed fire management and allow us to adapt future management to improve our success in maintain and promote rare Sandplain grassland and heathland vegetation communities.

Methods

In 2012, we established vegetation monitoring transects at Sanford Farm (n=17) (Figure 1) and Ram Pasture (n=15) (Figure 2). Using the Geospatial Modeling Environment in ArcGIS, we randomly selected transect starting locations within managed grassland and heathland habitats. These start locations were located in the field using a Trimble GPS unit. From the starting location, we laid a 50m measure tape in a pre-determined direction to locate the transect end locations. All transects are 50m in length and start and end locations were permanently marked using cut rebar buried at ground level so that it does not interfere with future mowing management but can be re-located using a metal detector.

We sampled plant species encountered along the transect length. At each meter mark along the transect line (including 50m), a thin dowel was lowered to the ground immediately adjacent and perpendicular to the meter tape. We recorded each plant touching the sampling dowel at that meter mark, with individual species only being recorded once at each meter mark. Using this method, individual plant species are recorded as they occurred at 50 points along each transect.

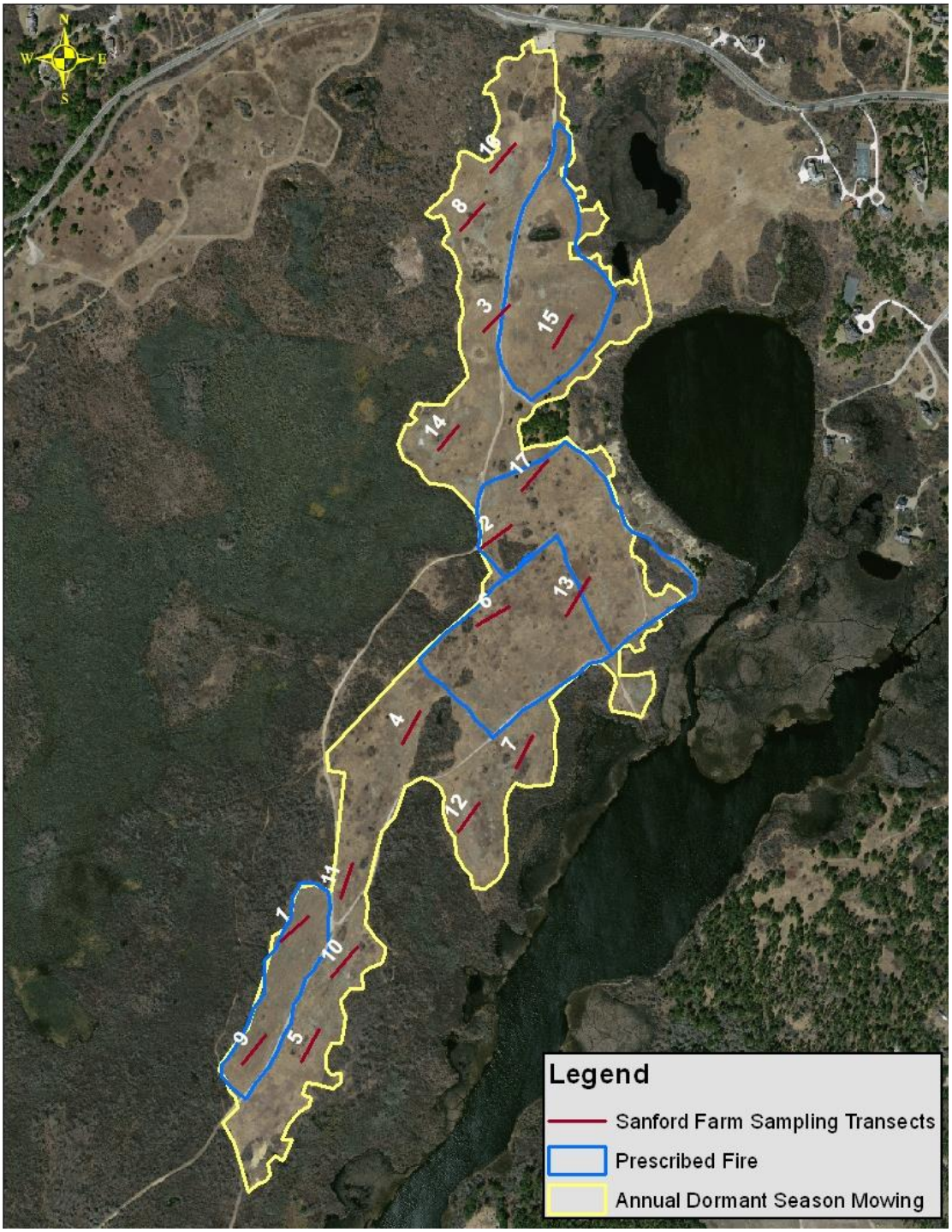

Figure 1: Sampling Transects and Managed Areas in Sanford Farm

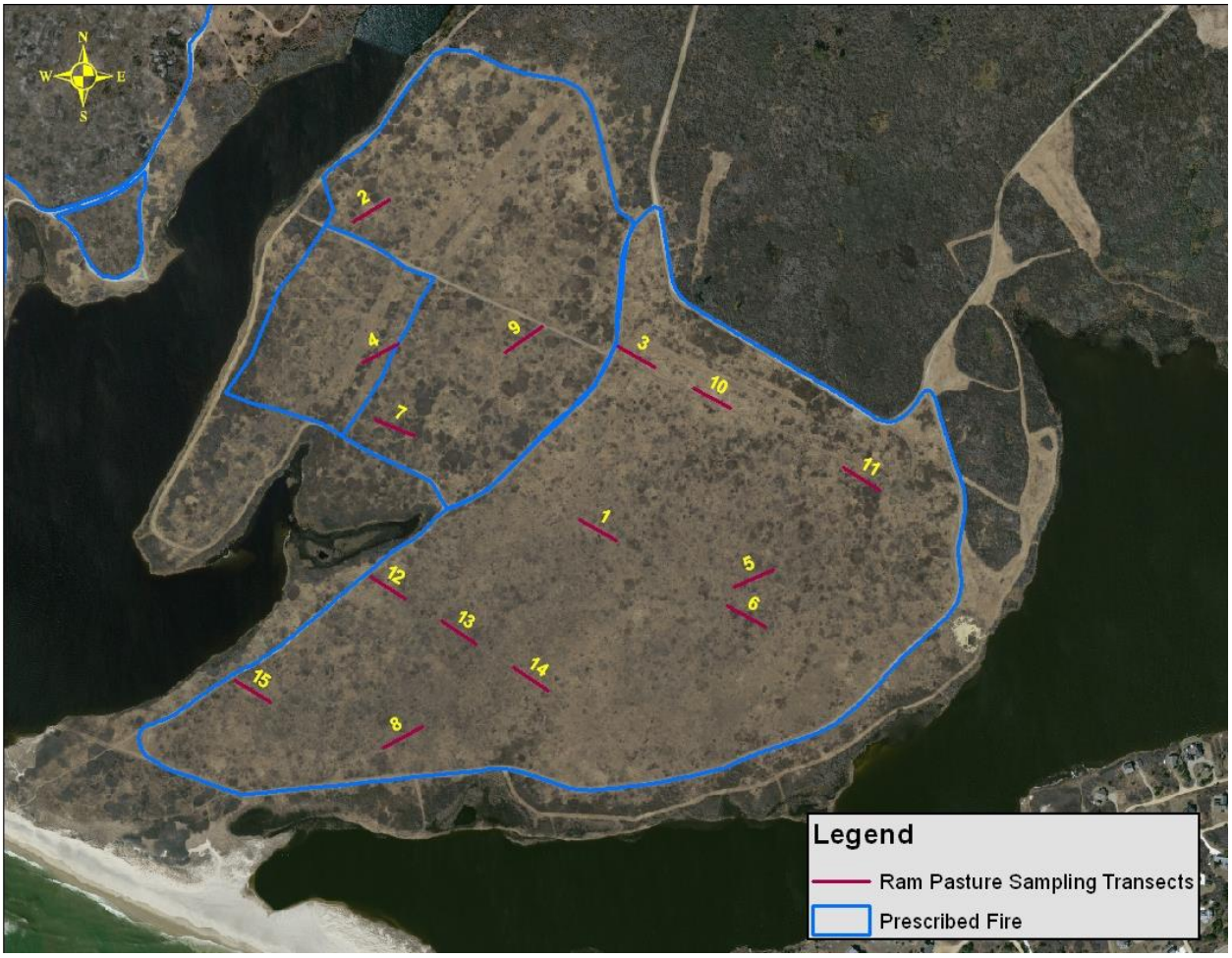

Figure 2: Sampling Transects and Management Areas in Ram Pasture.

