The Farm At Sunnyside

2014 Conservation Work Summary

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INTRODUCTION

It has been over four years since initiating our conservation program and in that time we have documented many benefits of integrating conservation science with agriculture. The wildlife habitat we cultivate throughout the farm supports sensitive wild species such as bobwhite quail as well as the pollinators and crop pest predators so important to our agricultural production. Routine monitoring of our soil and water has helped ensure that our natural resources remain plentiful while supporting healthy wild communities. Revenues from the wild products we harvest from our unfarmed spaces sustain our conservation work and help educate our customers on the importance of farmland biodiversity. Our network of collaborators now ranges from research institutions including George Mason University, the USDA and the Smithsonian, to food distributors like Wholefoods Market. Embedded conservation expertise has also allowed The Farm at Sunnyside to stay on the leading edge of emerging food safety regulations such as the National Good Agricultural Practices program (GAPs). Even elementary skills wildlife biology, chemistry and geographic information systems have allowed us to efficiently develop effective standard operating procedures to address GAPs requirements.

In the last several years there has been an explosion of interest in the ethical, social and ecological consequences of our food. Unfortunately, much of the public believes that a product simply bearing a "certified organic" sticker is automatically good for wild species while the reality is far more complex. The impact of food production on global biodiversity is paralleled by few other human activities yet our methods for accounting for the effects of agriculture on wild species are lacking. Our mission is to develop quantifiable mechanisms for assessing the relationship between biodiversity and farming and share these ideas with other farmers and conservationists. We hope that by relating our experiences we can make it easier and more attractive for farms to adopt meaningful conservation practices. We also wish to open new avenues of communication between farmers and conservationists, two groups that have much to gain by forging stronger partnerships.

THE CONSERVATION MANAGER

A conservation biologist on a farm is a fairly novel concept and our current working model is a product of multiple years of experimentation. While much of our work is somewhat unique to our region and production strategy, but the basic ideas we put forth can be shaped to fit most agricultural systems. The majority of the conservation manager's workload fits into the **Field Work** section and is the primary subject of this report (Figure 1). This broad category of work encompasses habitat management, monitoring of our natural resources and investigating relationships between wild species and food production. The conservation manager also contributes directly to the farm through managing the honeybee (*Apis mellifera*) apiary, assisting with pest and disease management and helping out at farmers' markets, which also serves as an opportunity to engage with customers about the importance of biodiversity on farms. Our collaboration with nonprofits, research institutes and other organizations has become an essential component of our conservation program. Working with entities like the Smithsonian Conservation Biology Institute gives us access to information that allows us to contextualize the effects of our conservation practices with other similar properties in the region. These partnerships also let us inventory a wider range of species diversity by attracting specialists in fields such as entomology.

