2013 Conservation Work Summary

Samuel A. Quinn and Nicholas P. Lapham

INTRODUCTION

Agriculture is the foundation of modern civilization, yet few other human practices pose a greater threat to biodiversity than production of the food, materials, fuel and medicines that sustain modern society. The irony is that agriculture, as we know it today, depends heavily upon the biodiversity that it jeopardizes. In the face of a growing body of scientific research and rising public interest in ecologically responsible food production, one of the next major challenges for conservationists is how to more fully integrate meaningful conservation practices in farm businesses.

Since 2010, The Farm at Sunnyside has approached the issue of biodiversity conservation on farmland in a novel way: by staffing a full-time biologist as the farm's "conservation manager." We are exploring a model of agriculture in which biological conservation is an explicit part of our food production system; where wild nature is not incidental to, but an actively managed component of our farming strategy. The conservation manager works alongside farm staff to guide initiatives such as inventorying biodiversity, monitoring environmental health, enhancing habitat for native species and quantifying interactions between agricultural and wild areas of the farm.

After nearly three years of collecting baseline data, enhancing scores of acres of wildlife habitat and defining how conservation can work within a farm business, we felt that it was time to begin sharing our experiences with a broader audience in hopes that our ideas would gain traction with other farmers and conservationists. And so, in June the conservation manager presented our work on the importance of integrating conservation knowledge in food production systems at the International Congress for Conservation Biology (ICCB). After years of being hosted across the globe, the 2013 Congress was held in Baltimore and attended by thousands of biologists, policy-makers and managers from dozens of nations. Yet even at the world's largest conference on conservation science, discussion on the critical importance of agriculture to biodiversity was conspicuously absent. Indeed, the words "farm" or "agriculture" appear less than a dozen times in the 180 page schedule for the four day event—mostly in the catering section. The lack of discussion on the relationship between wild species and food production was highly out of balance with the reality of agriculture's impact on global biodiversity. This has reinforced our belief in the importance of bringing conservationists and farmers closer together as allies in the fight to slow the loss of global biodiversity and promote sustainable food production systems.

This is the third annual report on our farm's conservation activities. These reports highlight our major conservation efforts and are meant to share our experiences with other farmers, conservationists and customers who may also be interested in promoting biodiversity on their land. By relating our methodology for developing, applying and funding a farm conservation program we hope to provide a window into our efforts and perhaps develop the foundation for stronger integration of conservation science in other farm businesses.

CONSERVATION MANAGER: HOW CONSERVATION FITS AT THE FARM AT SUNNYSIDE

After a few years of experimentation, we have arrived at the basic working model for how the conservation manager fits into our production system. All farms are unique, but elements of the broad principles on which our conservation program operates can be applied within any agricultural setting or at any scale. In general, the conservation manager's time is broken into four categories: field work, "desk" work, farm work and community outreach and education. Within these classifications are more specific work elements as outlined in Figure 1.

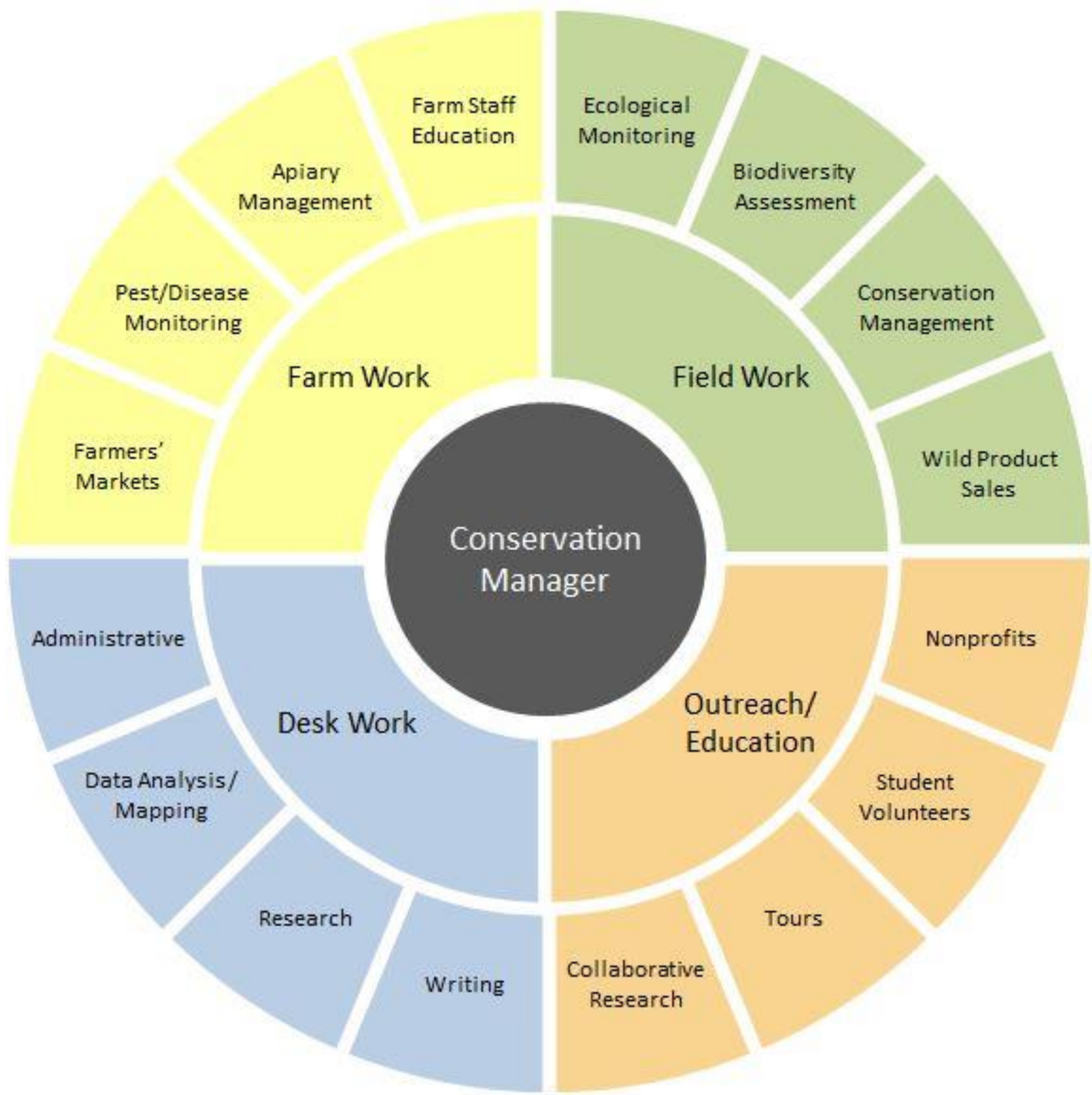


Figure 1: General schematic of the conservation manager's workload. Findings from the year's **field work** are the subject of this report and aspects of this category are outlined in greater detail in the following sections. "**Desk work**" includes day-to-day administrative necessities such as managing inventories of supplies and the analysis and summary of field work. Also part of this category is the publishing of reports, such as this one, meant to share our experiences with other farmers and scientists. The fastest growing area of our conservation program is **community outreach and**

education. We host an ever growing number of tours and student groups ranging from George Mason University, the Smithsonian and other academic institutions, to important links in the food production system like Whole Foods Market (Figure 2). Mentoring environmental science students from the Smithsonian-Mason School of Conservation every semester has become an integral part of both our conservation program and farm operation. Moreover, our participation in research projects such as the Smithsonian Conservation Biology Institute's (SCBI) Virginia Working Landscapes Initiative has allowed us to develop an even deeper understanding of the Farm's ecology and given us the ability to contextualize our work among similar properties in the region. The farm owner and conservation manager also serve on the boards of several local nonprofits and help direct environmental initiatives in the county.

Figure 2: The farm owner leading a tour of international environmental professionals participating in a climate change course hosted by the Smithsonian Conservation Biology Institute.

It is important to highlight the role of the conservation manager as a farm employee as well as director of the conservation program. A significant portion of the conservation manager's time is devoted to **farm work**. All of our conservation practices arguably benefit the farm operation in some fashion, such as creating habitat to bolster ecosystem services, but some of the conservation manager's efforts have substantially more direct influence on farm productivity. For example, in addition to designing habitat for native pollinators the conservation manager runs our honeybee (*Apis mellifera*) apiary. The conservation manager also works farmers' markets. This provides labor directly to the farm and gives us an avenue to discuss the importance of conservation on farms with our customers. We extend our conservation knowledge to our staff as well as consumers. We especially hope to instill this in our seasonal workers, many of whom will eventually carry these experiences with them to other farms.

One notable benefit of staffing a conservation biologist—or any personnel with an environmental science background—is their ability to contribute to the monitoring and management of pests and diseases. This year we stepped up our efforts to control orchard pests by increasing the precision of our management tactics through rigorous monitoring and predictive modeling, detailed further in the ecological monitoring section. We are not saying this is unique to our farm, rather that the implementation of these practices is greatly enhanced when there are staff in place who are experienced in systematic identification of species, data management and developing predictive models.

FIELD WORK

The foremost aspect of the conservation program—and the subject of our yearly reports—is field work, which is divided into four broad categories:

(1) **Ecological Monitoring**: tracking environmental conditions by monitoring local weather trends, water and soil quality, and population dynamics of bio-indicator species.

(2) **Biodiversity Assessment**: inventorying property-wide biodiversity through our own research efforts and collaboration with other institutions.

(3) **Conservation Management**: enhancing wildlife habitat, fostering beneficial interactions between wildlife and agriculture, and maximizing benefits from ecosystem services.

(4) **Wild Product Sales**: exploring the value of wild species as a component of our food production system and promoting their nutritional and ecological benefits to consumers.

As in previous years, about half of the conservation manager's field time was dedicated to conservation management activities, i.e. the establishment and maintenance of wildlife habitat (Figure 3). This year we also ramped up our marketing of wild products and met with success to match our efforts. Another significant portion of the conservation manager's time in 2013 was dedicated to increasing our ecological monitoring capacity. This was made possible by collaboration with student groups from the Smithsonian-Mason School of Conservation who conducted research projects at the Farm.

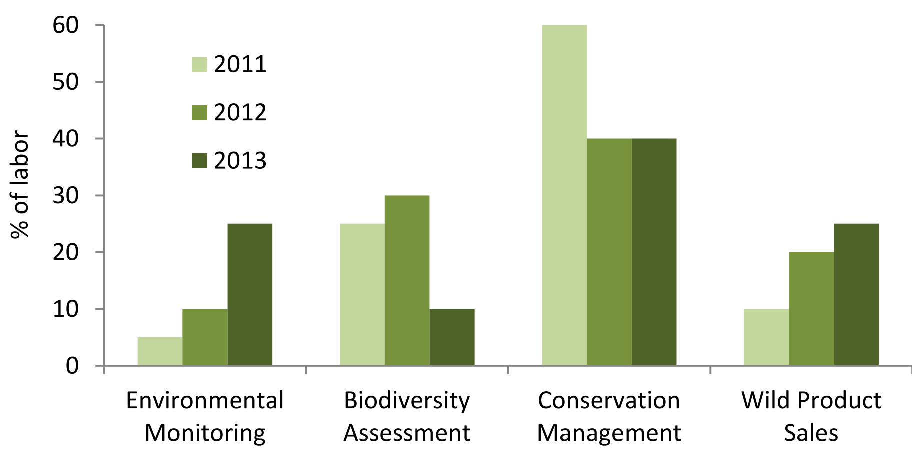


Figure 3: Comparison of the estimated amount of field time dedicated to each aspect of the Farm's conservation program from 2011 - 2013. A considerable portion of the conservation manager's time is also applied to research, land management planning, data analysis and community outreach through educational events, collaboration with local institutions and participating at farmers' markets.

We devoted less time to direct inventorying of biodiversity compared to previous years for two reasons. First, we have already captured much of the species diversity present at the Farm that is within our capacity to identify at this time (i.e. plants, mammals and birds) with invertebrates representing the major gap in our current understanding. In addition, much of our expanded ecological monitoring work was designed to simultaneously catalogue species while using their population structure to determine the health of ecosystems at the Farm. These bio-indicators include aquatic invertebrates, earthworms, salamanders and other sensitive species that can serve as an index for the quality of their habitat. We discuss these studies in greater detail in the following section.

ECOLOGICAL MONITORING

GOAL: To assess, analyze and monitor abiotic (e.g. water quality and weather patterns) and biotic (e.g. bio-indicator populations) environmental conditions. Understanding and tracking such conditions is fundamental to gauging the Farm's ecological health and provides important data necessary to inform and enhance agricultural activities.

Weather Patterns. 2013 was a much cooler year than 2012 with an average temperature of 54.1° F compared to 56.6° F (Figure 4). The difference can mostly be attributed to 2013's far colder winter and, to a lesser degree, a mild summer. We also received 9% more precipitation this year (41.6 inches) than the previous (38.2 inches). This value is closer to the region's historical annual precipitation average of 42.36 inches[1].

