PLANT INVENTORY OF RANDOM SITES AT THE APPALACHIAN STATE SUSTAINABLE DEVELOPMENT TEACHING AND RESEARCH FARM FOREST

by

Charles Robert Mize

Honors Thesis

Appalachian State University

Submitted to The Honors College

in partial fulfillment of the requirements for the degree of

Bachelor of Science

May, 2016

Approved by:

____

Christoffel den Biggelaar, Ph.D., Thesis Director

____

Gary Walker, Ph.D., Second Reader

____

Ted Zerucha, Ph.D., Interim Director, The Honors College

Abstract

To create an initial, partial plant inventory of the Sustainable Development Farm forest, 21 randomly generated sample sites were visited in the fall of 2015 and the Spring of 2016 and the plants found were collected and identified. Forty-seven species were encountered, as well as an interesting variation in site diversity, which is discussed. The resulting initial inventory, the sample sites, the digitized forest tract map, and the photos of the sites and of the specimens will be available for reference for holistic forest management planning, more complete surveys, and for future ecological studies of the property.

Introduction

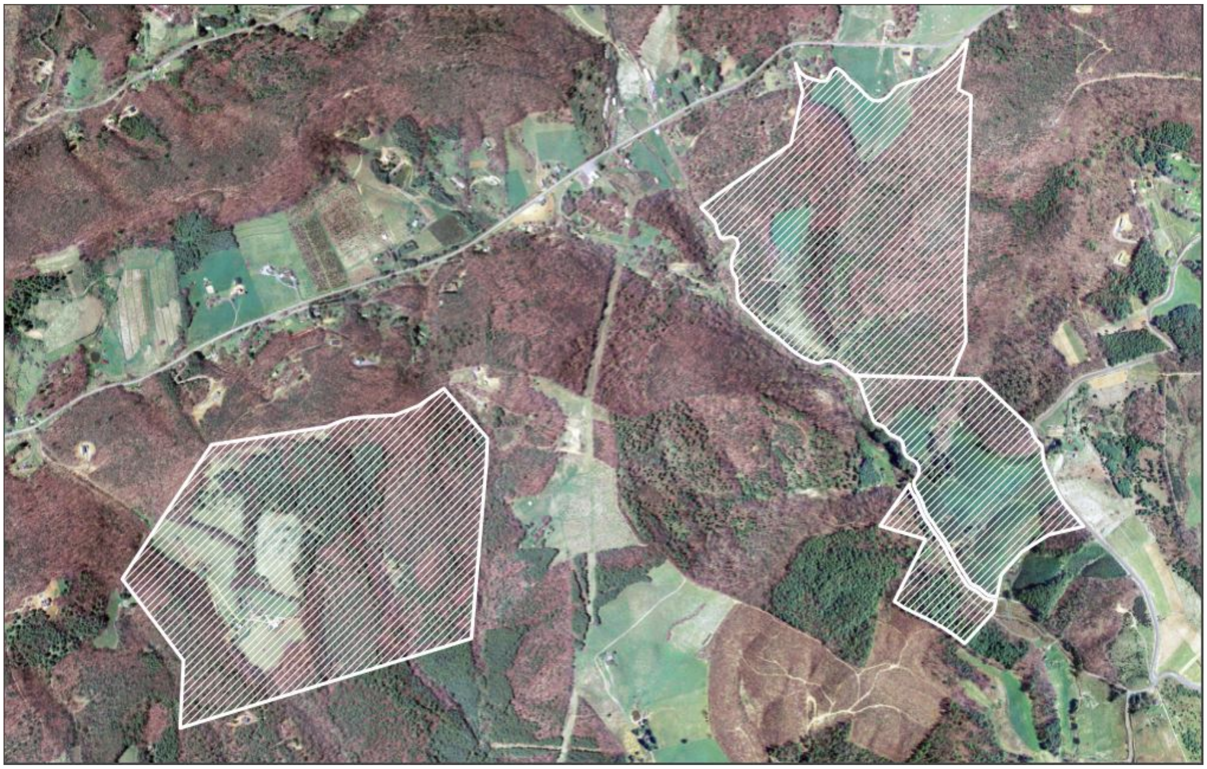

Figure 1. Appalachian State Sustainable Development Teaching and Research Farm properties.