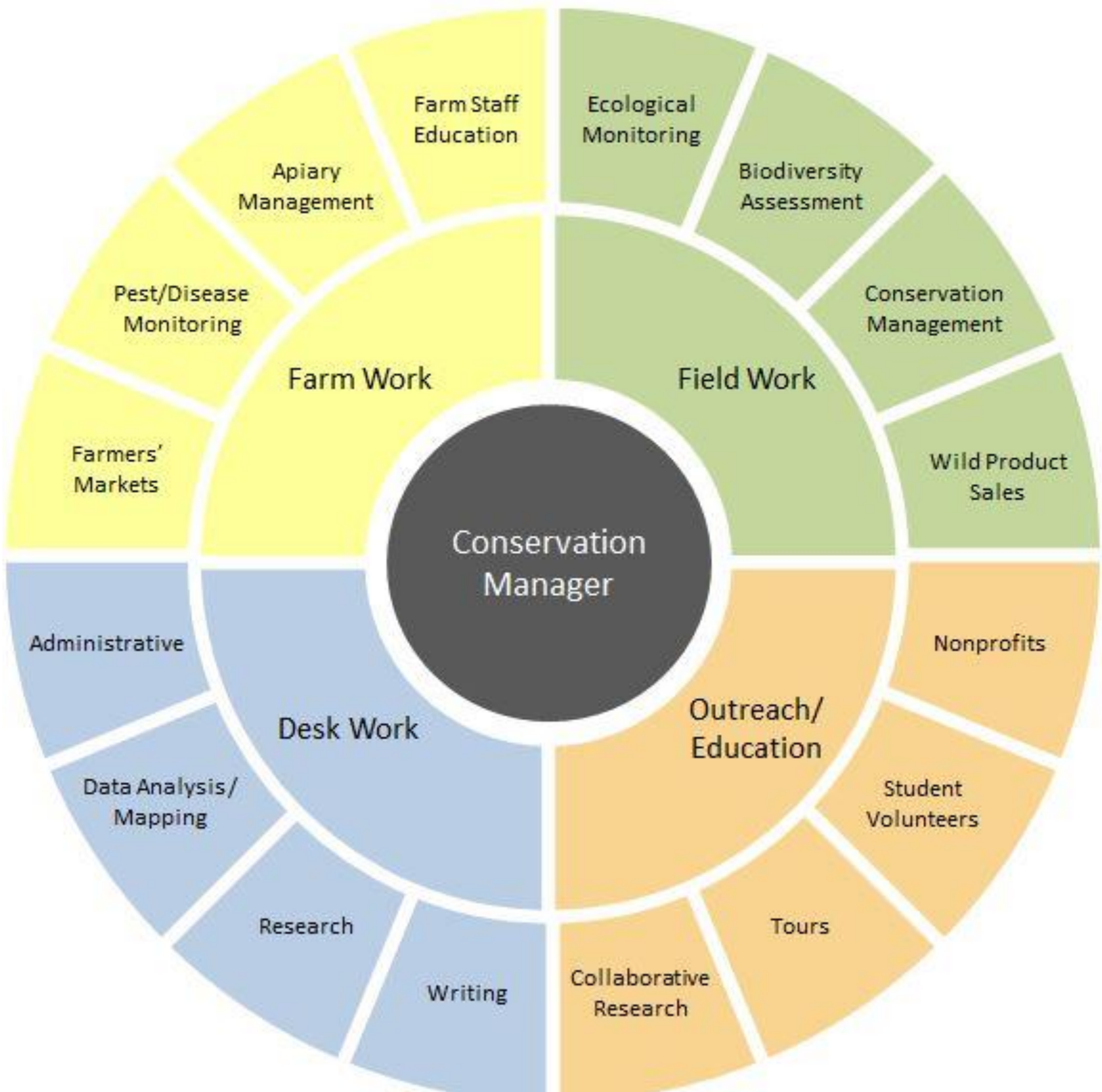


Figure 1: An illustration of the conservation manager's role at The Farm at Sunnyside.

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.

The largest proportion of time was devoted to conservation management in 2014 than in any year since initiating our conservation program (Figure 2). This was driven by two factors. First, we completed the most extensive meadow planting that we have yet attempted in a single year: in total, 21 acres were seeded divided among four sites using three seed mixes. Moreover, we experimented with a new establishment technique in one of these areas which required substantially more of the conservation manager's time. Second, we launched our most aggressive invasive plant management campaign to date which ran continuously through the year. Both of these points will be discussed in detail in the conservation management section.

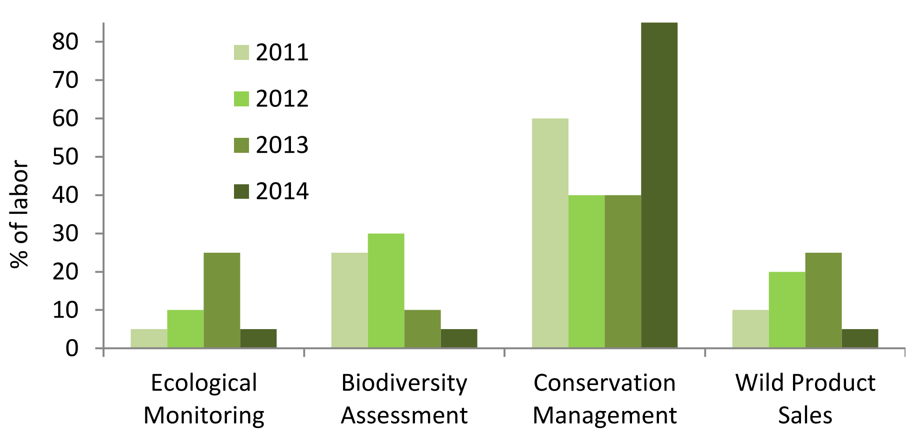


Figure 2: Comparison of the estimated amount of field time dedicated to each aspect of the Farm's conservation program from 2011 - 2014. Most of the conservation manager's field time in 2014 was devoted to managing wildlife habitat. A considerable portion of the conservation manager's time is also applied to research, land management planning, data analysis and community outreach through educational events, collaboration with local institutions and helping at farmers' markets.

With our time spent elsewhere, less was available for the other aspects of the conservation program. We were able to compensate for this by hosting other research projects through organizations like the Smithsonian Conservation Biology Institute (SCBI). Serving as a study site for groups like SCBI has been a tremendous benefit to us because it allows us to develop datasets on taxa for which we do not have the time or expertise to investigate on our own, such as invertebrates. These studies also give us the ability to contextualize our property and conservation practices with other similar landscapes throughout the region, granting us metrics with which to assess the effectiveness of our efforts.

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. Mean annual temperatures at the Farm continued to fall with 2014 being our coolest year since record keeping began in 2011 and the only year in which the average temperature for a month (January) was below freezing. The average temperature in 2014 was 53.0 °F, compared to 54.1 °F in 2013 and 56.6 °F in 2012, our warmest year to date (Figure 3). We received slightly less precipitation in 2014 (41.0 inches) than in 2013 (41.6 inches), but storm events were more frequent and less severe. The pattern of dampening storm intensity is even more pronounced when compared to 2012 in which >20% of our yearly precipitation was delivered in one 12 hour deluge brought by hurricane Sandy. We also had a wetter spring in 2014 while September remains our driest month (Figure 4).