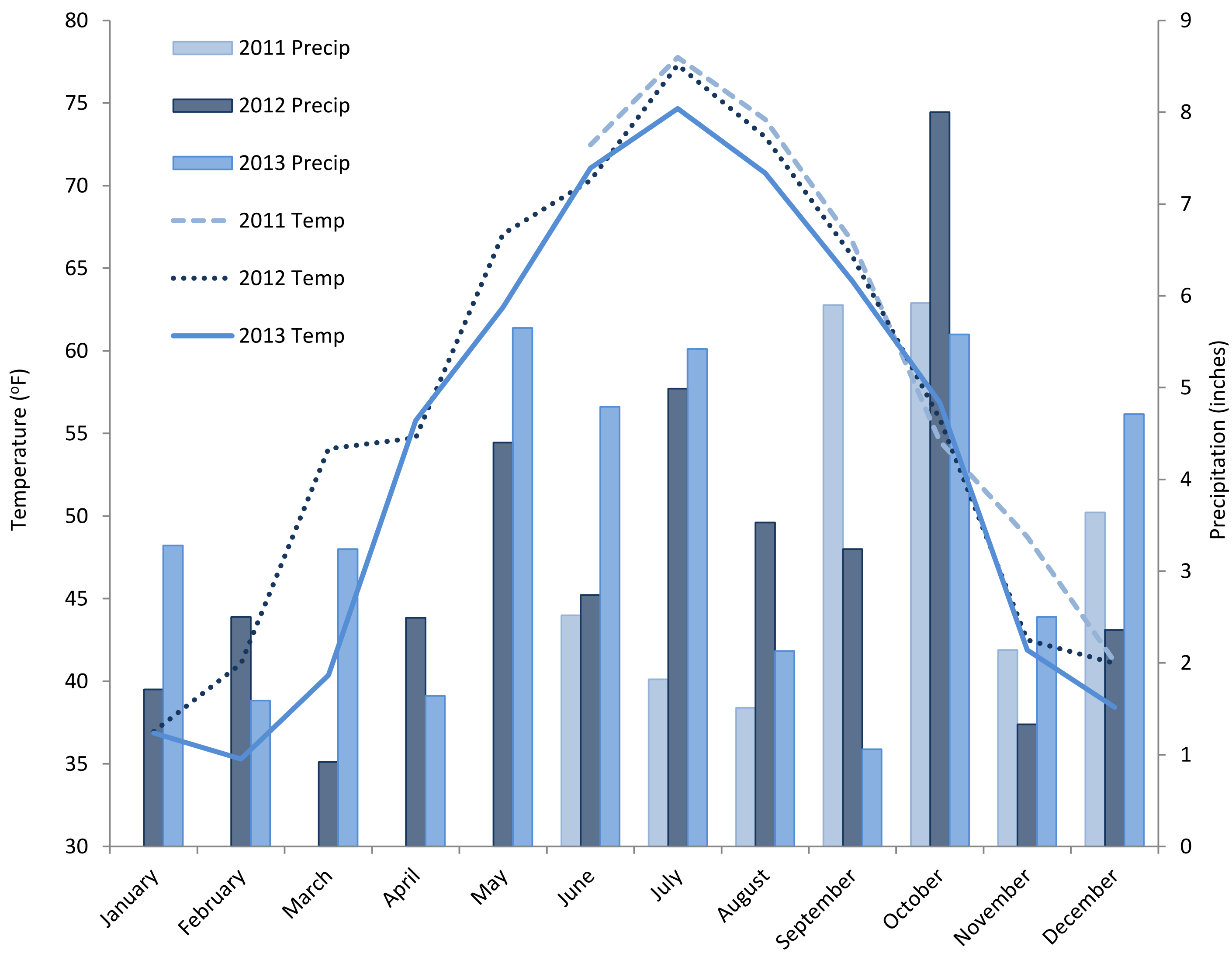
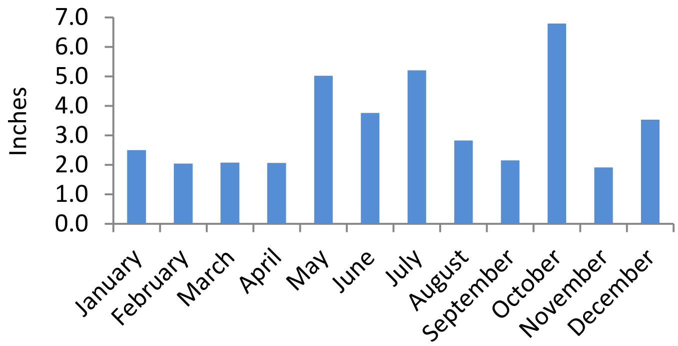


Figure 4: Average monthly temperature and precipitation from 2011 – 2013. The weather station was deployed in May, 2011 making June the first full month of data collection in 2011.

[1]Weather.com. http://www.weather.com/weather/wxclimatology/monthly/graph/22747. (May 2, 2012).

Averaging precipitation data in 2012 and 2013 highlights the impact of hurricane season on local weather patterns (Figure 5). October has been by far our wettest month, with most of the precipitation coming in one or two severe rain events. Another agriculturally relevant difference from 2012 was lower night time temperatures (Figure 6). Temperatures exceeding 70° F at night can lead to higher respiration rates in certain crops, thereby reducing their yield. This environmental influence cannot easily be countered, and we are investigating ways in which to compensate for this seemingly more frequent reality.



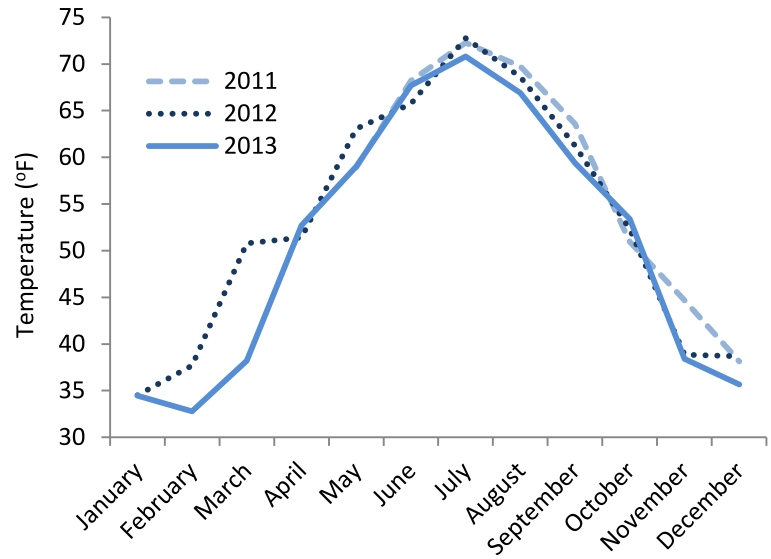


Figure 5 (above): Average monthly precipitation in 2012 – 2013. **Figure 6** (right): Average monthly night time temperatures (7 pm – 7 am) in 2011 – 2013. Data collection in 2011 began in June.

Water Chemistry. We continued our water monitoring protocol of monthly sampling of the Farm's nine ponds (APPENDIX A). Three samples were taken from each pond, and values for temperature (Temp), pH, conductivity (Cond), total dissolved solids (TDS) and salinity were averaged (Table 1). Field methods are outlined in our 2011 report. Overall, there was little change in water quality at the ponds. Annual averages for conductivity (99.6 µs) and TDS (70.3 ppm) for the nine ponds remain well below average values for drinking water in the US (375 µs and 350 ppm, respectively) (Figure 7).

Table 1: Average water quality parameters of the Farm's nine ponds in 2013 with percent change from 2012 in *italics*.

Pond	Temp (°C)		pH		Cond (µS)		TDS (ppm)		Salinity (ppm)	
Compost	17.61	*-3.29%*	8.50	*+17.46%*	184.20	*+6.07%*	130.67	*+5.64%*	82.07	*-1.47%*
4-Barn	18.36	*-4.94%*	8.29	*-8.95%*	108.78	*-0.38%*	77.93	*+0.34%*	47.97	*-11.76%*
El Grande	18.26	*-7.74%*	8.30	*-3.07%*	100.39	*+7.69%*	65.17	*-1.19%*	40.03	*-16.15%*
House	19.41	*-3.47%*	8.80	*-6.95%*	112.47	*+9.07%*	79.97	*+9.14%*	49.30	*-2.96%*
Sycamore	18.39	*-7.38%*	8.59	*-3.86%*	122.10	*+3.99%*	86.83	*+3.97%*	53.77	*-6.98%*
Lower Necklace	18.70	*-6.70%*	8.13	*-7.99%*	68.63	*-0.53%*	49.00	*-0.25%*	30.70	*-17.16%*
Middle Necklace	18.09	*-10.67%*	7.46	*-16.47%*	63.60	*-12.26%*	45.27	*-11.97%*	28.57	*-30.09%*
Upper Necklace	17.60	*-8.48%*	8.31	*+7.87%*	63.87	*-35.10%*	45.40	*-35.14%*	32.90	*-32.76%*
Henry's	18.62	*-6.62%*	7.37	*-19.96%*	72.68	*-8.13%*	52.07	*-7.22%*	32.87	*-23.02%*

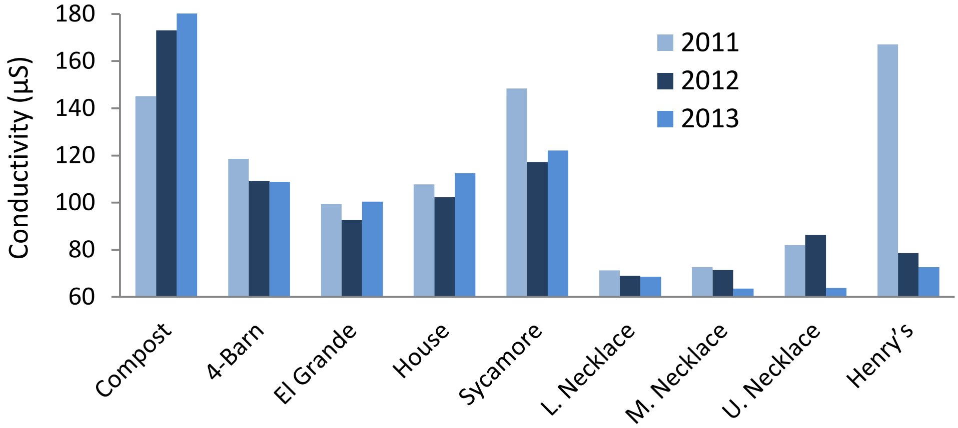


Figure 7: Average conductivity of the Farm's nine ponds from 2011-2013. Overall conductivity values remained relatively stable between 2012 and 2013 with a negligible (3.3%) decrease.

The Necklace Ponds consistently show the lowest conductivity values among the Farm's ponds (APPENDIX A). Conductivity is a measure of dissolved ions in water and, when high, can indicate inputs of materials from erosion. These low values may be a result of the surrounding land cover—whereas most other ponds are situated below agricultural fields, the immediate upslope drainage basin of the necklace ponds is covered by forests and by warm season grass (WSG) meadows that have been in place for five or more years (Figure 8). This is only an assumption at this time and must be coupled with the fact that all of our ponds are bordered by thick vegetation which would act as a buffer against eroded sediments to some degree.

Figure 8: The three Necklace Ponds (lower left) are immediately downslope from 14 acres of native warm season grass meadows. The meadows filter both groundwater and the intermittent stream that originates in the mountains of Shenandoah National Park to feed these irrigation ponds.

Bio-indicators. We dedicated more effort than in previous years to monitor wild populations that serve as indicators of the health of their environment. The use of indicator species to assess ecosystem integrity, particularly in aquatic habitats, is in many ways superior to tracking changes in abiotic chemical variables. Taxa such as benthic macro-invertebrates and aquatic salamanders are always present in streams and are subject to any fluctuations in water quality throughout the year which may be missed by periodic water sampling. The population structure of soil-dwelling animals like earthworms can provide clues as to how historic land uses have shaped current conditions.

Aquatic Salamanders. Stream salamanders are useful indicators of the health of their aquatic environment because they are sensitive to fluctuations in the environment, easy to sample and abundant enough to provide statistically meaningful data. We survey for salamanders at seven sites distributed among the Farm's two streams (APPENDIX B). Sampling is conducted in spring and fall.

As in previous years, northern dusky salamanders (*Desmognathus fuscus*) accounted for the vast majority of individuals observed (>83%), followed by northern two-lined salamanders (*Eurycea bislineata*) at slightly over 13% (Table 2). Only one northern spring salamander (*Gyrinophilus porphyriticus*) was recorded. All three of these species are plethodontids, or "lungless" salamanders that respire by absorbing oxygen directly through their skin, thereby making them particularly sensitive to changes in water quality. Moreover, these species take multiple years to mature, therefore the presence of adults indicate the relatively long-term health of a stream. This, combined with the high numbers of individuals we found, suggests that these streams are stable and healthy environments. The two frog species observed during sampling are not considered bio-indicators in this study but were included here to highlight that many generalist amphibians will also exploit these small streams as habitat.

Table 2: Aggregated findings from the spring and fall stream salamander surveys at the Farm's two streams. Site 6 was dropped from sampling.

Site	N. dusky salamander	N. spring salamander	red salamander	N. two-lined salamander	green frog	American toad	total
1	28	1	0	2	2	0	**33**
2	24	0	0	7	0	0	**31**
3	28	0	0	2	0	0	**30**
4	36	0	0	5	0	1	**42**
5	8	0	0	3	0	0	**11**
7	2	0	0	0	0	0	**2**
8	0	0	0	1	1	0	**2**
total	**126**	**1**	**0**	**20**	**3**	**1**	**151**

Aquatic Macro-invertebrates. These aquatic invertebrates are the archetype bioindicator organisms and include worms, molluscs, larval insects and other soft-bodied animals. Some groups are more sensitive to fluctuations in water quality than others; therefore, the proportion of one assemblage of species over another can indicate the overall health of a water body. The Orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) are among the most pollutant-sensitive aquatic invertebrates. Collectively these taxa are abbreviated as EPT. High representation of EPT species indicates a healthy stream. Other invertebrates, such as midges and blackflies, are more tolerant to impacts in stream quality. The overrepresentation of these aquatic larvae is an indicator of impaired stream health. Coincidentally, midges and blackflies are a biting nuisance to humans when they emerge as adults in spring and summer.