The Appalachian State Sustainable Development Teaching and Research Farm (SD Farm) comprises two noncontiguous tracts of historic farm land in Ashe County, North Carolina. The combined area of the land is 365.39 acres. The eastern tract is slightly larger than the western at 185 acres and is almost entirely wooded but contains about 35 acres that is more open, having recently been in Christmas tree production (ENV). Almost all of the farm's current educational, agricultural, and research enterprises take place on the smaller tract, which is home to the historic farm house and various other historic and modern structures. Even so, most of this tract, about 130 acres, is also wooded. The forests were selectively timbered in the past, and Appalachian State's Sustainable Development Department has planned to practice its own sustainable timber management regime, which is beginning to be implemented through classes offered to University students. This program began with and is based upon the results of the Spring 2011 section of SD 3533, a special course offering in the App State Sustainable Development program, under the instruction of Christof den Biggelaar, Ph.D., Ian Snyder, M.A., and Mark Fanatico, M.A.T. Students established forest management tracts A-G, surveyed timber species in each, and composed a *Forest Management Plan for the Blackburn-Vannoy Home Place* (Paynter, et al.) This document informed the University of the timber resources on the property, advised management plans for each tract, and compiled a list of stakeholder objectives for the forest (see Appendix A). These goals mention "sustainable and natural farming techniques," "restorative, low impact approaches to silviculture," and "synergistic, progressive land stewardship," making it clear that the management practices will be deliberate and ecologically-informed (Paynter, et al.). For this to happen, it is important to understand the forest ecosystem to a greater degree than simply estimating how much timber and what tree species are present. Overall management goals are likely to include maintaining biodiversity, sequestering atmospheric carbon, and fulfilling other facets of sustainable development rather than simply maximizing revenue. In addition, other forest revenue sources may one day be considered, such as woodland medicinal herbs, fungi, and other non-timber forest products. A nuanced understanding of forest ecology is needed to implement such a plan. Knowing, for instance, what woodland plants are naturally present in a given area of the forest may give hints as to what medicinal herbs would be able to grow there. In the same way, knowing what plants and fungi grow in a given area would give hints as to which edible and medicinal mushrooms would thrive. Possible pest problems for those enterprises would also have to be considered, which again calls for a nuanced understanding of the forest's ecology in order to know what pests are present, whether their predators are also present, and what other food sources those creatures have available. Identifying forest plant species is the first step toward a holistic ecological understanding of the forest. Local ethnobotanist Marc Williams completed three walks of the property in April and May of 2012, compiling a list of medicinal, edible, and otherwise useful plants he encountered, contributing to this goal. His walks produced a list of 174 plants, some definitively found on the property and some not positively identified but suspected to be present. The plants are listed with their scientific and common names, whether they are native or introduced, their uses, and other comments (Williams).

This study is novel and complementary because it considers all forest plants in order to seek an ecological perspective rather than focusing on useful plants in order to evaluate potential economic value. The study does not yield a comprehensive catalogue but rather a collection of species encountered, in order to give a preliminary glimpse into the level of plant diversity in different areas of the forest. It establishes sample sites that can be used in future studies, and provides a small amount of data that may inform some of the ecological questions related to the sustainable management of the property.