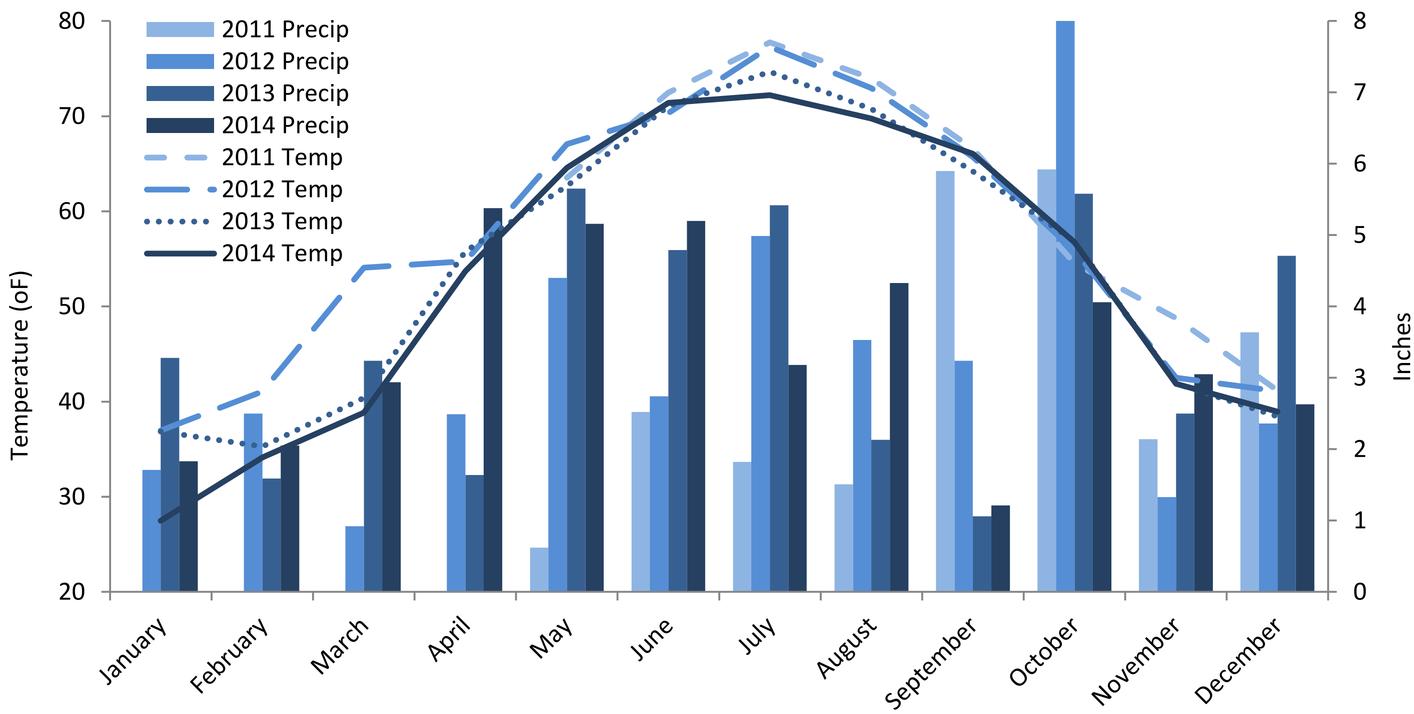


Figure 3: Average monthly temperature and precipitation from 2011 – 2014. The weather station was deployed in May, 2011.

Though cooler than the previous year, night time temperatures (7 pm – 7 am) were marginally higher in 2014 (51.2 °F over 50.8 °F) (Table 1). Notably, in 2014 the night time temperatures throughout January and March were higher than the total average temperatures for those months. The photosynthetic efficiency of many crops declines when temperatures rise above the mid-90s F. A plant's night respiration is also dependent on temperature. When night time temperatures are high, plants respire faster which can limit the amount of storage products such as sugars

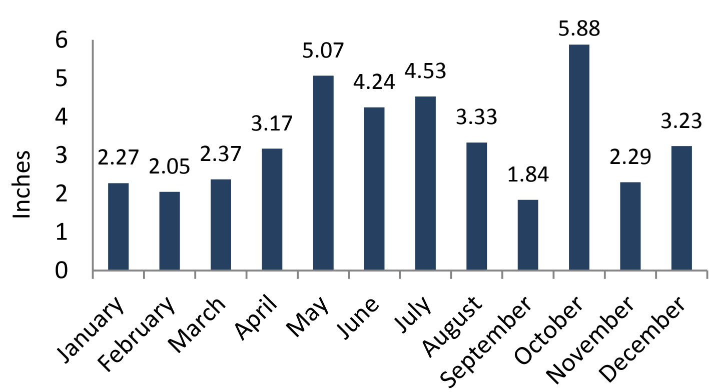


Figure 4: Average monthly precipitation 2012 – 2014.

that these plants use to build their fruits and vegetative structures. High temperatures can have a direct effect on our crop yield, yet is a challenging factor to mitigate. Temperature control even in our indoor production houses is limited. To date we have addressed this issue by increasing the diversity of crops we grow. Ginger, turmeric and other sub-tropical species can be grown in hoop houses when summer temperatures reach their peak.