Two surveys for aquatic macro-invertebrates were conducted in the spring and fall by students from the Smithsonian-Mason School of Conservation at four sites along the Western Stream which originates in Shenandoah National Park before flowing through our property and eventually joining the Rush River (APPENDIX A). This semi-permanent 1st order stream briefly flows over a neighbor's property before resuming its course across the Farm. The group surveyed two sites upstream from the stream's entry into our neighbor's property and two downstream after it returns to the Farm. The upstream sites are bordered by intact forest whereas those downstream are buffered only by turf grass and a narrow band of woody vegetation (APPENDIX C).

The students collected samples by disturbing the stream sediment to dislodge macro-invertebrates that were then swept into a net downstream. Multiple samples were taken at each site to cover the variation present within the stream (e.g. areas with large rocks verse those characterized by gravel or soft sediment). Nitrate and nitrite profiles were also developed as an elevated presence of these substances can indicate that manure or other agricultural materials are being washed into the stream.

Despite considerable differences in the physical characteristics both in and around the four sampling sites, all sites were rated in the healthiest categories for bio-indicator populations and chemical values for nitrate and nitrite levels. Ongoing sampling over multiple years is necessary to develop a more robust profile of stream health, yet these initial findings suggest that our agricultural practices are not having a negative effect on aquatic organisms when compared to sites upstream nested within intact forest.

Terrestrial Salamanders and Soil Health. The Farm at Sunnyside has an agricultural history stretching back hundreds of years. As such, crop production on the property has run a wide gamut of management strategies, including the use of lead arsenate, which was widely employed to manage insect pests in apple orchards throughout the early to mid-20th century (APPENDIX D). Fortunately, during the peak use of this compound in the 1940s and 1950s, most of the apple production was concentrated in what is now early-successional forest not used for agriculture. Still, all crop production areas are rigorously tested for the presence of heavy metals. So far, we have not recorded levels of lead or arsenic above the background range naturally expected in soil.

Our modern agricultural areas may be free from elevated lead and arsenic levels, but we have long wondered whether the presence of harmful amounts of these substances in former orchard sites could be a factor in the apparent absence of normally abundant soil-dwelling salamanders. A case in point is the northern red back salamander (*Plethodon cinereus*), one of the most abundant and cosmopolitan salamanders in the eastern US and quite reliably found under most any woody debris in upland forests (Figure 9). Still, not a single individual has ever been recorded on the property. Based on observations during the annual spring amphibian migrations, we know the Farm supports a robust population of other terrestrial salamanders, namely the spotted salamander (*Ambystoma maculatum*), yet this species is far more mobile than the red back—whose home range is approximately 1^2 m— and may therefore be better equipped to move in accordance with changing habitat conditions (Figure 10).

Figure 9 (left): red back salamander (*photo credit*: Virginia Herpetological Society[2]). **Figure 10** (right): spotted salamander.

[2] http://www.virginiaherpetologicalsociety.com/

To determine if elevated heavy metals may be contributing to the absence of common terrestrial salamanders, a group of Smithsonian-Mason School of Conservation students performed a survey of salamander occurrence in association to soil arsenic and lead levels at former orchard sites at the Farm. The group examined eight sites, four within an area known to have historically been in orchard and four in an area that had not been managed as orchard during the use of lead arsenate. Students searched for salamanders by carefully lifting rocks and woody debris, and took soil samples at each site to be tested for the presence of heavy metals, as well as other physical and chemical characteristics known to have influence on salamander populations (i.e. soil moisture and pH and canopy cover).

Results from the soil analyses revealed that the control sites in which no lead arsenate was used had an aggregated arsenic level of 6.53 mg/kg of soil, slightly less than the approximate background arsenic level of ~13 mg/kg of soil expected in this region, while treatment sites showed levels at 44.49 mg/kg of soil. Lead was also more abundant in treatment sites (159.9 mg/kg of soil) compared to control sites (36.1 mg/kg of soil). Other environmental variables did not differ between treatment and control sites.

Because levels of arsenic and lead were the only environmental variables to show a biologically significant difference between treatment and control sites, it allowed for more confidence with which to determine if these compounds have an influence on salamander populations. However, as in all previous sampling conducted by the conservation manager, not a single salamander was found in either the former orchard sites or the older and more "pristine" control sites, ultimately making it impossible to inculpate the elevated presence of these heavy metals as a cause behind the absence of salamanders. Research into the mystery of the missing salamanders will continue.

Orchard Pest & Disease Monitoring. Apples were the primary crop grown at The Farm at Sunnyside for most of the last two hundred years and for much of that time orchards covered a large percentage of the property. Much of the current orchard is relatively young, being installed in the late 1990s by the previous owner who also diversified the crop inventory with 18 varieties of apples, peaches, cherries and two varieties of Asian pear. Today, apples and other fruit trees are just one component of a diverse production system, totaling slightly over 21 acres (APPENDIX E).

Organic orchard management, especially in the mid-Atlantic, poses a range of challenges, and the current orchard at the Farm has been maintained inconsistently by both the current and previous owners. The ground cover contains many aggressive species (both native and exotic) that compete with the fruit trees for resources. The orchards also hide many of our most problematic invasive plants such as Johnson grass (*Sorghum halepense*). Due to our limited control options within agricultural production areas (including even the impracticality of frequent mowing), the orchards have become a significant exporter of invasive weeds.

In 2013 we were determined to explore the costs and benefits of investing additional resources into a more intensive style of orchard management. We wanted to test whether more precise timing of pest suppression strategies, such as spraying a species specific pesticide. The conservation manager took on responsibility for monitoring apple pests and diseases with the help of experienced personnel at Virginia Tech. Yet despite considerable efforts to increase the precision of management actions in the orchards we saw little change in yield. Regardless of this outcome, we feel that we are well-equipped to increase the precision of our pest management strategies by utilizing the latest technology and the conservation manager's statistical skills. In the coming years we will further integrate the conservation manager in these farm practices.

BIODIVERSITY ASSESSMENT

GOAL: To comprehensively inventory the full range of biodiversity present on the Farm. In this way, we aim to establish a robust baseline of species occurrence from which we can monitor change over time, make certain assumptions about habitat diversity and quality and set conservation priorities.

This year the conservation manager dedicated a larger proportion of his time to ecological monitoring, leaving less opportunities for direct sampling of biodiversity. To compensate, most of our new monitoring efforts were targeted at the bio-indicator species discussed in the previous section. This shift in focus allowed us to continue inventorying species while developing new metrics to gauge environmental health. Many of our 2013 biodiversity assessment activities and collaborative research efforts were directed at invertebrates.

Mammals. 2013 marked the last season of our camera trapping project in collaboration with Environmental Studies on the Piedmont (see 2011 report for details). The cameras were removed from their stationary locations in forests to be used for targeting species in other habitat types on the property such as forest edges and WSG meadows, and for continued identification and study of wildlife corridors. Unlike the random placement of cameras in the Environmental Studies on the Piedmont study, we began situating cameras to maximize the probability of observing new species. Our new approach yielded observations of long-tailed weasel (Figure 11) and eastern spotted skunk (*Spilogale p. putorius*) (Figure 12), a state-endangered species of conservation concern throughout its range.

Figure 11 (left): Long-tailed weasel. **Figure 12** (right): Eastern spotted skunk

Birds. The Farm maintains a list of all birds recorded on the property since its purchase in 2006 (APPENDIX F). That list now reflects 148 species, the majority of which have been recorded by the farm's owner. New sightings in 2013 included American wigeon (*Anas americana*), great egret (*Ardea alba*), Wilson's warbler (*Cardellina pusilla*) and Lincoln's sparrow (*Melospiza lincolnii*). Of particular interest this year was the arrival of three barn owls (*Tyto alba*) on the property, two of which were occupying a nest box erected in an abandoned silo near the farm center in 2011. Attracting a stable population of these owls has been a priority for the Farm for many years, both because they are diminishing across their range and also because they are tremendously efficient predators of small rodents. With luck, nest box monitoring in 2014 will show that these birds are successfully breeding at the Farm.

Amphibians. As we outlined in our previous reports, the Farm contains several ephemeral wetlands that play host to an explosive night of amphibian breeding each spring. Some of our local amphibians such as spotted salamanders and the wood frog (*Lithobates palustris*) only breed in these temporarily flooded wetlands, making these large "puddles" a critical habitat component for these species. To date, the only ephemeral wetlands (or vernal pools) that we have found are remnants of farm practices. These artifacts of historic agricultural uses include an abandoned cattle watering pond and a spring box. It is possible that these sites were natural vernal pools before being altered and have since reverted to their historic ecosystem function. Today we carefully monitor these areas to ensure that they are fulfilling the needs of sensitive amphibians and are not merely “ecological traps” that do not function adequately and may even have a sink effect on the population.

Vernal pools are the characteristic standing water wetland of the Piedmont, but because of their temporarily flooded nature their value in ecosystems has historically been disregarded and many have been destroyed. Given the importance of these wetlands to many of the Farm’s amphibians—and other wildlife and plants—we decided to experiment with creating our own vernal pool. In the spring, after the yearly migration of pool-breeding amphibians was completed, we dug a small depression near a patch of forest next to our asparagus field (Figure 13). We then capped the hole using clay from a nearby section of the Farm. The operation took about two hours. We will continue to monitor the pool for amphibian activity and plan to create more of this habitat in the coming years.

Figure 13: Constructing an artificial ephemeral wetland. We used a backhoe to remove the porous top soil then added a layer of clay from a nearby area of the Farm (top left). The clay was compacted to form a watertight cap lining the bottom of the pool (top right) and the top soil was replaced. By mid-summer the pool was holding water but its sediments had not yet stabilized (bottom left). Finally, the pool displayed the crystal clear water characteristic of these wetlands by winter (bottom right).

Plants. In 2011 we began the initial steps to eradicate ailanthus AKA tree of heaven (*Ailanthus altissima*) from the property (APPENDIX G). As is discussed in the following conservation management section, we contracted the Virginia Forestry and Wildlife Group to control the trees using an injection herbicide method. Most of this work was conducted in a belt of early successional forest situated between older forest and the open areas of the Farm. We were very interested in how removal of such a large component of the canopy would affect regeneration of the forest considering that in the next 10-15 years the arrival of the emerald ash borer (*Agrilus planipennis*) will decimate the ash trees (*Fraxinus* spp.) that comprise another significant portion of the canopy cover in forested areas of the Farm.

To gain a more in-depth understanding of how the plant community would respond to increased light availability, we characterized plant diversity and relative cover on the forest floor at 24 sites throughout the treatment area during and shortly after the herbicide application. Sites were defined by a 1 m^2 square and split among areas where the canopy was dominated (>50% cover) by either ailanthus or native hardwoods (APPENDIX G).

Detailed findings from the first survey are outlined in our 2011 report, but in general we observed higher forest floor diversity at sites with a greater proportion of native hardwoods in the canopy whereas sites dominated by ailanthus had more extensive invasive plant cover at the ground level, such as Japanese honeysuckle (*Lonicera japonica*), and almost no native hardwood seedlings. We revisited these sites in 2013 and initial results show relatively little change in sites with a native hardwood canopy (as would be expected) while many of those in areas where the ailanthus had been removed have changed dramatically. We found 71 plant species in 2011 and 82 in 2013. This change was almost entirely driven by the appearance of “old field” plants such as Canada goldenrod (*Solidago canadensis*) at sites with a newly opened canopy, though a few new hardwood seedlings (e.g. mockernut hickory [*Carya tomentosa]*) were observed. Overall, coverage by species considered invasive, including Japanese honeysuckle, ailanthus seedlings and Japanese barberry, increased by 50% from 2011 to 2013. Again, this trend was dictated by expansion of these invasive species at sites formerly covered by ailanthus and released by the increased availability of light. Notably, several new hardwood seedlings were found at these sites in 2013, suggesting the opening of the canopy also created an opportunity for these species to grow. However, nearly all of the individuals found were smothered under dense mats of exotics.

These data reflect the initial stages of a long-term study on regeneration in a specific section of our forest. We now have reasonable evidence to determine that areas with a substantial invasive plant presence can be expected to experience increased spread of these species once the tree canopy is removed, as will be the case for much of these areas in a post-emerald ash borer Virginia. The sites will be revisited over the coming years to further examine the fluctuations in the plant community. Over time this study will give us insight into how to develop management strategies to prepare for the effects of emerald ash borer.

Invertebrates. As discussed in the previous section, some of our new ecological monitoring techniques focused on examining the population structure of invertebrate species. 2013 was also marked by several other notable events in the Farm’s invertebrate world.

Butterflies and Moths. We were once again fortunate to be part of the North American Annual Butterfly Count conducted by the Old Rag Master Naturalists on July, 28th. Eight searchers sampled for 2.5 hours using a random encounter survey method in three WSG meadows: the Tall Grass, Wildflower and Sycamore Meadows (APPENDIX H). In total, 31 of the 39 species found across the 17 properties surveyed were observed at the Farm, making us the most diverse site. The Farm also supported the greatest abundance of butterflies among sites in the countywide survey with 32% (n = 1523) of all individuals counted here (APPENDIX I). Notably, the only monarch butterflies (*Danaus plexippus*) observed during the entire survey were found at the Farm.

Earthworms. These ubiquitous invertebrates can have such a profound effect on local ecology that they are considered ecosystem engineers. Given their potential to significantly alter the quality of soil we are working to develop a stronger understanding of earthworm populations at the Farm with regard to both agricultural production and from a biodiversity/habitat management perspective. Many species found in northern Virginia, such as the familiar nightcrawler (*Lumbricus terrestris*), are exotic invasives that can outcompete native earthworms and actually reduce soil quality by consuming too much of the organic matter in soil, thereby having the potential to negatively affect plant community structure.