Methods

This study consisted of two rounds of collection and identification of plants at 21 sample sites across the SD Farm's forest. The 21 sites were established using three sets of coordinates in each of the seven pre-established forest tracts at the farm. The tracts are mostly described from a timber management and extraction standpoint; however, because each tract contains a certain degree of ecological similarity, the stablished tracts proved appropriate for this project as well. To generate the random locations, the seven tracts were first conveyed into a polygon shapefile by digitizing a hand-drawn map that delineated the boundaries. The hand-drawn map was a product of the Spring 2011 SD 3533 class and was devised manually without GPS-generated boundary coordinates or any other exact data. Therefore, as the seven tracts were digitized, features such as streams, ridgelines, and paths, data already available in the SD Farm GIS, were often used as tract boundaries, making the divisions intuitive and consistent with the preexisting GIS data. It seems to have been the intention of the crude, original map to follow those features. The SD Farm GIS layers are available on the ASU Geography Spatial Data Engine and were compiled by geography graduate students Matthew Anthony and Cheryl Hagevik in 2009-2010. Once polygon vector data representing the seven forest tracts were established, three random coordinate pairs were generated within each tract. This was done in ArcMap 10. The coordinates were entered into the Sustainable Development Department's Garmin GPS as waypoints, named A1, A2, A3, B1, B2, etc. through G3. The letter corresponds to the forest tract containing the sample site, and the number differentiates between the three points within each tract. The seven forest tracts and the distribution of the sample points can be seen in Figure 2.

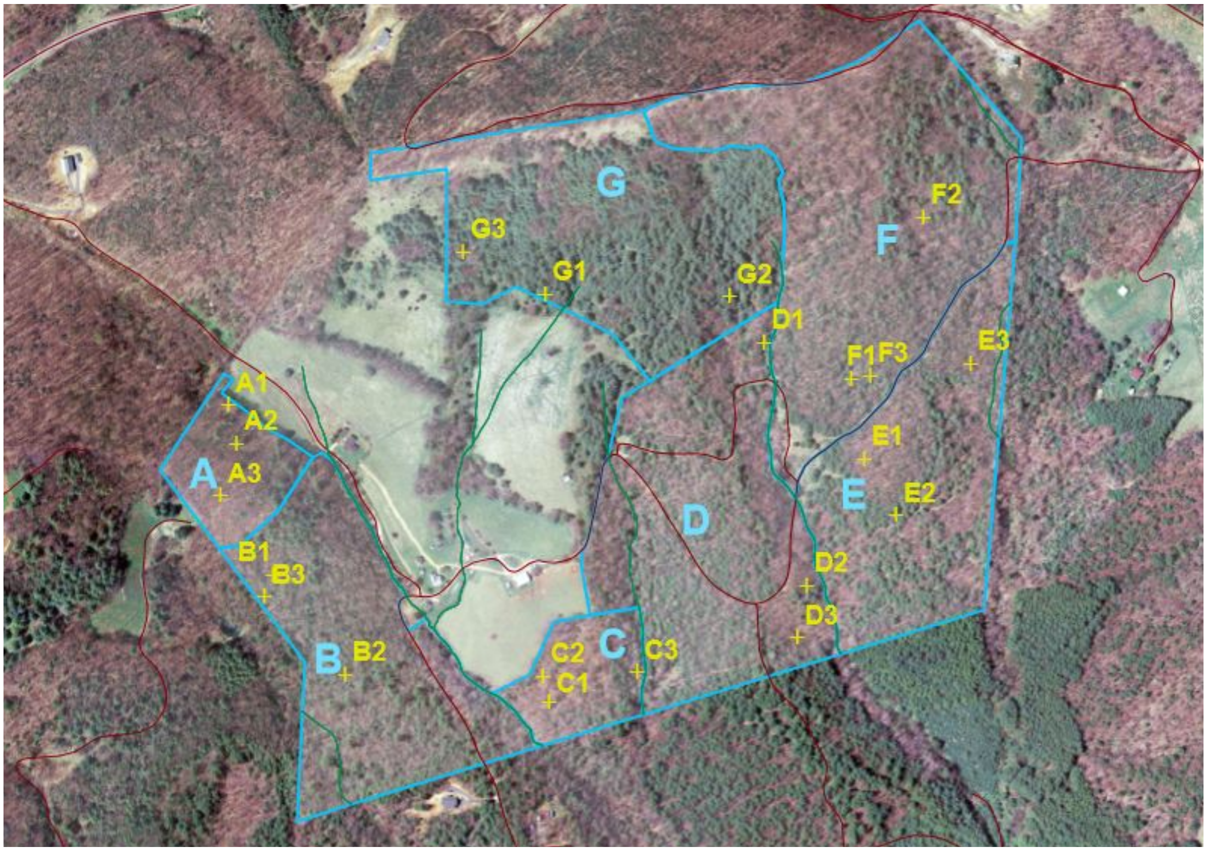

Figure 2. SD Farm forest tracts and site locations.