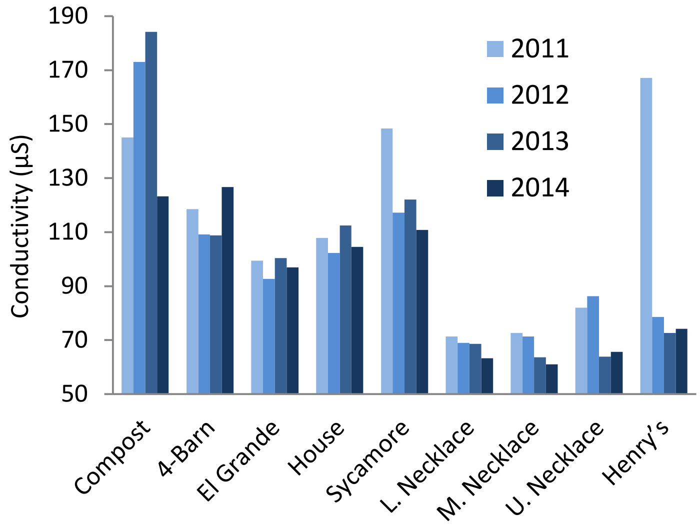
Table 1: Average monthly temperatures from 2011 to 2014. Night time temperatures (7 pm – 7 am) appear in *italics*. Note that the night time temperatures in January and March 2014 were higher than the total average temperatures for those months. Data collection began in May 2011.

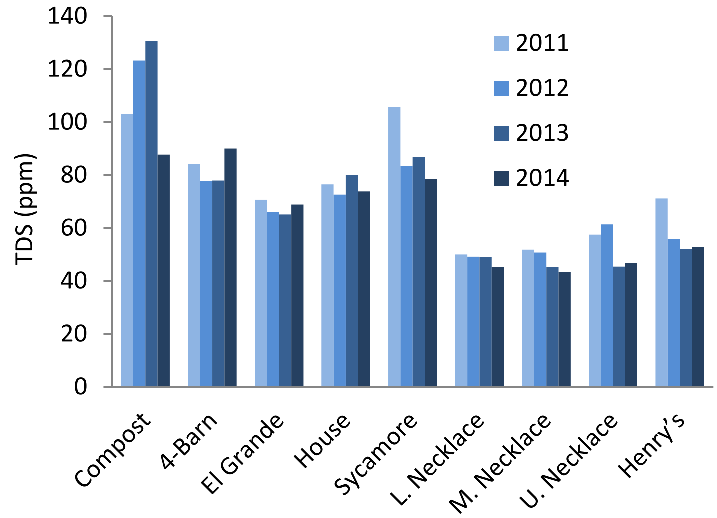
	2011		2012		2013		2014	
	total	*7pm-7am*	total	*7pm-7am*	total	*7pm-7am*	total	*7pm-7am*
January			37.0	*34.5*	36.9	*34.5*	27.5	*31.2*
February			41.1	*37.7*	35.3	*32.8*	34.1	*33.8*
March			54.1	*50.8*	40.4	*38.2*	38.8	*41.5*
April			54.7	*51.4*	55.8	*52.7*	53.7	*51.3*
May	63.5	*58.9*	67.1	*63.1*	62.6	*59.0*	64.6	*60.2*
June	72.5	*68.2*	70.3	*65.7*	71.1	*67.7*	71.4	*66.7*
July	77.8	*72.3*	77.3	*72.7*	74.7	*70.8*	72.2	*70.6*
August	74.0	*69.7*	72.9	*68.6*	70.8	*66.9*	69.8	*67.5*
September	66.6	*63.6*	65.7	*61.3*	64.2	*59.4*	66.1	*61.4*
October	54.5	*51.0*	55.9	*52.3*	56.9	*53.4*	56.7	*52.5*
November	48.8	*44.7*	42.5	*38.9*	41.9	*38.4*	41.9	*40.1*
December	41.2	*38.2*	41.1	*38.7*	38.4	*35.7*	38.9	*37.2*
Annual Avg.			**56.6**	***53.0***	**54.1**	***50.8***	**53.0**	***51.2***

