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Global Information Systems Analysis of Changes in Temporal Flowers Distribution, by Species, Across the Biology Trail System of Southern Adventist University in Collegedale, Tennessee

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Introduction

Plants have a variety of purposes: from providing food, clothing, and medicine to the very oxygen that we breathe. However, an increasing number of habitats are being destroyed to make room for the expanding human population. Due to habitat destruction and the subsequent loss of wildflower abundance and diversity, research and preservation effort are being carried out worldwide to prevent further loss of these natural resources/treasures (Scott R. Abella, 2014). Natural habitats such as Denali National Park & Preserve in Alaska, Great Sand Dunes National Park & Preserve in Colorado, and Tallgrass Prairie Preserve in Kansas have been set aside for the purpose of preserving native plants, education, and recreational enjoyment (National Park Service, 2015).

The White Oak Mountain Biology Trails is located in Collegedale, Tennessee. This trails system is on university-owned property and is maintained by the school for use by students and the public. It is a recreational site for hiking and mountain biking (Hutagalung, 2011). According to Judy Sloan Ph.D., a professor in outdoor leadership at Southern Adventist University, this biology trail system is ranked third place for the best mountain biking trails in the state of Tennessee (The Best Mountain Bike Trails in Tennessee, 2015). Every year, hikers and mountain bikers from all over the United States come to this biology trail system for recreational use. The impact of trail usage on native wildflower species on the biology trail is not known. More research is required to monitor the impact of recreational use on the flowering plants of the trail system.

The White Oak Mountain Biology Trails contain many species of native flowering plants of Tennessee, and are a valuable natural resource that needs to be preserved. Part of the preservation process is educating university students and the public about what flowering plants

are there and when they are in bloom. However, little is known of the diversity of wildflowers on the biology trails. With this gap in our knowledge we cannot tell if the plants are being threatened and preservation cannot take place.

To help fill the gaps in our knowledge of ecology and conservation, we will identify flower species and monitor the relationships between the plant populations and ecological conditions including ambient temperature, soil moisture, elevation, and light intensity.

Many longitudinal studies have been performed to monitor the diversity and abundance of various plant species in different ecosystems. For example, floral diversity was monitored using digital photography and field sampling in the United Arab Emirates deserts (Ksiksi & El-Keblawy, 2013). Another study at Fort Riley, Kansas measured the impact of military training on plant species diversity from 1994 – 2001 (Althoff, Gipson, Pontius, & Woodford, 2006). Woody and herbaceous plants were inventoried using permanent monitoring plots in Botany Glen, Grant County, Indiana (Stonehouse, Badger, Ruch, & Rothrock, 2003). Along the same line, this investigation will establish a longitudinal study of the wildflowers diversity and abundance modified from techniques reported by Elzinga, Salzer, & Willoughby (1998).

There are many types of monitoring methods that can be used to monitor flowers diversity, but the method that will be used in this research is permanent quadrants sampling. This method was chosen for its use in measuring density, frequency, and biomass. Permanent quadrant sampling is also advantageous in determining the correlation of sampling units over time (Elzinga, Salzer, & Willoughby, 1998).

This study establishes a longitudinal designed for the purpose of providing information regarding the variety and distribution of wildflowers present on the biology trail system. The

data gathered will be analyzed and used for public education and preservation of wildflowers on the White Oak Mountain Biology Trails.

Objectives

Specific study objectives are to:

1. Establish baseline data on wildflower diversity and abundance on the biology trail system in order to detect possible changes in the same over time.
2. Collect data regarding environmental conditions (soil moisture, light intensity, ambient temperature) for each quadrant established on the White Oak Mountain Biology Trails.
3. Determine the impact of trail usage, if any, with data collected using the Browning Strike Force 10.0 MP Mini Trail Camera BTC 5.

Materials and Methods

Data Collection

On March 22nd and 29th, the route on the White Oak Mountain Biology Trails of Southern Adventist University, as outlined in Figure 1, was taken to determine the best locations for ten quadrants (4 x 8 feet) that are representative of the various habitats within the this system. Eight quadrants were chosen to be within twelve feet of the trails while two were fifty-eight and eighty-one feet from the trails, serving as control quadrants. The distance of the quadrants from the trails was determined by measuring from the center of the quadrant to the closest edge of the trails. To permanently establish the location of these quadrants, ½ inch x 3 feet rebar were driven into the four corners of the quadrants leaving about 6-9 inches of rebar above ground, which was then capped for safety purposes. Location and elevation (GPS coordinates, Garmin GPS 72H Handheld Track Plotter) of the quadrants were recorded.

Once the size and distance of the quadrants were established, all species of flowers were identified[1], photographed, and the abundance determined. Light intensity (Sper Scientific Mini Environmental Quality Meter), soil pH and moisture (Kelway Soil pH and Moisture Meter) were also collected for each quadrant. Game cameras (Browning Strike Force 10.0 MP Mini Trail Camera BTC 5) were set up in April 5th near each quadrant to monitor trail usage. After four weeks, the cameras were taken down and the data from SD cards will be downloaded and used later for analysis. Wildflower diversity was collected by the General Biology class. A check list of wildflowers was given to fifty pairs of students. Students walked the outlined route in Figure 1 and checked off the flowers that they see on the list. Only flowers that were observed by at least ten groups or personally observed by the researcher were reported. This data will be collected yearly in the month of April.