Using a Garmin GPS unit, the site locations were located on the ground and marked with posts. A 1- by 1-meter square made of small-diameter PVC pipe was used to delineate the plots at each site. The square was positioned so that the marker post was in the northeast corner of the sample plot, ensuring that the same area was used in the spring as in the fall. At each site, the tree species composing the forest canopy were noted. The slope aspect of the location was also noted, and the plot was photographed. Specimens of the plants in each plot were collected, pressed, and dried to be identified later. The fall sampling occurred on October 8 (tract A), October 10 (B1), October 15 (B3, B2, tract C, D1, E3, F2, and tract G), and October 17, 2015 (D2, D3, E1, F1, F3). The spring sampling occurred on April 3 (tract

A, tract B, tract C, D2, D3) and April 10, 2016 (D1, tract E, tract F, tract G). The two samplings dates were used in order that the study survey a broader range of species.

Figure 3. Example plot photograph and specimen identification photograph.

Plant species identification was completed with the aid of Weakley's *Flora of the Southern and Mid-Atlantic States* 2010 pdf version, and the regional plant identification online tool, Namethatplant.net. Plant specimens were identified to the species when possible, but often only to the genus level. Several specimens could not be identified due to lack of distinguishing characteristics. These were included in the study in terms of being distinct plant species that were encountered, and were enumerated as "Unknown A-I." Herbarium sheets were not prepared due to the poor quality of many of the samples, but photographs were taken of the specimens laid out on black construction paper for future reference. Figure 3 shows how the PVC square was used to delineate the plots and how photographs of the samples were taken and used to organize the specimens during identification.

Results

This study has resulted in the collection of 47 plant species of plant, including ferns, forbs, club moss, and tree sprouts, as well as 9 ostensibly distinct species of plant which could not be identified due to poor specimen quality. All the unidentified plants are forbs. Some of the most common species were *Smilax rotundifolia* (a species of greenbrier), *Toxicodendron radicans* (poison ivy), *Ageratina altissima* (white snakeroot), *Acer rubrum* (red maple), *Fragaria virginiana* (wild strawberry), *Festuca arundinacea* (tall fescue), and *Polystichum acrostichoides* (Christmas fern). A particularly common plant in the spring survey was spring beauty (*Claytonia* spp.) which was found in six of the 21 plots. The genus *Viola* was the most represented in both the fall and the spring inventories, with the species *V. hastata*, *V. hirsutula*, *V. sororia*, *V. walteri*, *and V. rotundifolia* identified.

Table 1. Tracts, and species present.

tract	Surrounding trees	aspect	fall	spring	# sp. in site	# sp. in tracts
A1	maple, poplar, black locust	E	*Sassafras albidum, Rubus* sp., *Ageratina altissima, Polystichum acrostichoides, Potentilla simplex, Rosa* sp., *Toxicodendron radicans, Parthenocissus quinquefolia*	*Potentilla canadensis var. canadensis,* Unknown B	9	21
A2	maple, poplar, black locust	E	*Prunus* sp., *Smilax hugeri, Smilax rotundifolia, Viola hirsutula, Viola sororia, Athyrium asplenioides, Toxicodendron radicans*	*Podophyllum peltatum, Viola rotundifolia*	8	
A3	maple, pine	W	*Smilax rotundifolia, Quercus* sp., *Prunus* sp.	*Claytonia* sp., *Festuca arundinacea,* Unknown H	6	
B1	chestnut oak, pine, maple, mountain laurel		*Acer rubrum*		1	3
B2	rhododendron and laurel, red oak, chestnut oak, red maple, pine		*Acer rubrum*		1	
B3	rhododendron, laurel, red oak, white oak, chestnut oak, pine, maple		*Smilax rotundifolia, Acer rubrum*	*Claytonia* sp.	3	
C1	hickory, poplar, red maple, white oak		*Viola walteri, Fragaria virginiana, Ageratina altissima, Panicum* sp., Unknown D	*Claytonia* sp., *Viola hastata, Viola rotundifolia, Fragaria virginiana*	8	12
C2	pine, chestnut oak, white oak, red maple		*Acer rubrum, Prunus* sp., *Quercus rubra, Fragaria virginiana, Festuca*	*Festuca arundinacea,* Unknown C	6	