Water Chemistry. The Farm at Sunnyside contains nine artificial ponds, most constructed in the mid-1990s (APPENDIX A). We rely on three for all of our field irrigation needs, though we regularly monitor water quality in every pond and actively work to improve their wildlife habitat value. Following our methodology from previous years (see our 2011 report for details), three samples were taken from each pond, and values for temperature (Temp), pH, conductivity (Cond), total dissolved solids (TDS) and salinity were averaged (Table 2). Aside from cooler temperatures there was little change in water chemistry at the ponds. One notable difference was the nearly 50% decline both in conductivity and TDS in the Compost Pond, as well as a 38.4% drop in salinity. This change is interesting because the Compost Pond has historically had the highest conductivity, TDS and salinity among all of the waterbodies at the Farm now to be topped by the 4-Barn Pond in 2014 (Figure 5). We are currently investigating whether any of our agricultural activities could have contributed to this change.

Table 2: Average water quality parameters of the Farm's nine ponds in 2014 with percent change from 2013 in *italics*.

Pond	**Temp (°C)**		**pH**		**Cond (µS)**		**TDS (ppm)**		**Salinity (ppm)**	
Compost	16.55	*-6.41%*	7.14	*-18.99%*	123.29	*-49.40%*	87.71	*-48.98%*	59.30	*-38.40%*
4-Barn	17.72	*-3.64%*	8.25	*-0.42%*	126.69	*+14.13%*	90.06	*+13.46%*	60.63	*+20.89%*
El Grande	17.45	*-4.63%*	8.34	*+0.50%*	96.93	*-3.58%*	68.90	*+5.42%*	47.45	*+15.63%*
House	17.43	*-11.35%*	8.68	*-1.37%*	104.55	*-7.57%*	73.87	*-8.25%*	50.55	*+2.47%*
Sycamore	17.19	*-6.97%*	8.49	*-1.17%*	110.88	*-10.12%*	78.51	*-10.60%*	53.60	*-0.32%*
Lower Necklace	17.67	*-5.83%*	8.27	*+1.63%*	63.30	*-8.43%*	45.13	*-8.58%*	32.92	*+6.76%*
Middle Necklace	16.89	*-7.10%*	7.99	*+6.64%*	61.00	*-4.26%*	43.41	*-4.28%*	31.59	*+9.58%*
Upper Necklace	16.28	*-8.08%*	7.57	*-9.74%*	65.64	*+2.71%*	46.71	*+2.80%*	33.52	*+1.84%*
Henry's	17.22	*-8.11%*	7.86	*+6.23%*	74.22	*+2.07%*	52.81	*+1.41%*	37.49	*+12.34%*





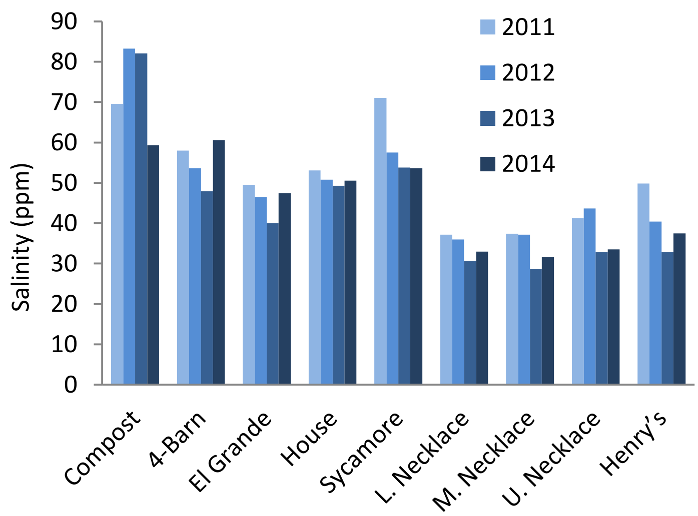


Figure 5: Average water quality parameters of the Farm's nine ponds from 2011-2014. The Compost Pond has historically been characterized by the highest conductivity (top left), TDS (top right) and salinity (bottom left). In 2014, the 4-Barn Pond has taken the top spot for each of these values. This change was driven more by the marked decrease in these measures in the Compost Pond than by the proportionally smaller increases observed in the 4-Barn Pond. While the reason for these shifts is unclear, the degree of change is still relatively minor and does not indicate a significant decline in water quality in either pond.

In addition to our regular water quality testing regimen, this year we investigated the potential occurrence of elevated heavy metal loads in and around our farm ponds. The Farm at Sunnyside's agricultural history spans centuries and in that time the land has absorbed a wide array of pest management strategies including the use of lead arsenate-based pesticides. These compounds were widely used to manage orchard pests throughout the mid-20th century until being banned in the US in the late 1980s. As we've discussed in previous reports, most of the Farm's apple production during peak use of lead arsenate was situated in areas now occupied by early successional forest no longer in agricultural production. Extensive testing has not detected lead or arsenic above natural levels expected in the soil in and around growing areas.