Data Analysis

Using plant species data collected and information about previous management and other environmental characteristics, we were able to examine how management practices might be influencing the plants we observed in each area.

Non-metric Multidimensional Scaling Analysis (nMDS) is a graphical tool, allowing us to examine similarities between locations using a large dataset and examining the influence of environmental conditions (soil type, number of times burned, etc.) on plant species. We examined differences in the species detected during sampling in each area using a perMANOVA test, a multivariate analysis of variation based on permutations, which does not require normalcy in multivariate data (R.). Finally, we conducted an Indicator Species Analysis (ISA) to examine the significant association of individual species within particular sampling locations (R). ISA calculated values are a function of a species relative abundance (how common or rare a species is in relation to other sampled species) and relative frequency (the number of times a species is encountered during sampling) within a sampling location.

Results and Discussion

Using a statistical ordination technique called nMDS, we were able to plot the sampled transects to visually assess how similar each of them were based on vegetation composition. In Figure 3, each red + represents an individual transect, and these are arranged on the graph according to how similar the plants are on each transect. The sampled transects segregated very definitely by location, with transects in Ram Pasture on one side of the graph and transects from Sanford Farm on the other. This indicates that the Ram Pasture transects have very similar plant species and the Sanford Farm transects have very similar species, with little overlap. This agrees with the perMANOVA results, which indicated a strong statistical difference in plant species between Ram Pasture and Sanford Farm ($p<0.0009$) (Table 1).