			arundinacea			
C3	black birch, pine, red maple, red maple, poplar, chestnut oak	E			0	
D1	pine, black birch, rhododendron	SE	*Fragaria virginiana, Smilax rotundifolia, Berberis thunbergii, Thelypteris simulata,* Unknown A	*Thelypteris simulata, Fragaria virginiana, Festuca arundinacea*	6	13
D2	maple, poplar, cherry, pine, rhododendron, black birch, red oak	N	*Viola sororia, Smilax rotundifolia, Diphasiastrum digitatum, Acer rubrum*	*Smilax rotundifolia*	4	
D3	black birch,, red maple, poplar, black locust, rhododendron	N	*Polystichum acrostichoides, Smilax rotundifolia, Fragaria virginiana*	*Claytonia* sp.	4	
E1	rhododendron, laurel, red maple, chestnut oak, red oak, pine	W	*Acer rubrum, Pinus strobus*	*Claytonia,* Unknown G	4	11
E2	red maple, black birch, hickory, chestnut oak	SE	*Diphasiastrum digitatum, Smilax rotundifolia, Festuca arundinacea*	*Viola rotundifolia, Smilax rotundifolia, Claytonia*	4	
E3	Pine, white oak, red oak, red maple, rhododendron, laurel	E	*Quercus rubra, Acer rubrum, Gentiana clausa, Chimaphila maculata*	*Chimaphila maculata, Viola rotundifolia, Toxicodendron radicans*	6	
F1	laurel, rhododendron, pine, oak, black birch, red maple	SW	*Nyssa sylvatica, Acer rubrum*		2	7
F2	pine, maple	E	*Diphasiastrum digitatum, Smilax rotundifolia*	*Pinus strobus,* Unknown E	4	
F3	laurel, white oak, red oak, chestnut oak, pine, magnolia	SW	*Acer rubrum,* Unknown I		2	
G1	pine	S	*Ilex opaca* var. *opaca*	*Ilex opaca* var. *opaca*	1	10
G2	pine, black locust, red maple, black birch, poplar, holly	SE	*Dennstaedtia punctilobula, Polystichum acrostichoides, Toxicodendron radicans*	*Polystichum acrostichoides, Potentilla indica, Viola rotundifolia*	5	
G3	cedar, pine	S	*Oxalis* sp., *Toxicodendron radicans*	*Viola rotundifolia, Potentilla canadensis var. canadensis, Houstonia caerulea,* Unknown F	6	
total in each season			31	22	47	

Table 2. List of all plant species encountered

Ageratina altissima	*Podophyllum peltatum*	*Thelypteris simulata*
Athyrium asplenioides	*Polystichum acrostichoides*	*Toxicodendron radicans*
Acer rubrum	*Potentilla canadensis* var.	*Viola hastata*
Berberis thunbergii	*canadensis*	*Viola hirsutula*
Chimaphila maculata	*Potentilla indica*	*Viola sororia*
Claytonia sp.	*Potentilla simplex*	*Viola walteri*
Diphasiastrum digitatum,	*Prunus* sp.	*Viola rotundifolia*
Dennstaedtia punctilobula	*Pinus strobus*	Unknown A
Fragaria virginiana,	*Parthenocissus quinquefolia*	Unknown B
Festuca arundinacea	*Quercus rubra*	Unknown C
Gentiana clausa	*Quercus* sp.	Unknown D
Houstonia caerulea	*Rubus* sp.	Unknown E
Oxalis sp.	*Rosa* sp.	Unknown F
Ilex opaca var. *opaca*	*Smilax hugeri*	Unknown G
Nyssa sylvatica	*Smilax rotundifolia*	Unknown H
Panicum sp.	*Sassafras albidum*	Unknown I

Table 1 is the chart of species found at the 21 sample plots. The three plots in each tract are named by the letter of the tract in which they were found followed by a number, one through three. The three *Prunus* seedlings were assumed to be the same species. As the chart shows, 9 more species were found in the fall than were found in the spring, and many of the species were found in both seasons. Plot C3 was vacant of any plants in either season, and B1, B2, and F3 were vacant in the spring. The plot with the most diversity was A1 with 9 different species, and tract A, with 21 species, also had a greater number of species than any other tract. Tract B had the least diversity, with only 3 species.