With good baseline data on lead and arsenic, in 2014 we shifted focus to another metal: copper. We use foliar applications of copper as one of multiple strategies to combat plant pathogens, a practice that has been employed by many organic farms throughout the world for centuries. To date, applications of copper have largely been restricted to our orchards, and testing in 2013 by Smithsonian-Mason School of Conservation students confirmed that soil copper levels were highest in the orchards (6.71 ppm) compared to other land cover types at the farm including vegetable production areas (1.05 ppm) and mature forest (0.51 ppm).

While copper levels in soil are within safe limits (6.71 ppm is less than half of the minimum concentration known to begin affecting soil biota), this element can be extremely harmful to aquatic organisms even in very low quantities. In 2014 our region was struck by late blight much earlier in the season than in previous years. This pathogen attacks solanaceous plants such as tomatoes, one of our most lucrative crops. We determined that foliar applications of copper on tomato plants would be our best chance to combat the blight. However, given the frequency of applications needed and the proximity of the tomatoes to one of the farm ponds we were concerned by the risk of copper contamination. Moreover, all but one of our ponds (including each of the three used for irrigation) were constructed within the last 15 years, and it is unclear where the materials used to build the ponds originated from. Though unlikely, it is conceivable that some of the fill used to build the ponds may have come from sources on the farm that had enough copper present to affect aquatic species.

To address these concerns, a group of Smithsonian-Mason School of Conservation students sampled water in our three irrigation ponds: the 4-Barn Pond, the El Grande Pond and the Lower Necklace Pond, as well as the House Pond which is not used for irrigation but is situated down slope from a major growing area and thus potentially susceptible to inputs of copper through erosion (APPENDIX B). Because copper drops out of the water column quickly, the group also tested the soil in and around the ponds. Samples were taken at the inlets and outlets, as well as in the direction of the nearest crop production field being the most likely route of transport of eroded sediments carrying copper. Tests revealed that copper levels in all samples were <0.5 ppm, the lowest measureable value and within expected safe limits. The students also conducted macroinvertebrate sampling at various points within each pond and found a relatively diverse community of species known to be sensitive to copper. While we expected the results to be as such, this was an important step toward developing baseline data of the content of heavy metals in our ponds.

Bio-indicators. Whenever possible we couple records of water chemistry and other abiotic metrics of environmental health with bioindicator data. The community structure of certain species can reveal information about the health of their ecosystem. In many ways studying bioindicator populations is superior to tracking changes in abiotic chemical variables. Benthic macro-invertebrates, aquatic salamanders and other taxa are always present in the farm's waterbodies and are therefore subject to any fluctuations in water quality which may be missed by periodic water sampling. Also, we have learned much about soil health by examining the occurrence patterns of fossorial species like terrestrial salamanders and earthworms (see our 2013 report for details). Invertebrates remain the largest gap in our species inventory of the property and so in 2014 we continued our strategy of designing ecological monitoring efforts to simultaneously record new species and use their populations to discern information on their habitat.

Aquatic Salamanders. Twice a year in spring and fall we survey for aquatic salamanders at seven sites distributed throughout the two streams that flow through the property (APPENDIX C). Stream salamanders can indicate the health of their environment because they are sensitive to fluctuations in the environment and are easy to sample and identify. We sample these populations by gently lifting rocks in the streambed, counting whatever salamanders are present then replacing the rock in its original position with equal care (Figure 6). Surveys of stream salamanders in the Farm's two streams yielded fewer individuals than in previous years, with only 106 observed compared to 151 in 2013. This trend was likely due to the cooler summer which resulted in the streams we survey remaining full for most of the year. We typically survey when the streams are low to make locating salamanders easier. This also has the effect of concentrating salamanders, particularly under rocks. The fact that

Figure 6: We survey populations of aquatic salamanders by gently lifting rocks in the streambed.

salamanders had considerably more favorable habitat in 2013 allowed them to spread out within the stream basin and is likely why we did not uncover as many compared to previous years.

Northern dusky salamanders (*Desmognathus fuscus*) once again made up the largest portion of the sample comprising nearly 90% of individuals (Table 3). Notably, we did not find northern two-lined salamanders (*Eurycea bislineata*) this year, the species that is typically next most common behind the northern dusky. In fact, over 6% of species found target species in this survey, being either frogs or terrestrial phase eastern spotted newts (*Notophthalmus viridescens*) which are not considered bioindicators in this case. We did locate a northern spring salamander (*Gyrinophilus porphyriticus*), our region's largest Plethodontid salamander and red salamanders (*Pseudotriton ruber*). These species, together with the northern dusky salamander, are plethodontids, or "lungless" salamanders that respire by absorbing oxygen directly through their skin, thereby making them particularly sensitive to changes in water quality. The presence of these species is a good sign for the health of our streams. Female northern spring salamanders take five years to mature and reproduce, so even a minor disturbance to their habitat can have far-reaching consequences on these populations.