[1] Flowers will be identified using the guide book: *Wildflowers of Tennessee, the Ohio Valley, and the Southern Appalachians: The Official Field Guide of the Tennessee Native Plant Society.*

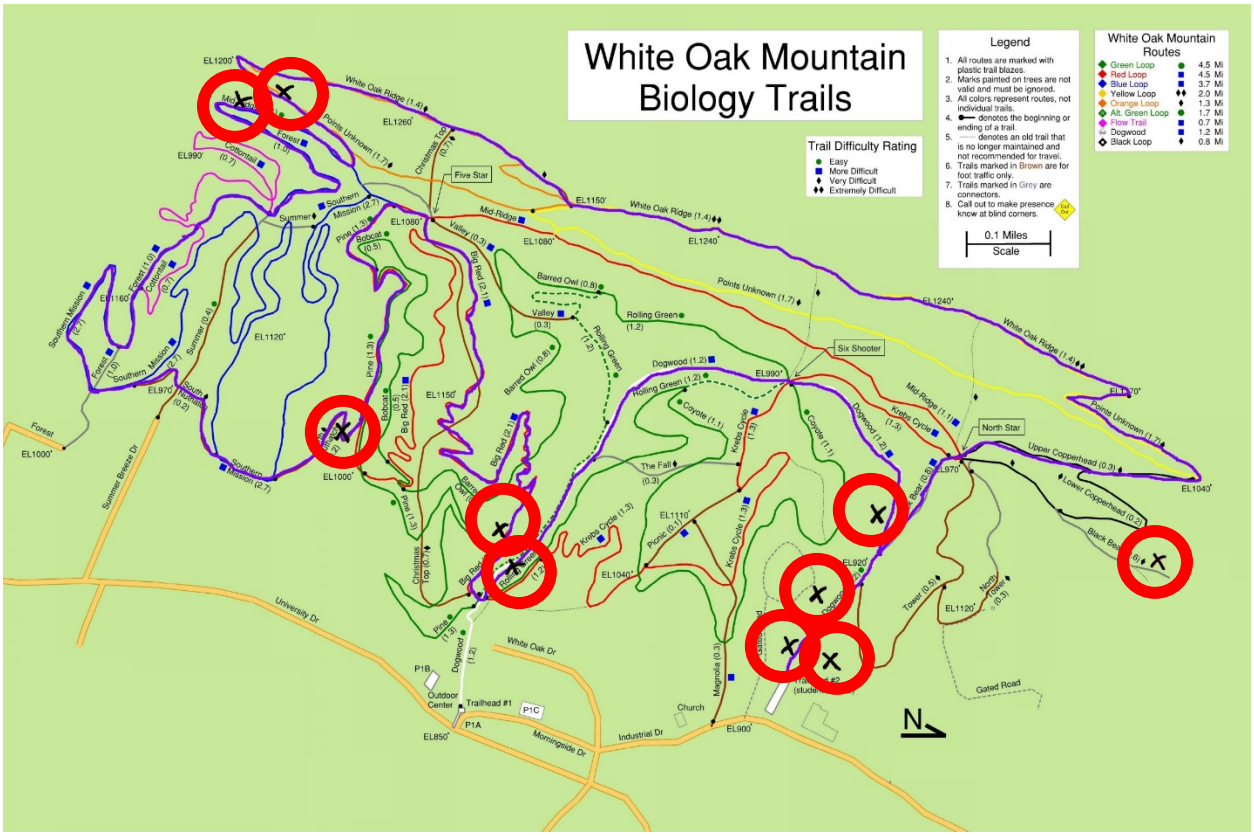

Figure 1. Map of the Biology Trails System on the campus of Southern Adventist University. Quadrants used for wildflower abundance study marked with an "X" and circled.

Results

Wildflowers Diversity

As seen in Table 1, fifty seven species of wildflowers were identified on the Biology trail system in April of 2015. One species was not identified (Figure 3).

Table 1. Reported observations of wildflowers made by students and researcher on the Biology Trails System on April 2015. Only flowers observed by at least 10 groups are reported.