In late summer, students from the Smithsonian-Mason School of Conservation began initial work to inventory the earthworm community at the Farm. The students compared earthworm occurrence across six habitat types: agricultural fields, orchard, warm season grass meadows, pasture dominated by tall fescue (*Schedonorus phoenix*), mature forest and early successional forest (APPENDIX E). The group collected samples at multiple sites per land cover type by pouring a water/mustard mixture on a small plot (the mustard irritates the earthworms and coaxes them to the surface). A suite of soil samples were also collected at each site to be analyzed for the chemical properties and nutrients important to crop production and wild plant growth.

Only two native earthworm species were found among the eight observed, yet the natives were the most abundant species (Table 3). Earthworms can be difficult to identify to species, and it should be noted that multiple species may have been represented in the sample of *Diplocardia* spp. The most earthworms were found in the fescue pasture (n = 131), followed by the orchard (n = 113), which has a fescue ground cover similar to the pasture, and agricultural fields (n = 104). While comparatively few individuals were found in warm season grass meadow, this habitat had the highest relative proportion of natives to invasives. Moreover, the only habitat in which natives were not found was the agricultural field. This may be due to the more intensive management of these areas where soil is routinely disturbed for crop production. Species composition may also have been determined by the history requirements of these different types of earthworm.

Table 3: Earthworm species occurrence among six habitat types (adapted from student project Ruther et al., 2013)

Latin Name	Status	Agricultural Field	Orchard	WSG Meadow	Fescue Pasture	Mature Forest	Young Forest	total
Diplocardia spp.	Native	0	0	45	0	12	44	**101**
Eisenoides carolinensis	Native	0	83	0	58	0	0	**141**
Amynthas spp.	Invasive	11	0	0	3	0	7	**21**
Dendrobaena octaedra	Invasive	0	12	8	6	0	28	**54**
Eisenia eiseni	Invasive	11	0	7	0	14	0	**32**
Eisenia fetida	Invasive	0	0	0	0	4	0	**4**
Lumbricus rubellus	Invasive	0	18	0	64	0	0	**82**
Lumbricus terrestris (adult)	Invasive	11	0	0	0	0	0	**11**
Lumbricus terrestris (juvenile)	Invasive	71	0	0	0	0	0	**71**
total		**104**	**113**	**60**	**131**	**30**	**79**	**517**

Brown Marmorated Stink Bugs. Taliaferro Trope of Virginia Tech continued her research on brown marmorated stink bug (BMSB) (*Halyomorpha halys*) occurrence at the Farm. This year the study was focused on BMSB plant and crop associations, particularly sweet corn (Figure 14). Populations of this pest were especially high in 2013 and the damage they caused to corn, tomatoes, peppers and numerous other crops was significant. Observations of their activity on wild plants showed that BMSBs appear to be associated with sumacs (*Rhus* spp.) and white mulberry (*Morus alba*). It is possible that the presence of these species near growing areas may take some of the BMSB pressure off of crops.

Figure 14: Brown marmorated stink bugs on sweet corn.

Cicadas. 2013 was a special year in the invertebrate world as the 17-year periodical cicadas (*Magicicada* spp.) emerged from their larval home in the soil. The metamorphosis of so many individuals to flying adults has dramatic effects on the ecosystem. After mating, female cicadas deposit their eggs in slim tree branches, preferring those about the diameter of a pencil. After a short development phase, the larvae drop to the ground and began their 17 year period in the soil feeding on the fluids in roots.

While generally harmless to mature trees, young or weak trees can be damaged or even killed as the larvae grow within the twig. Many of our orchard trees were impacted and production appeared to be noticeably reduced. Unfortunately, several of our restoration plantings were significantly damaged, particularly the grey dogwoods (*Cornus racemosa*) and red twig dogwoods (*Cornus sericea*) that dominate the Ramble restoration site (APPENDIX E). Damage was also apparent, though not as dramatic, on recently planted American hornbeam (*Carpinus caroliniana*) and river birch (*Betula nigra*), which were already weakened from transplant stress (Figure 15).

The emergence of the 17-year cicadas is also a time of feasting for wildlife. Many species take advantage of this plentiful source of protein. Our trail cameras recorded multiple species plucking cicadas from trees like ripe fruit (Figure 16). Cicada remains were also found in American kestrel (*Falco sparverius*) nest boxes, the adult birds apparently feeding these nutritious insect to their young. Anecdotally, there appeared to be more juvenile striped skunk (*Mephitis mephitis*) and raccoon (*Procyon lotor*) than had ever been observed at the farm. It may be that the adults were able to produce and support more offspring because of the abundance of the nutritious and readily available cicadas.

Figure 15 (left): A periodical cicada ovipositing her eggs on the branch of a river birch. Depositing the eggs creates the scar pattern seen along the twig. As the larvae grow the twig will further split and may be destroyed. **Figure 16** (above): A raccoon plucking a cicada from a shrub.

CONSERVATION MANAGEMENT

GOAL: To increase farm biodiversity and enhance its agricultural benefits by improving habitat quality for target species. While we view biodiversity conservation as an important objective in its own right, we also seek to enhance the contribution of wild species to food production.

Land Use Planning. In 2012 we created a land management planning document identifying sections of the property that we consider "marginal" land defined by a lack of agricultural or wildlife benefit and carrying recurrent costs from the frequent mowing needed to prevent these areas from becoming a source of weeds (APPENDIX E). The goals of this project were to (1) increase the agricultural and/or wildlife value of units; (2) strengthen connectivity of warm season grass meadows, forests and other habitat patches; (3) improve ecosystem services such as expanding buffers around streams and ponds; and (4) reduce the maintenance costs of unproductive units.

At the time of developing this document in 2012 there were approximately 55 acres of marginal land distributed throughout the Farm. This year we began the initial stages of transitioning 21 acres of that area to WSG meadow. Over time these sections of the farm, formerly dominated by invasive weeds, will serve as valuable habitat for wildlife, and be a source of ecosystem services by providing habitat for pollinators and crop pest predators.

Invasive Plant Control. We still struggle against the harmful effects of exotic invasive plants, but we have made significant progress in the suppression of particular species in key habitat and agricultural areas. Most exotic plants are harmless components of the ecosystem, yet some, such as Johnson grass (*Sorghum halepense*) and mile-a-minute (*Persicaria perfoliata*), are so aggressive that they outcompete native vegetation, ultimately reducing the quality of a habitat patch. It is this group of highly invasive species on which we focus our eradication efforts. Notably, there are also many highly aggressive native species that are similarly deleterious to plant biodiversity when they occur in high numbers. Species like yellow crownbeard AKA wingstem (*Verbesina occidentalis*) and Canada goldenrod (*Solidago canadensis*) present difficult management issues in our warm season grass meadows.

To date, our most extensive efforts to control a single species have been directed at ailanthus AKA tree of heaven (*Ailanthus altissima*). In 2011, we contracted the Virginia Forestry and Wildlife Group to eradicate ailanthus at the Farm, with most of the effort focused on a 15 acre belt of early successional forest formerly in orchard (APPENDIX G). The team used a method known as "hack-and-squirt" in which the tree is wounded and a small amount of herbicide is injected. Results from the initial treatment were largely successful, with only an estimated 1-2% of treated ailanthus needing a second application. As of 2013, there were only a handful of mature trees known to still occur on the property. Seedling control (ongoing since 2012) will need to be continued moving forward and can be expected to lessen in intensity as the seedbank is depleted.

Our highest priority control targets for 2013 were Johnson grass, mile-a-minute, sericea lespedeza (*Lespedeza cuneata*) and Chinese privet (*Ligustrum sinense*) (APPENDIX J). These species rank so highly because they are capable of rapid spread, are known to outcompete native plants and are localized enough in their infestation to make eradication possible. Other species, like Japanese honeysuckle, are aggressive competitors, but occur so extensively that property-wide control is not realistic at this time[3]. As we outline in the previous reports, we use a variety a control methods including mowing, hand pulling, fire and targeted herbicide applications (outside of agricultural production areas)[4].

Johnson grass (right) is currently the most extensive exotic plant infestation we are actively managing at the Farm. This species is a major concern in both our warm season grass meadows and agricultural growing areas where it competes with our vegetable crops. Johnson grass spreads through a rhizomatous root system and produces an extraordinary abundance of seeds. These factors make it especially hard to control. Our management has largely focused on mowing and hand pulling, but these methods are time and labor intensive. Spot spraying is also occasionally used in our meadows—problematically, however, as it is difficult to avoid damage to non-target species. This year we have shifted to using the grass specific herbicide Sethoxydim for spot spraying Johnson grass in established wildlife habitat in order to minimize non-target damage to surrounding forbs.

Mile-a-minute (left) is a herbaceous vine that can smother and kill established vegetation. As its name suggests, this species grows incredibly fast making constant monitoring necessary to keep it from producing seed and spreading further. Previously known to occur in only one location on the property in 2012, we found mile-a-minute in several new locations by mid-summer. Others in the county observed similar explosions of this plant at their properties where it had never been seen prior. We suspect that the wetter spring weather may have been associated with the apparent expansion of this moisture loving species at our property and across the region.

[3]Additional species of concern include tall fescue (*Schedonorus phoenix*), multiflora rose (*Rosa multiflora*), Canada thistle (*Cirsium arvense*), Japanese stilt grass (*Microstegium vimineum*), autumn olive (*Elaeagnus umbellata*), garlic mustard (*Alliaria petiolata*), and Japanese barberry (*Berberis japonica*). While some of these species provide food and cover for wildlife—and were historically introduced partially for this purpose—their aggressiveness can drastically alter the structure of the landscape, ultimately diminishing biodiversity.

[4]We have concluded that it is not feasible to address the Farm's invasive species challenges using only organic means. Accordingly, we have opted to supplement mechanical treatments with selective herbicide use in certain non-agricultural areas. We maintain required buffers, store herbicide material and equipment away from agricultural equipment and infrastructure, and limit applicators to the conservation manager, farm owner and licensed contractors.

Sericea lespedeza (right) has been a serious issue in our northern warm season grass meadows (APPENDIX E). The previous owners intentionally planted this species, presumably as a bank stabilizer. Left unmanaged for over a decade, the result is a robust seed bank requiring repeated yearly management. Little impact on sericea lespedeza abundance was apparent after our 2012 treatment, but given the tremendous seed bank present in the soil this outcome is not surprising. We performed multiple rounds of herbicide treatment at these sites, spot spraying with the broadleaf specific herbicide Crossbow to minimize non-target damage to surrounding native grasses. The follow-up applications targeted individuals missed the first time around. Additional treatment will almost certainly be needed in the coming years.

Chinese privet (left) is commonly used in hedges and, like sericea lespedeza and Johnson grass, was most likely introduced intentionally. This large shrub grows so thickly that it prevents other plants from growing beneath its canopy. It also grows in full-shade, and because of this may be having a negative effect on forest regeneration where infestations are severe. We identified this species as a top control target in 2013 because its occurrence is somewhat localized, thereby making full eradication a possibility. Also, being woody this species can be controlled in winter by applying herbicide directly to the cut stump, thus reducing the risk of damage to surrounding dormant plants. We plan to attempt property-wide control of Chinese privet in the winter of 2014.

Conservation plantings. The establishment of native warm season grass and flower meadows has been at the center of our wildlife habitat enhancement efforts. In 2013 we converted two small patches of marginal land to WSG meadow, totaling just less than 0.75 acres (APPENDIX E). This relatively small addition raised our total land area of WSG and naturally managed meadows to approximately 33 acres. (Naturally managed meadows are meadow-like in their plant structure and are periodically burned like our warm season grass meadows to create disturbances in the tall fescue monoculture to allow other plants to take hold, thereby increasing diversity). Given the size of these sites we did not expect them to support resident grassland specialist species such as northern bobwhite quail (*Colinus virginianus*). Instead, we chose to develop a seed mix designed to maximize pollinator diversity (APPENDIX K). As in previous years, a subset of meadows were burned as part of their 2-3 year management cycle (APPENDIX L).

In spring we planted several large trees throughout the property. We transplanted 20 river birch at various locations around the Farm, primarily to bolster riparian buffers. We also created a grove of 12 American hornbeam to further expand the “Ramble” restoration area (APPENDIX E). This patch of land situated between warm season grass meadow and forest was formerly dominated by ailanthus and other invasive plant species. Since 2011 we have been actively controlling invasive plants while restoring native low canopy and shrubby species to create an early successional forest structure. Many of the dogwood species planted in 2011 have become large enough to support nesting birds and shade out tall fescue and other exotic weeds growing under their canopy. Several of the American hornbeam we planted this year were used by nesting birds and will help shade out remaining ailanthus seedlings in coming years.

In the fall of 2012 we planted several species of native flowers near one of our vegetable fields (Figure 17). Comparatively little native vegetation is present near this growing area. This “pollinator patch” was designed to act as beacon to foraging bees, butterflies, flies and other pollinators, thus drawing their traffic closer to our crops. We selected species to ensure the longest possible nectar flow throughout the season. We also chose plants known for their aggressive growth habit, such as obedient plant (*Physostegia virginiana*) and short-tooth mountain mint (*Pycnanthemum muticum*), so they could hold their own against the surrounding tall fescue. The plants were arranged to create large displays of single colors known to be attractive to native bees. While only in its first full growing season, this small patch of flowers was covered with pollinators throughout the warm season (Figure 18).

Figure 17 (above): This “pollinator patch” is situated in a sea of tall fescue. We designed this site based on an understanding of how bees and other native insect forage. Once fully established, we can begin studying how this patch of wildflowers affects the occurrence of pollinators in the area. Do bees visit our crop flowers once this colorful beacon draws them to the field? The coming years will tell. **Figure 18** (left): We observed an enormous abundance and diversity of pollinator species using this small section of land. Three insect species are pictured on these hoary mountain mint (*Pycnanthemum incanum*) flowers.