This study has also established 21 sample sites which are marked on the ground in the SD Farm forest as well as on digital maps and has produced a digital version of the forest tract map which can be integrated with the rest of the SD Farm GIS data, which includes slope, elevation, aspect, soil type. Two photographs of each sample plot were also produced, one for each season in which collections took place. All of these resources will be available for reference for future studies.

Discussion

As previously mentioned, certain sample sites and forest tracts contained many more species of plants than others. A1, the sample site with the most diversity, was located within several meters of the edge of the forest where it borders a garden area. Abundant light is available at that site compared to the tracts in comparable, darker hardwood forest sample sites in the interior of the woods, such as tracts C, D, and E, which may explain the greater number of species present in A1.

Certain sample sites had far fewer species, including C3, which had no plants at all. In the case of C3, which fell in a hardwood forest in a dark cove, the high level of shade may help explain the lack of plants. This effect may also be part of the explanation for the low plant diversity at the sites in tracts B and F and at site G1. These sites are shaded by the evergreen foliage of the pine trees in the area, and in the case of tract B and sites F1 and F3, a thicket of rhododendron and/or mountain laurel blocked even more light from reaching the forest floor at any part of the year. These tree species, especially pine, are also known for creating a thick mulch of fallen foliage, which serves not only as a physical barrier to potential plant growth but also acidifies the soil, which may make the area inhospitable to many plant species.

There are certain weaknesses in the study, one of which relates to the method used to make a small study represent a large area. The randomly generated sample sites were established to accomplish this, but the task of identifying everything inside the squares and nothing outside of them created the problem of having some incomplete or otherwise poor-quality specimens which cannot be identified. Another weakness is that the two collections were taken in early spring and late fall, omitting plants that appear closer to the height of the growing season. It is for this reason, as well as simply the small scale of the project, that biodiversity assessments and other statistical analyses were not carried out. However, even this simple list of plant species present in the SD Farm forest can be a starting reference for farm management and future investigations. For instance, it was revealed that white snakeroot (*Ageratina altissima*), rhododendron, cherry, and mountain laurel are all present. All of these species are toxic to cattle, so great caution should be taken with any effort to allow cattle forest access.

Conclusion

This investigation has yielded an incomplete inventory of plants in the Appalachian State University Sustainable Development Teaching and Research Farm forest, which is a valuable reference in and of itself, but which will also be a helpful reference for other studies in the continued effort of establishing sustainable management practices in the forest. For instance, after a tract of the forest undergoes significant change another plant inventory can be made of that tract to see if the change has affected the species present. This technique could be used to measure the effectiveness of practices meant to affect the forest ecology, such as deer population control programs, or it could be used to measure one aspect of the ecological effect of an agricultural practice that has been introduced, such as fencing off an area of the forest and allowing hogs or goats to forage on it. Even for the low-impact selective timber cutting that occurs in the forest, a study could be carried out to inventory the plants present in the timbered area and compare it to what showed up in this study and others. Since the SD Farm strives to exemplify the use of environmentally-friendly practices, a likely goal is that if the ecology is changed, it is in a way that results in greater biodiversity, especially of native and endemic species. If any practice appears to result in that change, it can be considered an environmentally favorable practice. Certain invasive species appeared in this initial inventory, and reduction of the number of those individuals present in the forest would also indicate a favorable trend.