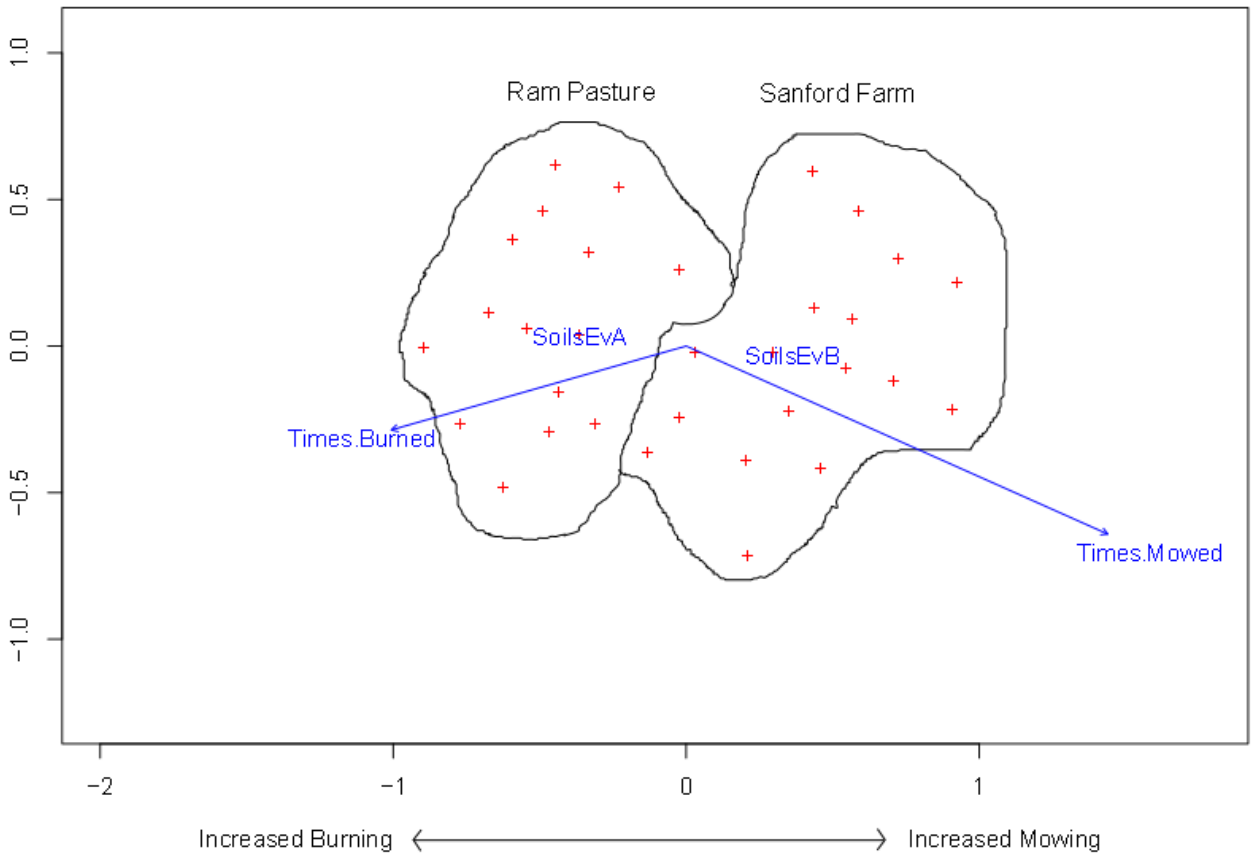

Figure 3: Graphical Results of the nMDS analysis. The red + represent the sampling transects. Text in blue represents the environmental conditions significantly influencing species observed on each transect.

Table 1: Results from the perMANOVA statistical test.

	Degrees of Freedom	Sum of Squares	Mean Squares	F. Model	R^2	Pf (>F)
Location	1	1.3999	1.3993	11.599	0.27883	**0.000999**
Species	30	3.6208	0.12069		0.72117	
Total	31	5.0208			1.000	

In addition to the plant species located on each transect, we also analyzed a suite of environmental characteristics that might be driving the observed differences between areas: Number of Times Mowed, Number of Times Burned, Soil Type, Last Year Burned, Last Year Mowed, Distance from Ocean, and Overall Management. As seen in Figure 3, three environmental factors strongly influenced which plants were found in Ram Pasture vs. Sanford Farm. The history of management on these sites, particularly the number of times a site has been burned (r^2=0.3472, p< 0.001) and more importantly, the number of times a site has been mowed (r^2=0.7868, p< 0.001) have an influence on the plants observed. Sites in Sanford Farm have been more consistently mown over a longer period of time than sites in Ram Pasture. The other environmental factor that may be influencing plant composition is the soil type. Ram Pasture and Sanford Farm each have slightly different soil types, which was significantly correlated with the plant species seen in each site (r^2=0.344, p< 0.001). Ram Pasture is predominantly underlain by Evesboro sand A (0-3% slope) while Sanford Farm is underlain by Evesboro sand B (3-8% slope).

These two soil types belong to the Evesboro Association with soils tending to be nearly level to gently sloping, excessively drained and sandy formed in outwash deposits. These two soil types are mostly distinguished by their slope, with more topography occurring in Sanford Farm and Ram Pasture being almost consistently flat. The influence of soil type on the plants we observed in each area may not be related to actual soil composition but to other environmental characters influenced by slope – e.g., the amount of sun and solar heating, soil nutrient composition and hydrology. These are factors that we can explore further in future research by studying the soil present in these areas.