Nest boxes. We continued our efforts to provide nesting habitat for birds at the Farm with a focus on species that provide the ecosystem service of pest control (APPENDIX M). Of particular interest are songbirds that consume insects in our agricultural fields—many of which may be crop pests—and birds of prey that target small mammals such as voles and other rodents that cause significant damage to crops.

In May we banded 14 American kestrels. Roger Jones, licensed by the US Fish and Wildlife Service, assisted with the banding as part of a countywide effort to monitor kestrel populations (Figure 19). Eastern screech owls (*Megascops asio*) continue to employ nest boxes for winter roosting, though have yet to use them to nest, and as discussed earlier, barn owls (*Tyto alba*) have been observed more frequently this year but have yet to breed in their artificial nest boxes.

Figure 19: A fledgling American kestrel

This year we added a 19th box to our array of nests designed for eastern bluebirds (*Sialia sialis*) and tree swallows (*Tachycineta bicolor*). A number of these boxes are positioned within and adjacent to our vegetable production areas (APPENDIX M). In total, 65 chicks were fledged (46 eastern blue birds and 19 tree swallows) among 12 of the nests (Table 4) (APPENDIX N). Considerably more bluebirds were fledged in 2013 compared to 2012, but tree swallow fledging was down, a trend that may be attributed to a few predation events.

We are experimenting with different nest box designs with the goal of discouraging both invasive species (i.e., European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*)) and predators. About half of our boxes have protective baffles to deter snakes and raccoons.

Table 4: Summary of hatchling success in nest boxes for eastern bluebirds and tree swallows.

Nest	Baffle	Open Roof	Blue Bird	Tree Swallow	Total Fledged
1	no	no	5	3	**8**
2	no	no	0	0	**0**
3	yes	yes	0	10	**10**
4	yes	no	0	4	**4**
5	yes	no	0	0	**0**
6	yes	yes	0	0	**0**
7	yes	yes	0	0	**0**
8	yes	no	5	0	**5**
9	yes	yes	0	0	**0**
10	no	no	0	0	**0**
11	no	no	0	0	**0**
12	no	no	8	0	**8**
13	no	no	4	2	**6**
14	no	no	7	0	**7**
15	no	no	1	0	**1**
16	no	no	5	0	**5**
17	no	no	4	0	**4**
18	no	no	3	0	**3**
19			4	0	**4**
Species Totals			**46**	**19**	**65**
change from 2012			*+34.8%*	*-47.4%*	*+10.8%*

WILD PRODUCT SALES

GOAL: To generate revenue and educate the public on the value of biodiversity by harvesting and selling fruits, berries, flowers and other products from wild species on the Farm.

By adding native species to our crop inventory we are able to promote the aesthetic and culinary value of biodiversity while directly contributing to farm revenue and helping recover the costs of establishing and maintaining their source habitat. Our most successful wild products include fruits and herbs that grow wild on the property, as well as items generated by our restoration efforts such as bouquets of flowers from our warm season grass meadows. We include sales of honey in this category as well. Honeybees are not native to this continent—and honey is a traditional farm product—but the bees transform our warm season grass meadows and other restoration plantings into a lucrative value-added product.

Following the continued success in marketing wild products alongside our fruits and vegetables, we dedicated significantly more time into developing this new component of our inventory. As a result, sales from wild products reached $7,226.60 in 2013 (Table 5), up 250% from 2012 (Table 6). Honey drove this trend, though gains from our increased effort to promote previously successful items such as mojito mint and spicebush berries were also substantial (Table 6). The Dupont Circle farmer's market remains our best outlet compared to our newest market at Reston, highlighting the variable consumer taste for these items and the importance in understanding the marketing potential of wild species in a given region (Table 5).

Table 5: Line item comparison of wild product sales at our three direct-to-customer outlets.

Product	Dupont Circle	Reston	CSA	total
Apple Blossom	$45.00	$0.00	$0.00	**$45.00**
Coreopsis	$350.00	$0.00	$0.00	**$350.00**
Dried Grasses	$20.00	$0.00	$0.00	**$20.00**
Mojito Mint	$479.00	$78.00	$0.00	**$557.00**
Honey	$2,760.00	$1,206.00	$290.00	**$4,256.00**
Paw-paws	$347.60	$44.00	$0.00	**$391.60**
Peach Blossom	$39.00	$0.00	$0.00	**$39.00**
Serviceberries	$60.00	$0.00	$0.00	**$60.00**
Spicebush Berries	$268.00	$52.00	$8.00	**$328.00**
Spirea	$230.00	$60.00	$0.00	**$290.00**
Wild Rudbeckia Mix	$240.00	$0.00	$0.00	**$240.00**
Wild/Cultivated mix	$312.00	$0.00	$0.00	**$312.00**
Wildflower Mix	$228.00	$60.00	$50.00	**$338.00**
total	**$5,378.60**	**$1,500.00**	**$348.00**	**$7,226.60**

Table 6: Line item comparison of wild product sales from 2011 – 2013.

Product	2011	2012	2013	total
Apple Blossom	$0.00	$0.00	$45.00	**$45.00**
Coreopsis	$0.00	$402.00	$350.00	**$752.00**
Dried Grasses	$0.00	$80.00	$20.00	**$100.00**
Mojito Mint	$0.00	$231.25	$557.00	**$788.25**
Honey	$0.00	$122.00	$4,256.00	**$4,378.00**
Paw-paws	$349.00	$1,140.30	$391.60	**$1,880.90**
Peach Blossom	$0.00	$0.00	$39.00	**$39.00**
Serviceberries	$0.00	$0.00	$60.00	**$60.00**
Spicebush Berries	$0.00	$144.00	$328.00	**$472.00**
Spirea	$0.00	$0.00	$290.00	**$290.00**
Wild Rudbeckia Mix	$0.00	$0.00	$240.00	**$240.00**
Wild/Cultivated mix	$0.00	$0.00	$312.00	**$312.00**
Wildflower Mix	$568.00	$782.00	$338.00	**$1,688.00**
total	**$917.00**	**$2,901.55**	**$7,226.60**	**$11,045.15**

We established our first apiary of five **honeybee** (*Apis mellifera*) colonies in 2012. Despite the quick growth of our colonies through the summer all died in winter. There are a few possible causes for the die offs. The winter of 2012 was relatively warm, and when the temperatures get above the low 50s F bees will leave the hive in search of water or to defecate. The odd warm day in winter is essential to honeybee survival for these reasons, but too many leads to bees expending too much of their energy and thus exhausting resources more rapidly. Even so, all hives contained dozens of pounds of remaining honey so starvation was not likely the cause. In fact, the hives exhibited symptoms characteristic of Colony Collapse Disorder (CCD), a poorly understood condition affecting honeybees and other bee species worldwide. As was observed in our apiary, inspection of the dead colonies reveals a very small number of bees, not sufficiently large to maintain the minimum temperature to survive the cold. Many other local beekeepers experienced similar losses in what was a high mortality year for honeybees across the nation.

After our first-year loss we established another 14 hives in spring. We reasoned that a good defense against the high winter losses being experienced by beekeepers throughout the region would be to have a large number of colonies. This way, if we again suffered heavy winter losses we could propagate new colonies from the survivors, hopefully passing on their genetics to tolerating our variable winter weather.

Compared to 2012, revenue from wild **pawpaw** was down significantly (Table 6). Like apples and other fruit trees, pawpaw yield can vary widely from year to year if not managed to correct this. It so happened that 2012 was a boom year while comparatively few fruits were found in 2013. This trend may have been driven by the physiology of the plant, climatic factors or a combination of both. Regardless, the lower sales were not a result of waning customer interest—pawpaws consistently sold out within a couple of hours at every farmers' market.

Community Outreach and Collaboration

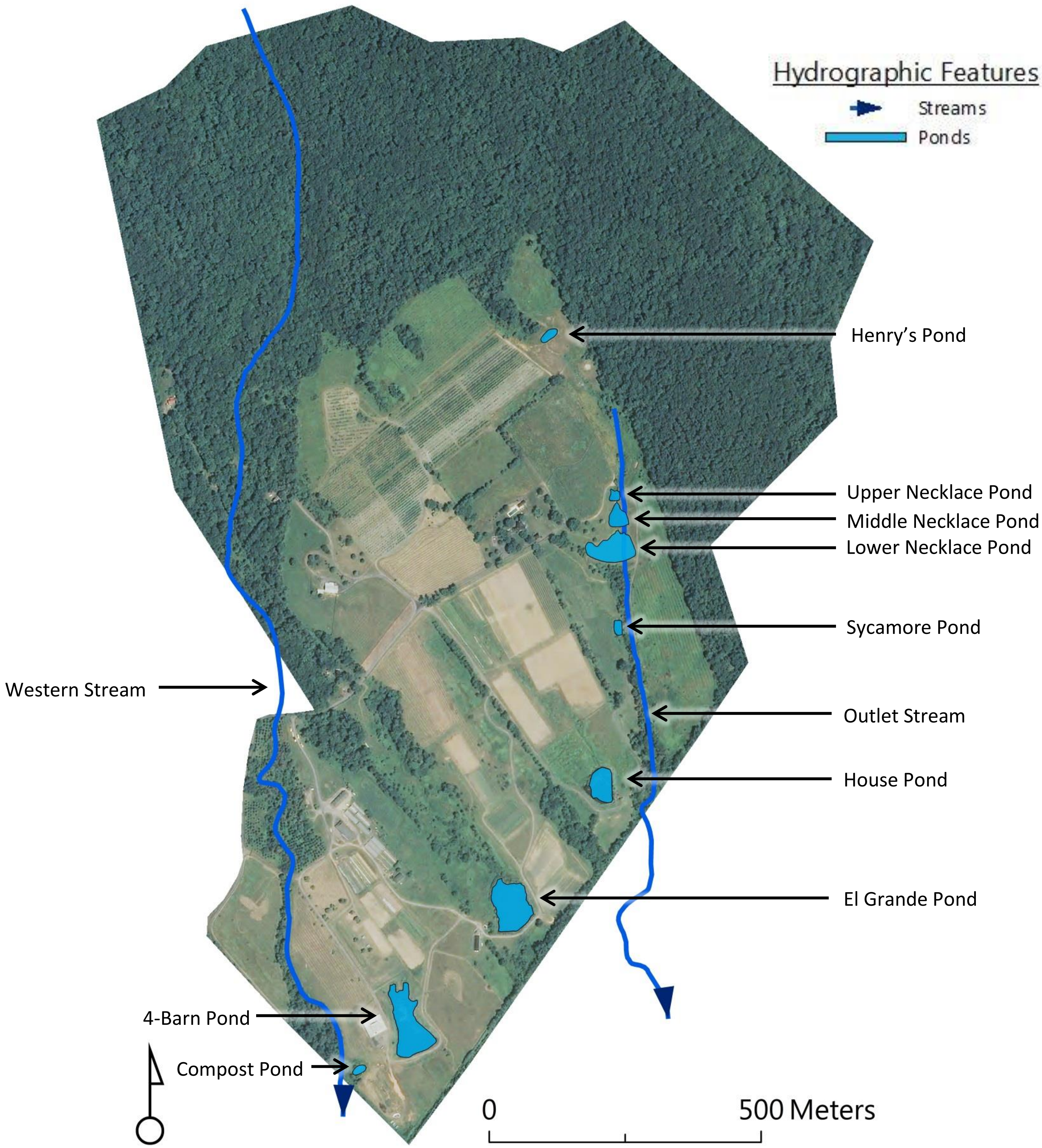
The Farm's partnerships with local non-profits, research institutions and ecological service providers continue to be fruitful. Participation in the Smithsonian Conservation Biology Institute's (SCBI) Virginia Working Landscapes Project has helped us broaden our inventories of birds, pollinators and meadow plants, and access to the project's database gives us the ability to contextualize the Farm's biodiversity with similar properties throughout the region. Our relationship with SCBI also has also gained us the help of students enrolled in the Smithsonian-Mason School of Conservation. This fall semester, Ellery Routher provided weekly assistance to both the farm staff and conservation manager and brought her own extensive expertise in field herpetology to help inform our research.

The conservation manager also sits on the board of two local environmental non-profits, RappFLOW (http://www.rappflow.org/) and the Rappahannock League of Environmental Protection (http://www.rlep.org/). The property owner chairs the Krebser Fund for Rappahannock County Conservation. Our work with these organizations has strengthened our ability to affect environmental action in the county and share our work with the community.