It is important to note that this inventory, which sampled only 21 square meters from the 130 acres of the whole forest and occurred only in fall and early spring, is by no means comprehensive. For example, if a plant species that was not found in this study is later found to occur in the forest, even in great numbers, it cannot be concluded that the species is new. However, if a species that was found in this study is later not found anywhere in the forest, it can be concluded that the species has disappeared. This weakness in the study could be greatly reduced by the use of larger plots and more frequent surveys on the project. If an additional round of plant identification occurred in the middle of the summer, a large number of plants that did not appear here would likely appear, and if the entire study was repeated at many more sites throughout the forest, the collective catalogue of plant species could be considered much closer to comprehensive. The catalogue would not only be of greater outright value to botanical curiosity, but would also provide a much more powerful tool for future assessment of management practices' effect on plant diversity. A common procedure for surveying plants in differently sized tracts is to use sample areas sized proportionally to the tract, which makes more statistical sense for generating an accurate picture of the whole forest. Although it would have required a lot more work for the sole researcher, this would have been a more appropriate procedure for the study than sampling the same area in each tract, since some tracts are much larger than others, and it is recommended that any future investigations use that method.

References

ENV - Environmental Consulting Services, Inc. *Report of Phase I Environmental Site Assessment; Blackburn-Vannoy Farm, Ashe County, NC, 365.39-acres*. Rep., 2010.

"NameThatPlant.net: Native Plants of the Carolinas & Georgia."*NameThatPlant.net: Native Plants of the Carolinas & Georgia*. SC Native Plant Society, accessed February, 2016. Web.

Paynter, Benjamin, Hana Crouch, Russell Paugh, Thomas Gibson, Cory Bryk, Daniel Clark, Neal Talbot, Billy Hoyle, Martin McVey, Amy Green, Christof Den Biggelaar, Ph.D., Ian Snyder, M.A., and Mark Fanatico, M.A.T. *Forest Management Plan for The Blackburn-Vannoy Home Place*. Rep. Fleetwood, NC: The ASU Sustainable Development Teaching & Research Farm, 2012.

Weakley, Alan S. *Flora of the Southern and Mid-Atlantic States*. Chapel Hill, NC: U of North Carolina Herbarium, North Carolina Botanical Garden, U of North Carolina, Chapel Hill, 2010.

Williams, Marc. *Inventory for Appalachian State "New" Sustainable Development Farm*. 2012

Appendix A. Stakeholder Objectives from *Forest Management Plan for The Blackburn-Vannoy Home Place*.

1. To establish a student centered teaching and research farm which maintains the agricultural, historic and cultural heritage of the farm.
2. To instruct students in sustainable and natural farming techniques within the post-modern Blue Ridge Mountain ecosystem.
3. To instruct students in sustainable forest management techniques with an emphasis on restorative, low impact approaches to silviculture.
4. To conduct collaborative, cross disciplinary research projects that engage and benefit the local community at the grassroots level.
5. To create an inspirational catalyst for synergistic, progressive land stewardship in the Southern Appalachian Bioregion.
6. Additional objectives to be determined by student and community feedback, the BV Property Management Committee and SD Farm Planning Committee.

Appendix B. Site locations. (WGS 84 – compatible with Garmin GPS units)

site	longitude	latitude
A1	-81.503729479999947	36.319270279000079
A2	-81.503604981999979	36.318861148000053
A3	-81.503802588999974	36.318295610000064
B1	-81.503078047999963	36.317465522000077
B2	-81.502089825999974	36.316415726000059
B3	-81.503184793999935	36.317224756000030
C1	-81.499370664999958	36.316172109000036
C2	-81.499455831999967	36.316453636000062
C3	-81.498212536999972	36.316519127000049
D1	-81.496637839999948	36.320095630000026
D2	-81.495989055999985	36.317493258000070
D3	-81.496098772999972	36.316933549000055
E1	-81.495265431999940	36.318874015000063
E2	-81.494826703999934	36.318274608000024
E3	-81.493888189999950	36.319922666000025
F1	-81.495464786999946	36.319726139000068
F2	-81.494561729999987	36.321477792000053
F3	-81.495214943999940	36.319761057000051
G1	-81.499558405999949	36.320544915000028
G2	-81.497111861999940	36.320572557000048
G3	-81.500662359999978	36.320982629000071