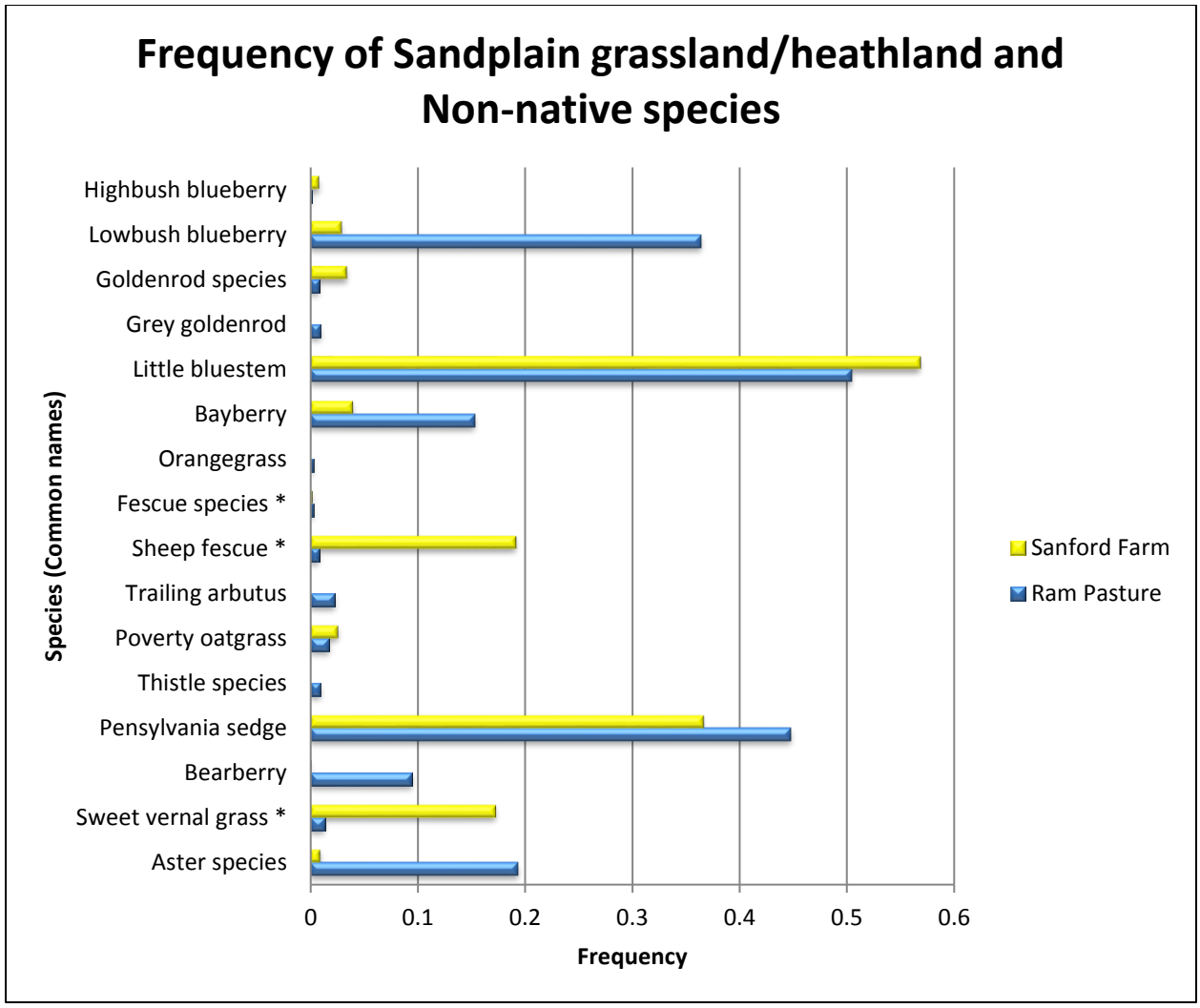

Figure 4: Frequency of common Sandplain grassland and heathland plants in each sampled unit. Additionally, frequency of species non-native to Nantucket (*).

To examine differences in individual plants found in Sanford Farm vs Ram Pasture, we looked at the frequency of species recognized by the Massachusetts National Heritage and Endangered Species Program as representative of Sandplain grassland and heathland habitats (MA NHESP Community Fact Sheets http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/fact_sheets.htm) as well as the frequency of species considered introduced and non-native to Nantucket (Figure 4) encountered in each area. Both Sanford Farm and Ram Pasture contain large concentrations of grasses although, Ram Pasture seems to have a higher frequency of the woody and forb species associated with Sandplain grasslands and heathlands. Sanford Farm contains a higher frequency of non-native species compared to Ram Pasture.

We examined the statistical different in individual plant species found in each sample area, by conducting an Indicator Species Analysis (ISA), a statistical test which examines the plants found on each transect and highlights species significantly associated with Ram Pasture versus those more significantly associated with Sanford Farm (Table 2). In analyzing the results of the Indicator Species Analysis, we again identified those species recognized by the Massachusetts National Heritage and Endangered Species Program as representative of Sandplain grassland and heathland habitats. Results indicated that Sanford Farm contains more weedy, non-native species and fewer species indicative of valuable Sandplain grassland and heathland habitats. In contrast, Ram Pasture contains many species identified as important species for Sandplain grassland and heathland habitats.