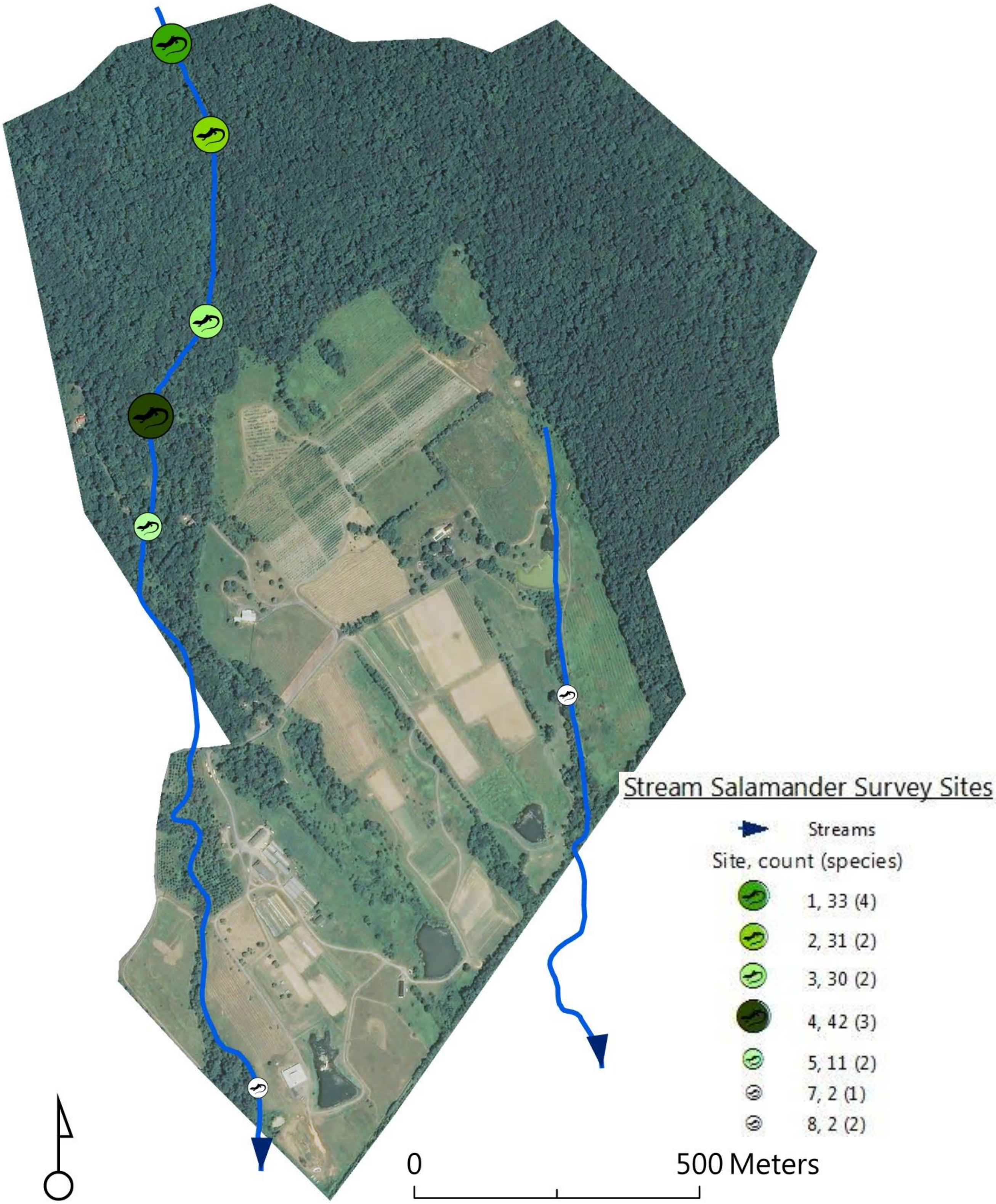
Other key partners include:

- **Environmental Studies on the Piedmont**: http://envstudies.org/
    - camera trap research and apiary consultation
- **German Perilla, beekeeping professor at GMU:** http://ncc.gmu.edu/people/gperilla
    - apiary consultation
- **Hill House Farm and Nursery**: http://hillhousenativeplants.com/
    - plant materials used in habitat restoration and enhancement
- **Old Rag Master Naturalists**: http://www.oldragmasternaturalists.org/
    - annual butterfly count
- **Piedmont Environmental Council**: http://www.pecva.org/
    - part of the Virginia Working Landscapes initiative
- **Roger Jones**
    - American kestrel banding
- **Smithsonian Conservation Biology Institute:** http://nationalzoo.si.edu/scbi/default.cfm
    - **Virginia Working Landscapes initiative**, surveys of birds, plants and pollinators:
        - http://www.vaworkinglandscapes.org/
    - **Smithsonian-Mason School of Conservation**, student internships and ecological monitoring research:
        - http://smconservation.gmu.edu/programs/undergraduate/
- **Sustainable Solutions, LLC**: http://www.sustainablesolutionsllc.net/
    - prescribed burning
- **Taliaferro Trope, M.S. candidate at Virginia Tech**
    - brown marmorated stink bug research
- **The Nature Conservancy of Virginia**
    - forest management consultation
- **Virginia Forestry & Wildlife Group**: http://vaforestwild.com/
    - ailanthus and other invasive plant eradication, wildlife habitat management consultation

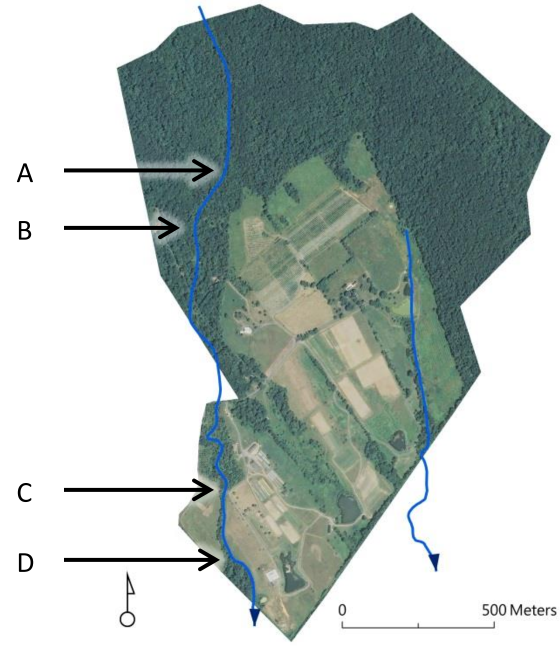
Appendix A: Hydrographic features at the Farm at Sunnyside.



Appendix B: Stream salamander survey sites. Larger, darker green symbols indicate higher salamander count.



Appendix C: Sites sampled by Smithsonian-Mason School of Conservation Students for the aquatic macro-invertebrate survey.



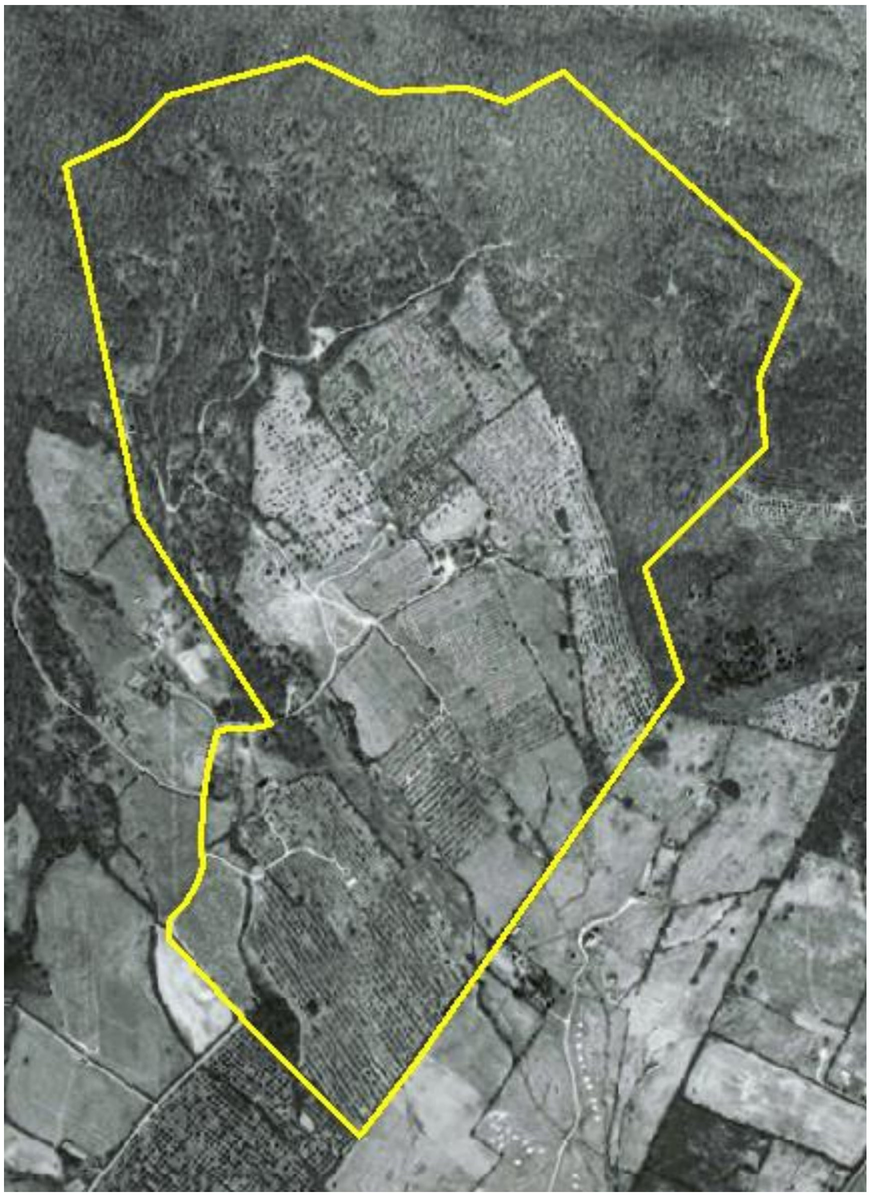

Site A


Site B

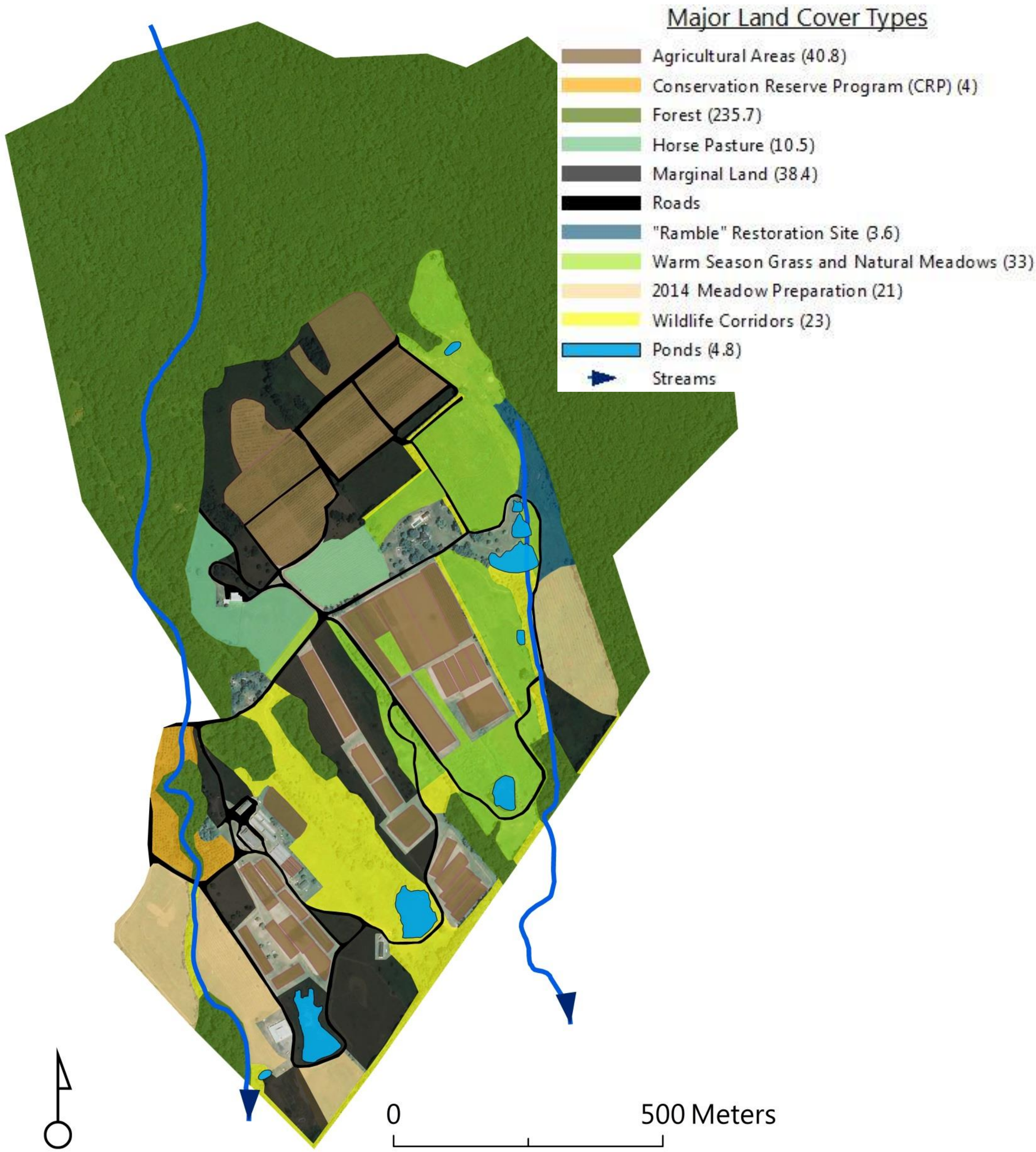

Site C


Site D

Appendix D: An aerial image of the Farm at Sunnyside (outlined in yellow) taken during soils surveys in 1970. Substantial road systems cut through what is currently early successional forest infested with ailanthus. Forests at higher elevation near the boundary with Shenandoah National Park also show signs of considerable disturbance.



Appendix E: Major land cover types at The Farm at Sunnyside. Acreage of each cover type is listed in parentheses.