Table 3: 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	E. spotted newt	N. spring salamander	red salamander	green frog	wood frog	total
1	13	0	1	0	0	0	**14**
2	28	0	0	1	0	0	**29**
3	13	2	0	2	1	1	**19**
4	28	1	0	0	0	0	**29**
5	10	0	0	0	0	0	**10**
7	0	0	0	0	0	0	**0**
8	3	0	0	0	2	0	**5**
total	**95**	**3**	**1**	**3**	**3**	**1**	**106**

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.

Following the trajectory set in 2013, more of the conservation manager's time was dedicated to conservation management leaving little for direct sampling of species diversity. And, as we discussed in last year's report, another reason for the shift away from species inventorying is that we have already captured most of the information that is within our ability to efficiently obtain. After over four years of work we have a reasonably strong understanding of the presence mammals, birds, reptiles, amphibians and other macro-fauna, and our inventory of plant species on the property continues to slowly expand. Invertebrates remain the largest gap in our knowledge.

Invertebrates. Insects, arachnids and other soft-bodied animals arguably play a more significant role in agricultural production than any animal with a backbone. Many are beneficial, like those that pollinate our crops and attack pests, while others, particularly exotics such as the brown marmorated stink bug (*Halyomorpha halys*), can have a devastating economic impact on farm operations. Some, like ticks, even pose serious health risks to farm staff. Invertebrates are also the most diverse and abundant animals on our property, and our relatively poor understanding of their community structure is out of balance with their ecological and economic importance. To ameliorate this deficit, we design our ecological monitoring protocols to simultaneously accumulate data on invertebrate diversity whenever possible, such as through the study of bio-indicator populations. We also take advantage of partnerships with institutions ranging from the SCBI to the USDA to host research by entomologists with the expertise to efficiently catalogue invertebrates present at our farm.

Ticks. Lyme disease, spread by black-legged ticks (AKA deer ticks) (*Ixodes scapularis*), may be the most famous tick-borne malady, but all of the ticks that parasitize humans in this region have the potential to carry some form of disease, such as Ehrlichiosis in lone star ticks (*Ambylomma americanum*) and Rocky Mountain spotted fever in dog ticks (*Dermacentor variabilis*). Given the health risks these invertebrates pose to our staff we dedicate substantial time and effort toward developing a comprehensive understanding of tick populations on the property. In particular, we were interested in where and when ticks are most abundant.

We sampled for ticks by dragging a 1 m^2 square of white felt along transects in areas falling into one of five land cover categories: warm season grass (WSG) meadow, fescue pasture, forest, forest edge (within 5 m of the wood line) and agricultural areas (vegetable fields and orchards). Ticks picked up by the cloth were counted and identified to species (Figure 7). Two 50 m transects were surveyed per land cover category for a total of 100 m^2 of area sampled in each. Four surveys were conducted in April, July, August and November totaling 2,000 m^2 of ground sampled in 2014.

Figure 7: Alcohol preserves ticks from this season's sampling efforts and those found on the person of the conservation manager throughout the year.

Most of the 26 ticks were found in April (n = 14), and almost half (n = 12) were picked up on the forest edges. Only one tick (lone star) was found in a pasture, and the five individuals observed in agricultural cover were in the orchards. Notably, no ticks were found in warm season grass meadows at any point in the year of sampling. Seasonality also influences tick populations, with dog ticks most prevalent in spring, lone star ticks in mid-summer and deer ticks in spring and fall, with relatively little activity in summer.

We suspect that the predominance of ticks on the forest edge was a result of deer activity. White-tailed deer (*Odocoileus virginianus*) are a significant dispersal agent for ticks which attach to the host animal and eventually drop off after their meal, potentially far from the point of initial contact. Because deer spend a large portion of their time along forest edges there are simply more opportunities for sated ticks to drop off and wait for their next host.

Butterflies and Moths. This year's North American Annual Butterfly Count conducted by the Old Rag Master Naturalists was held on July 19th. Seven searchers sampled for just over 2.5 hours using a random encounter survey method in three WSG meadows: the Tall Grass, Wildflower and Sycamore Meadows (APPENDIX D). Compared to record high numbers in 2013, the count this year was down sharply. Only 160 individuals were recorded at the Farm among 25 species, down from 1523 individuals among 31 species last year (APPENDIX E). Tallies from across the county were similarly low. We believe that the low counts were in large part due to the timing of the surveys. The cooler year appeared to delay the arrival of many species that were noticeably abundant in the weeks following the survey. For example, only five eastern swallowtails (*Papilio glaucus*) were observed by the surveyors (compared to 958 in 2013), yet were quite numerous in August. The same can be said for the monarch (*Danaus plexippus*), which were not observed during the survey yet appeared to be more abundant in the late summer of 2014 than in any year prior, at least anecdotally (Figure 8). Given these data we do not think the precipitous drop in butterflies counted at the farm this year is an indication of an ecological problem.