Scientific Name	Common Name
Anemone quinquefolia	Wood Anemone
Calycanthus floridus	Sweet Shrub
Cardamine hirsute	Hoary Bittercress
Claytonia virginica	Virginia Spring Beauty
Collinsonia verticillata	Whorled Horse Balm
Conopholis americana	Squaw Root, Cancer Root
Dentaria heterophylla	Slender Toothwort
Dentaria laciniata	Cutleaf Toothwort
Disporum lanuginosum	Yellow Mandarin
*Dodecatheon meadia**	Shooting Star
Erigeron philadelphicus	Common Fleabane
Geranium maculatum	Wild Geranium
Hepatica acutiloba	Sharp-Lobed Hepatica
Hexastylis arifolia	Little Brown Jugs
Houstonia caerulea	Quaker Ladies, Innocence
Houstonia serpyllifolia	Thymeleaf Bluet
Hypoxis hirsuta	Yellow Stargrass
Iris cristata	Dwarf Crested Iris
Myosotis macrosperma	Scorpion Grass
Narcissus spp.	Daffodil
*Obolaria virginica**	Pennywort
Osmorhiza longistylis	Sweet Anise
Oxalis stricta	Sourgrass
Oxalis violacea	Violet Wood Sorrel
*Phacelia fimbriata**	Fringed Phacelia
*Phlox divaricate**	Woodland Phlox
Podophyllum peltatum	May Apple
Polygonatum biflorum	Smooth Solomon's Seal
Potentilla canadensis	Dwarf Cinquefoil
Potentilla simplex	Common Cinquefoil
Ranunculus recurvatus	Hooked Buttercup
Rubus argutus	Southern Blackberry
Salvia lyrata	Lyreleaf Sage
*Saxifraga micranthidifolia**	Brook Lettuce
*Senecio aureus**	Golden Ragwort
Senecio glabellus	Butterweed, Yellowtop
Silene virginica	Fire Pink
Sisyrinchium albidum	Pale Blue-Eyed Grass
Smilacina racemosa	False Solomon's Seal
Stellaria pubera	Star Chickweed
Taraxacum officinale	Common Dandelion
Thalictrum thalictroides	Rue Anemone
*Thaspium barbinode**	Hairyjoint Meadow Parsnip
Tiarella cordifolia	Foamflower
Tipularia discolor	Cranefly Orchid
Trillium catesbaei	Catesby's Trillium
*Trillium simile**	Sweet White Trillium
*Uvularia perfoliata**	Perfoliate Bellwort
Vicia caroliniana	Carolina Vetch
Vinca minor	Periwinkle
Viola hastata	Halberdleaf Yellow Violet
*Viola macloskeyi**	Northern White Violet
Viola palmata	Wood Violet
Viola pubescens	Yellow Woodland Violet
*Viola rostrate**	Long-Spurred Violet
Viola sororia	Common Blue Violet
*Zizia aurea**	Common Golden Alexanders

* Flowers not verified to be present on Biology Trails System by researcher.

Figure 2. Wildflower species present on the Biology Trails System during April that was unable to be identified by researcher.

Wildflowers Abundance

Total wildflower abundance was determined for ten quadrants (Table 2). The average light intensity, soil pH and moisture are also recorded (Table 3).

Table 2. Wildflowers abundance of the Biology Trails System represented by the number of flowers totaled in ten quadrants during the month of April.

Flower ID	Total Count for 10 Quadrants
Cutleaf Toothwort	202
Virginia Spring Beauty	100
Hoary Bittercress	63
Rue Anemone	54
Smooth Solomon's Seal	32
Common Blue Violet	28
Star Chickweed	23
Yellow Mandarin	22
Unknown 1	16
Violet Wood Sorrel	14
Scorpion Grass	12
Yellow Woodland Violet	6
False Solomon's Seal	5
Sharp-lobed Hepatica	2
Wood Violet	2
Crane-fly Orchid	1
Daffodil	1
Little Brown Jug	1
Southern Blackberry	1
Sweet Anise	1

Table 3: Average light intensity, soil pH and moisture for ten representative quadrants on the Biology Trails System in April.

	Light Intensity (kLux)	Soil pH	Soil Moisture (%)
Quadrant 1	2.8	5.6	50
Quadrant 2	4.75	5.4	55
Quadrant 3	7.64	5.6	50
Quadrant 4	15.85	5.4	55
Quadrant 5	25.85	5.6	50
Quadrant 6	9.715	5.2	55
Quadrant 7	17.61	5.6	50
Quadrant 8	8.915	6.58	12.5
Quadrant 9	29.15	6.5	12.5
Quadrant 10	26.2	6.6	12
Mean*	14.85 ± 9.57	5.81 ± 0.55	40.2 ± 19.70

* Standard deviation shown.

Discussion

The wildflowers diversity of the Biology Trails System at Southern Adventist University included fifty-three species of wildflowers native to the state of Tennessee. Four species, though present on the Biology Trails System, are not native to Tennessee. These include Periwinkle, Daffodil, and Hoary Bittercress which were introduced from Europe. Common Dandelion was introduced from Eurasia. Table 1 also contains twelve species of wildflowers that were not verified to be present on the Biology Trails System at Southern Adventist University. To alleviate the problem, future students will photograph and give the coordinates of the flowers seen. Students will also be sent out in groups in different weeks during April to document all the flowers that bloom at different times during this month. This year's study provides us with baseline data. As we continue to collect this data over the next few years we hope to be able to detect any possible changes in the diversity and abundance of these wildflowers. If changes are detected, we will attempt to correlate these changes with the other parameters that were collected—trail usage, light intensity, soil pH, and soil moisture.

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