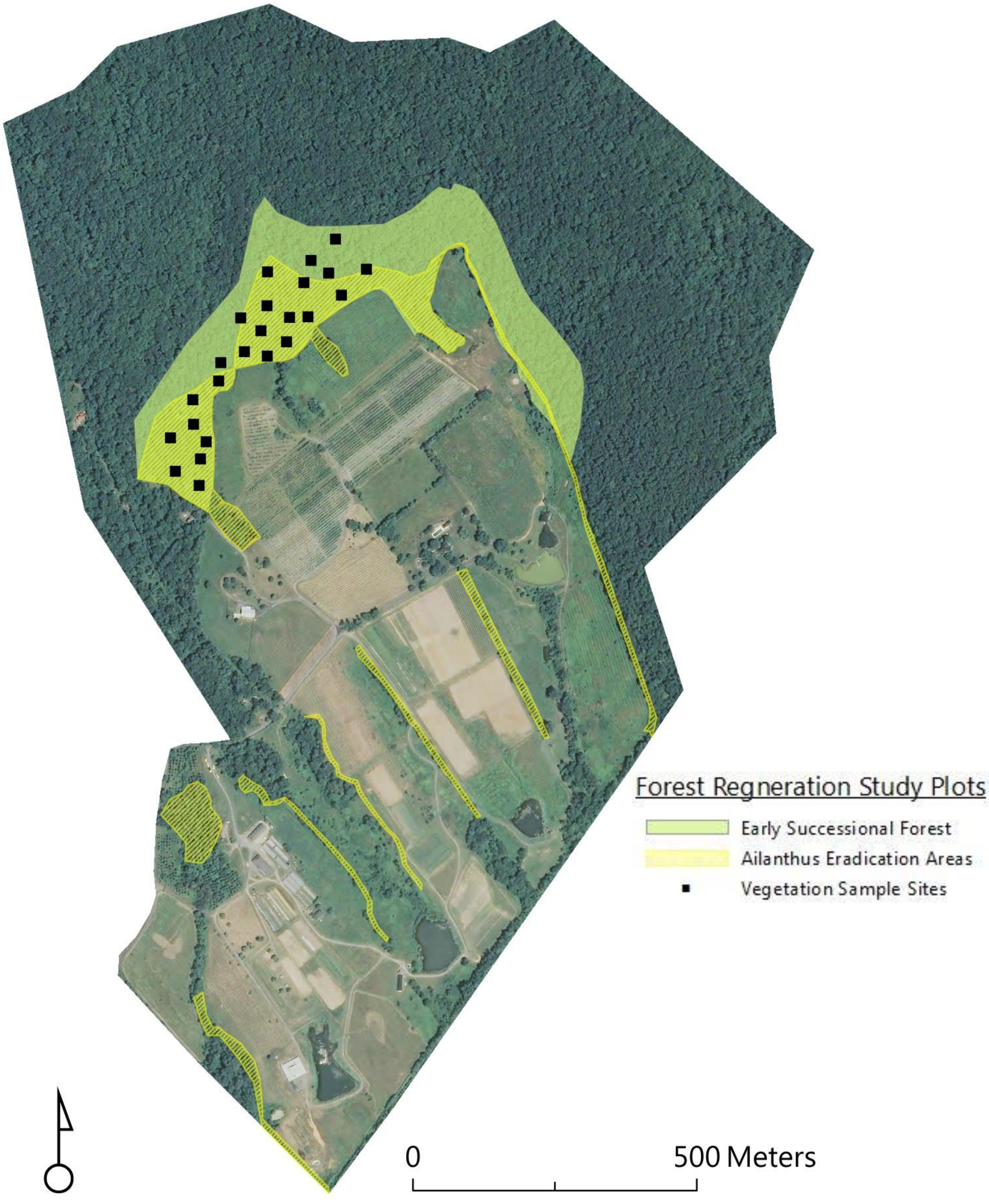
Appendix F: Bird list. New species sighted in 2013 are highlighted yellow.

Common Name	Latin Name	Breeding Y = confirmed P= probable
Common Loon	*Gavia immer*	
Pied-billed grebe	*Podilymbus podiceps*	
Tundra swan	*Cygnus columbianus*	
Canada goose	*Branta canadensis*	Y
Mallard	*Anas platyrhynchos*	
American black duck	*Anas rubripes*	
American wigeon	*Anas americana*	
Blue-winged teal	*Anas discors*	
Wood duck	*Aix sponsa*	Y
Redhead	*Aythya americana*	
Canvasback	*Aythya valisineria*	
Ring-necked duck	*Aythya collaris*	
Hooded merganser	*Lophodytes cucullatus*	
Red-breasted merganser	*Mergus serrator*	
Ruddy duck	*Oxyura jamaicensis*	
Turkey vulture	*Cathartes aura*	
Black vulture	*Coragyps atratus*	
Cooper’s hawk	*Accipiter cooperii*	P
Sharp-shinned hawk	*Accipiter striatus*	P
Northern harrier	*Circus cyaneus*	
Red-tailed hawk	*Buteo jamaicensis*	Y
Red-shouldered hawk	*Buteo lineatus*	Y
Bald eagle	*Haliaeetus leucocephalus*	
Osprey	*Pandion haliaetus*	
American kestrel	*Falco sparverius*	Y
Wild turkey	*Meleagris gallopavo*	Y
Northern bobwhite	*Colinus virginianus*	Y
Great blue heron	*Ardea herodias*	
Great egret	*Ardea alba*	
Green-backed heron	*Butorides striatus*	Y
Black-crowned night heron	*Nycticorax nycticorax*	
Virginia rail	*Rallus limicola*	
Sora	*Porzana carolina*	
American coot	*Fulica americana*	
Killdeer	*Charadrius vociferus*	Y
Lesser yellowlegs	*Tringa flavipes*	
Solitary sandpiper	*Tringa solitaria*	
Spotted sandpiper	*Actitus macularia*	P
American woodcock	*Scolopax minor*	Y
Common snipe	*Gallinago gallinago*	
Ring-billed gull	*Larus delawarensis*	
Rock dove	*Columba livia*	Y
Mourning dove	*Zenaida macroura*	Y
Yellow-billed cuckoo	*Coccyzus americanus*	Y
Black-billed cuckoo	*Coccyzus erythropthalmus*	
Eastern screech owl	*Otus asio*	Y
Great-horned owl	*Bubo virginianus*	Y
Barn owl	*Tyto alba*	
Barred owl	*Strix varia*	P
Whip-poor-will	*Caprimulgus vociferus*	Y
Chimney swift	*Chaetura pelagica*	Y

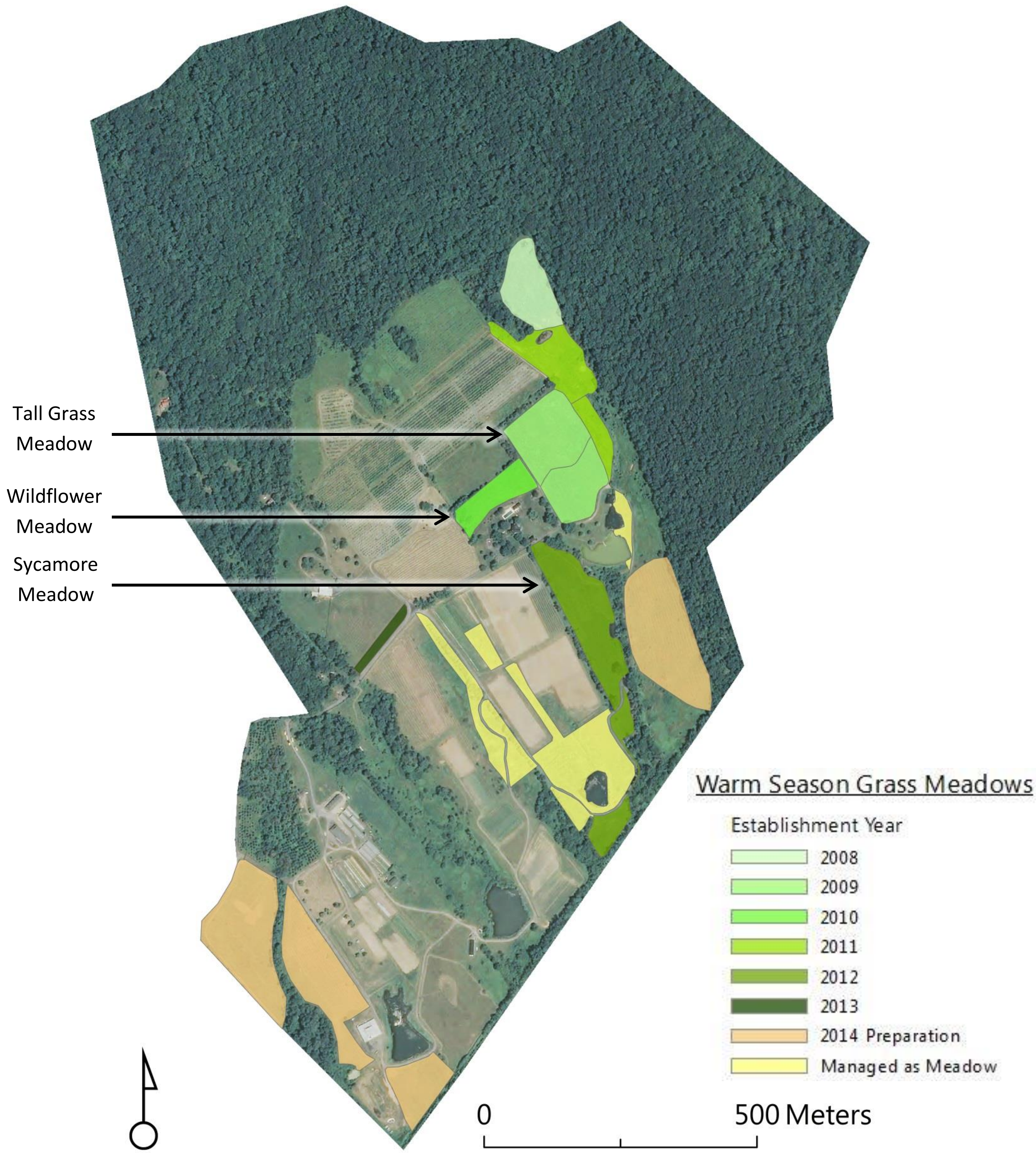
Ruby-throated hummingbird	*Archilochus colubris*	Y
Belted kingfisher	*Ceryle alcyon*	P
Common flicker	*Colaptes auratus*	Y
Pileated woodpecker	*Dryocopus pileatus*	Y
Red-bellied woodpecker	*Melanerpes carolinus*	Y
Red-headed woodpecker	*Melanerpes erythrocephalus*	
Yellow-bellied sapsucker	*Sphyrapicus varius*	Y
Hairy woodpecker	*Picoides villosus*	Y
Downy woodpecker	*Picoides pubescens*	Y
Eastern kingbird	*Tyrannus tyrannus*	Y
Great-crested flycatcher	*Myiarchus crinitus*	Y
Eastern phoebe	*Sayornis phoebe*	Y
Acadian flycatcher	*Empidonax virescens*	Y
Eastern wood pewee	*Contopus virens*	Y
Barn swallow	*Hirundo rustica*	Y
Cliff swallow	*Hirundo pyrrhonota*	Y
Tree swallow	*Tachycineta bicolor*	Y
Northern rough-winged swallow	*Stelgidopteryx serripennis*	
Purple martin	*Progne subis*	
Blue jay	*Cyanocitta cristata*	Y
Common raven	*Corvus corax*	P
American crow	*Corvus brachyrhynchos*	P
Carolina chickadee	*Parus carolinensis*	Y
Tufted titmouse	*Parus bicolor*	Y
White-breasted nuthatch	*Sitta carolinensis*	Y
Brown creeper	*Certhia americana*	
House wren	*Troglodytes aedon*	Y
Winter wren	*Troglodytes troglodytes*	
Carolina wren	*Thryothorus ludovicianus*	Y
Northern mockingbird	*Mimus polyglottos*	Y
Grey catbird	*Dumetella carolinensis*	Y
Brown thrasher	*Toxostoma rufum*	Y
American robin	*Turdus migratorius*	Y
Wood thrush	*Hylocichla mustelina*	Y
Hermit thrush	*Catharus guttatus*	
Eastern bluebird	*Sialia sialis*	Y
Blue-gray gnatcatcher	*Polioptila caerulea*	Y
Golden-crowned kinglet	*Regulus satrapa*	
Ruby-crowned kinglet	*Regulus calendula*	
American pipit	*Anthus rubescens*	
European starling	*Sturnus vulgaris*	Y
Cedar waxwing	*Bombycilla cedrorum*	P
White-eyed vireo	*Vireo griseus*	Y
Yellow-throated vireo	*Vireo flavifrons*	
Blue-headed vireo	*Vireo solitarius*	
Red-eyed vireo	*Vireo olivaceus*	Y
Warbling vireo	*Vireo gilvus*	Y
Blue-winged warbler	*Vermivora cyanoptera*	
Northern parula	*Setophaga americana*	Y
Yellow warbler	*Setophaga petechia*	Y
Chestnut-sided warbler	*Setophaga pensylvanica*	
Cape May warbler	*Setophaga tigrina*	
Black-throated blue warbler	*Setophaga caerulescens*	
Yellow-rumped warbler	*Setophaga coronata*	Y
Black-throated green warbler	*Setophaga virens*	
Palm warbler	*Setophaga palmarum*	

Prairie warbler	*Setophaga discolor*	P
Blackpoll warbler	*Setophaga striata*	Y
Black-and-white warbler	*Mniotilta varia*	
Wilson's warbler	*Cardellina pusilla*	
American redstart	*Setophaga ruticilla*	Y
Ovenbird	*Seiurus aurocapilla*	Y
Louisiana waterthrush	*Parkesia motacilla*	Y
Worm-eating warbler	*Helmitheros vermivorum*	P
Kentucky warbler	*Geothlypis formosa*	Y
Common yellowthroat	*Geothlypis trichas*	Y
Yellow-breasted chat	*Icteria virens*	Y
Scarlet tanager	*Piranga olivacea*	Y
Northern cardinal	*Cardinalis cardinalis*	Y
Rose-breasted grosbeak	*Pheucticus ludovicianus*	
Blue grosbeak	*Guiraca caerulea*	Y
Indigo bunting	*Passerina cyanea*	Y
Eastern meadowlark	*Sturnella magna*	Y
Bobolink	*Dolichonyx oryzivorus*	
Red-winged blackbird	*Agelaius phoeniceus*	Y
Common grackle	*Quiscalus quiscula*	
Brown-headed cowbird	*Molothrus ater*	Y
Orchard oriole	*Icterus spurius*	Y
Baltimore oriole	*Icterus galbula*	Y
House sparrow	*Passer domesticus*	Y
House finch	*Carpodacus mexicanus*	
American goldfinch	*Spinus tristis*	Y
Pine siskin	*Spinus pinus*	
Snow bunting	*Plectrophenax nivalis*	
Eastern towhee	*Pipilo erythrophthalmus*	Y
Field sparrow	*Spizella pusilla*	Y
Chipping sparrow	*Spizella passerina*	Y
Vesper sparrow	*Pooecetes gramineus*	
Savannah sparrow	*Passerculus sandwichensis*	
Grasshopper sparrow	*Ammodramus savannarum*	
Song sparrow	*Melospiza melodia*	Y
Swamp sparrow	*Melospiza georgiana*	Y
Lincoln's sparrow	*Melospiza lincolnii*	
Fox sparrow	*Passerella iliaca*	
White-throated sparrow	*Zonotrichia albicollis*	
White-crowned sparrow	*Zonotrichia leucophrys*	
Dark-eyed junco	*Junco hyemalis*	

Appendix G: Areas managed for ailanthus eradication by the Virginia Forestry and Wildlife Group. The vegetation sampling sites shown in black are part of a long-term study on the effects of ailanthus canopy removal on forest regeneration (see 2011 report for explanation of methods). A large proportion of the remaining early successional forest canopy is composed of ash trees, which will be decimated by emerald ash borer in the coming decade.