Table 2: Results of the Indicator Species Analysis showing plant species significantly associated with either Ram Pasture or Sanford Farm. Plant species recognized as being indicators of good Sandplain grassland and heathland habitats are in bold, species recognized as non-native to Nantucket have an *).

Species	Location	Indicator Value	p Value
Arctostaphylos uva-ursi (Bearberry)	Ram Pasture	0.52678669	0.002
Cirsium spp. (Thistles)	Ram Pasture	0.4	0.01
Epigaea repens (Trailing arbutus)	Ram Pasture	0.46666667	0.001
Festuca rubra (red fescue)	Ram Pasture	0.84593301	0.001
Gaultheria procumbens (Wintergreen)	Ram Pasture	0.55297647	0.01
Helianthemum canadense (Canadian rockrose)	Ram Pasture	0.4	0.006
Hudsonia ericoides (False heather)	Ram Pasture	0.36060606	0.048
Ionactis linariifolius (stiff aster)	Ram Pasture	0.53333333	0.001
Morella pensylvanica (bayberry)	Ram Pasture	0.79310345	0.001
Phontina spp. (Chokeberry)	Ram Pasture	0.6	0.001
Rubus hispidus (Swamp dewberry)	Ram Pasture	0.72817133	0.003
Sericocarpus asteroides (Toothed whitetop aster)	Ram Pasture	0.68936265	0.001
Solidago nemoralis (Grey goldenrod)	Ram Pasture	0.33333333	0.018
Symphyotrichum dumosum (Bushy aster)	Ram Pasture	0.70833333	0.001
Toxicodendron radicans (Poison ivy)	Ram Pasture	0.46666667	0.003
Anthoxanthum odoratum (sweet vernal grass)*	Sanford Farm	0.65535604	0.001
Festuca ovina (Sheep fescue)*	Sanford Farm	0.6776138	0.002
Pityopsis falcata (Sickle leaved golden aster)	Sanford Farm	0.60922563	0.003
Rumex acetosella (Red sorrel) *	Sanford Farm	0.78473906	0.001
Vaccinium corymbosum (high bush blueberry)	Sanford Farm	0.92523923	0.001

Conclusions

This initial survey of the plant species found in Sanford Farm and in Ram Pasture demonstrates that the two properties have significantly different species composition and that these differences may be driven by past land management practices. Sanford Farm has very rarely been managed by prescribed fire (the last time in 1995) and only in small areas of the property, but has experienced consistent

annual dormant season mowing for the past 27 years. Sanford Farm has significantly more weedy, non-native plants and fewer Sandplain grassland/heathland plants associated with sampled transects. Ram Pasture, on the other hand, has been infrequently mowed and more consistently managed through prescribed fire. Ram Pasture has a higher concentration of Sandplain grassland and heathland plants.

In addition to difference related to soils (potentially nutrient concentrations, hydrology, etc) habitat management over time appears to have the strongest impact on the presence of desirable plant communities. In particular, annual mowing alone does not appear to promote the existence of desirable Sandplain grassland and heathland plant communities and may promote an increase in weedy and non-native plants. There are many possible reasons for this observed trend. The frequency of mowing may facilitate the spread of disturbance dependent weedy species while also discouraging colonization by more flowering plants and woody species. Additionally, when mowing was first initiated, these species may have been present predominantly near the road and other disturbed areas near the current parking lot. Mowing would assist in moving the seeds of these species around the property, facilitating their spread. Additionally, this study assumes an influence of only the most historically recent management on species composition. Historical grazing and farming practices, not able to be accounted for in this study by have some impact on the species currently observed on the properties.

Without knowing the previous plant species composition of these two areas, it would be difficult to pinpoint the mechanism by which management is driving the observed differences in species composition but this study indicates that we should use caution in attempting to use only dormant season mowing to promote the continuation of Sandplain grassland and heathland habitats.