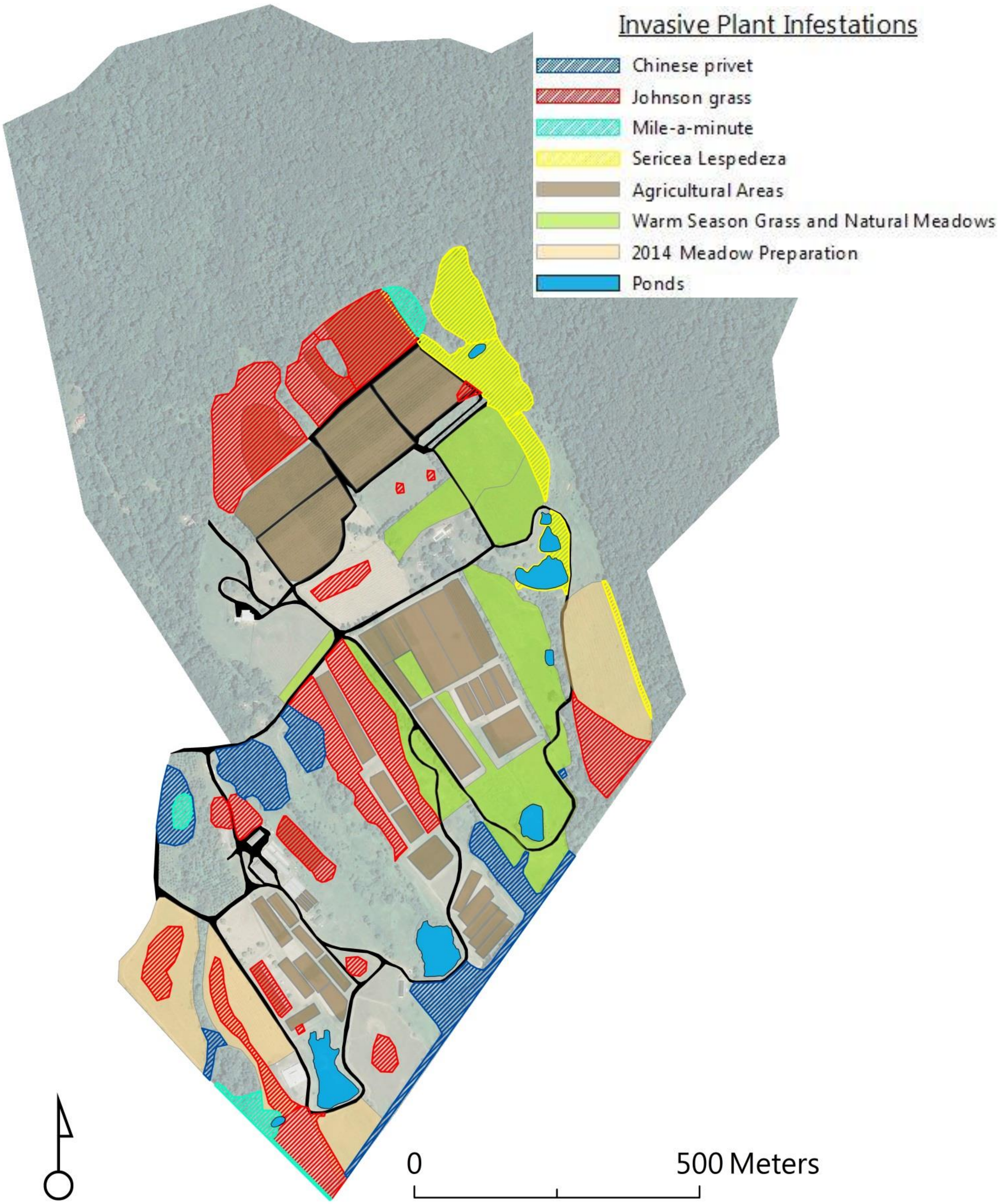
Appendix H: Warm season grass and flower meadows. The map also shows areas that are managed with fire to improve their wildlife value (yellow) and areas being prepared for establishment in 2014. Names are provided for the three meadows surveyed by the Old Rag Master Naturalists for the Annual North American Butterfly Count.



Appendix I: Results from the 2013 North American Annual Butterfly Count conducted by the Old Rag Master Naturalists.

Group, Species	**Tall Grass Meadow**	**Wildflower Meadow**	**Sycamore Meadow**	**total**
Swallowtails				
Black Swallowtail	12	7	2	**21**
Eastern Tiger Swallowtail	100	707	151	**958**
Spicebush Swallowtail	4	51	17	**72**
Swallowtail spp.	11	63	27	**101**
Whites & Sulphurs				
Cabbage White	9	2	1	**12**
Clouded Sulphur	5	8	6	**19**
Orange Sulphur	9	12	3	**24**
Cloudless Sulphur	3	2	2	**7**
Sulphur spp.	0	0	4	**4**
Hairstreaks				
Red-banded Hairstreak	2	0	0	**2**
Blues				
Eastern Tailed Blue	12	1	10	**23**
"Summer" Spring Azure	2	0	0	**2**
Brushfoots				
Variegated Fritillary	0	1	0	**1**
Great Spangled Fritillary	13	10	1	**24**
Silvery Checkerspot	3	30	14	**47**
Pearl Crescent	1	5	1	**7**
Red-spotted Purple	1	0	0	**1**
Brushfoots spp.	1	13	11	**25**
Satyrs				
Northern Pearly-eye	1	0	0	**1**
Milkweed				
Monarch	0	1	1	**2**
Spread Skippers				
Silver-spotted Skipper	19	66	35	**120**
Hayhurst's Scallopwing	1	3	0	**4**
Common Checkered-Skipper	1	0	0	**1**
Common Sootywing	0	0	1	**1**
Spread Skippers spp.	3	3	0	**6**
Grass Skippers				
Least Skipper	1	2	1	**4**
Sachem	1	2	1	**4**
Zabulon Skipper	3	7	0	**10**
Dun Skipper	0	1	0	**1**
Grass Skippers spp.	4	2	13	**19**
Hummingbird Moths				
Northern Clearwing	0	1	0	**1**
total	**222**	**1000**	**302**	**1524**

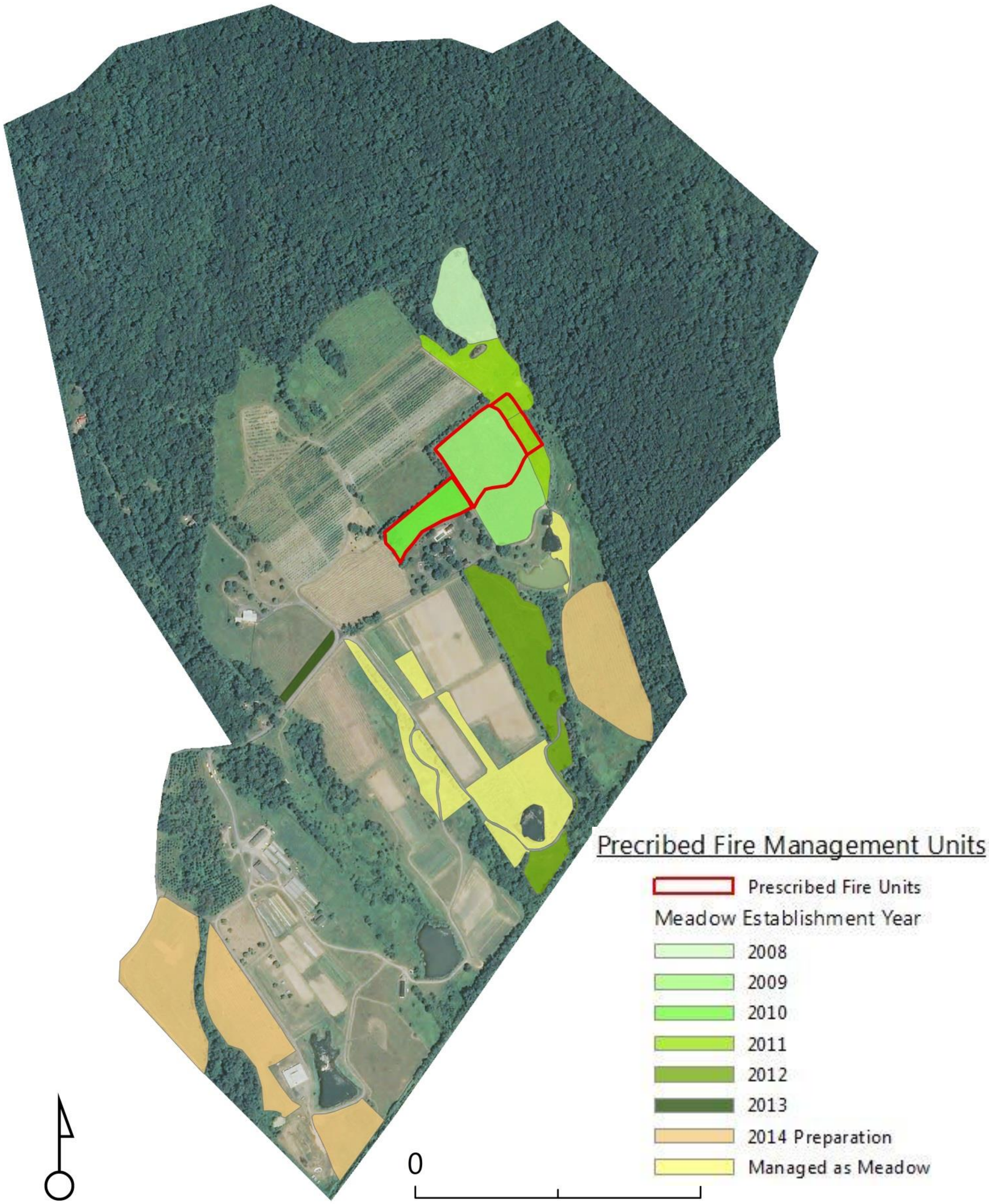
Appendix J: Major invasive plant infestation sites for Chinese privet, Johnson grass, mile-a-minute and sericea lespedeza. Agricultural production areas and warm season grass and flower meadows are also shown to highlight the importance of managing invasive plants near sensitive habitat and crop areas. The aerial image has been dimmed for clearer representation of infestation extents. Note also that many areas overlap.



Appendix K: Seed mix used for warm season grass meadow establishment in 2013.

% of Mix	Latin Name	Common Name
5	*Bouteloua curtipendula*	Side Oats Grama
17	*Elymus virginicus*	Virginia Wildrye
1	*Eragrostis spectabilis*	Purple Lovegrass
10	*Panicum anceps*	Beaked Panicgrass
27	*Schizachyrium scoparium*	Little Bluestem
3	*Asclepias syriaca*	Common Milkweed
1	*Aster laevis*	Smooth Aster
1	*Aster oblongifolius*	Aromatic Aster
6	*Chamaecrista fasciculata*	Partridge Pea
2	*Coreopsis lanceolata*	Lance Leaved Coreopsis
1	*Eryngium yuccifolium*	Rattlesnake Master
1	*Liatris spicata*	Spiked Gayfeather
1	*Liatris squarosa*	Scaly Blazingstar
1	*Monarda punctata*	Dotted Mint
2	*Parthenium integrifolium*	Wild Quinine
2	*Penstemon digitalis*	Tall White Beardtongue
0.5	*Penstemon hirsutus*	Hairy Beardtongue
2	*Rudbeckia hirta*	Black Eyed Susan
2	*Rudbeckia fulgida*	Orange Coneflower
1	*Solidago juncea*	Early Goldenrod
0.5	*Solidago odora*	Licorice Scented Goldenrod
1	*Tradescantia ohiensis*	Ohio Spiderwort
2	*Tradescantia subaspera*	Zig Zag Spiderwort

Appendix L: Prescribed fire management units burned in 2013. Note that only less than 1/3 of existing meadow acreage is burned in a year as to not eliminate too much habitat at a given time.



Appendix M: Bird nest box locations.

Appendix N: Eastern bluebird/tree swallow nest boxes. Larger, darker blue symbols indicate higher fledgling production.