Figure 8: A monarch caterpillar feasts on butterfly milkweed (*Asclepius tuberosa*) (left). Monarchs only eat plants in the milkweed family. We always design our meadow seed mixes to have a large milkweed component. The leaves of these plants are food for larval monarchs while the flowers are an excellent source of nectar for a wide range of pollinators. Once large enough, the caterpillar will envelop itself in a chrysalis (center) before finally emerging as an adult (right).

Brown Marmorated Stink Bugs. Since becoming a major pest in our region the brown marmorated stink bug (BMSB) has been able to successfully overwinter in natural cavities and in our homes. This year's relatively cold winter was especially hard on any BMSBs that were unable to find a house to ride out the cold. Some researchers predicted a 95% die off, and field surveys throughout the summer appeared to validate that number.

We once again hosted researcher Taliaferro Trope of Virginia Tech who continued to examine BMSB plant associations. This year Taliaferro planted several plots of trap crops including sweet corn and sunflowers to analyze how BMSBs move between plant species throughout the season. Following trends throughout the region, BMSB populations appeared to be smaller at the farm this season, with the highest numbers recorded in the blackberries (Figure 9). Anecdotally, we estimated an 80% reduction in product lost to BMSB damage compared to 2013. Observations from this year strongly suggest the importance of frigid winters as a defense against exotic insect pests.

Figure 9: Brown marmorated stink bug.

Crop Pest Predators. This year we were extremely fortunate to be a part of a USDA research project conducted by Bob Kula. The study was designed to characterize insect diversity in warm season grass meadows and assess the influence of fragment size and management practices on species richness and abundance. The survey focused on parasitic wasps of the family Braconidae, a highly diverse group of insects with over 50,000 known species, many of which are important predators of crop pests. The Farm at Sunnyside was one of three sites surveyed alongside Oxbow Farm and the Jones Nature Preserve.

Figure 10 (above): A SLAM trap (photo courtesy of Dr. Robert Kula). **Figure 11** (right): The traps, designated by yellow stars, were positioned in the interior of the Sycamore Meadow (right) and at the edge of the blackberry field (left). A wooded hedge bisects the two areas.

Insects were sampled using tent like SLAM traps that capture insects in flight and crawling through vegetation (Figure 10). Two traps were set at the Farm, one in the Sycamore Meadow and the second approximately 100' away next to the blackberries in the House Field (Figure 11). Dr. Kula was interested in characterizing insect diversity next to a production field because although warm season grass meadows are known to support populations of crop pest predators it is unclear to what degree the habitat exports the ecosystem services of these beneficial insects to agricultural areas. Traps were checked every two weeks from May-November.

Among the thousands of individuals captured, 683 Braconids were collected among 54 genera (excluding subfamily Microgastrines which are difficult to identify without DNA sequencing and not identified to genera at the time of this report). Several notable individuals were collected, including species in the rarely-encountered genera *Dinostigma* and *Stantonia*, the latter being known from only three species in North America. Moreover, several individuals identified to genus *Dinotrema* may represent a species that is either undescribed or previously known from a single specimen found in New York. While compelling to believe we support either extremely rare or undescribed species, we must also take into account that few researchers are studying Braconid populations in this region and these wasps may in fact be more widespread than these data suggest. We look forward to increasing sampling efforts next year to further explore the population dynamics of these agriculturally important crop pest predators.

Camera Traps. With the end of the camera trapping project in collaboration with Environmental Studies on the Piedmont (see 2011 report for details) in 2013, we removed the cameras from their stationary positions in the forest and began using them in a more targeted manner. By positioning the cameras along well-trafficked corridors such as rock walls we have been able to photograph rare and elusive species including last year's capture of the state-endangered eastern spotted skunk (*Spilogale p. putorius*).

Beginning in late 2013 we became curious as to how the Farm's wildlife exploit "gut piles," the unusable remains left after harvesting a deer. These waste products of hunting may represent a significant dietary supplement for a multitude of species during deer season. There is, however, a growing body of research showing a clear connection between the occurrence of lead poisoning in animals that consume carcasses taken with lead ammunition, particularly among vultures, ravens and other species that routinely scavenge carrion. While we only use lead free ammunition at the Farm, we were interested in how many species would potentially be exposed to meat contaminated with lead.

To investigate how gut piles were being used by the Farm's wildlife we focused trail cameras on remains left from harvested deer. We discovered that gut piles draw in a wide diversity of birds and mammals including black bear (*Ursus americanus*), bobcat (*Lynx rufus*), common raven (*Corvus corax*) and golden eagle (*Aquila chrysaetos*). A full list of species we have photographed at gut piles is compiled in Table 4.

Table 4: Using camera traps we have obtained photographic records of the following species eating the remains of harvested deer. The material is typically consumed within 24-48 hours depending on weather conditions (snow cover appears to slow wildlife activity). Other animals such as white-tailed deer have been photographed inspecting the remains but do not consume them.

Birds		**Mammals**	
American crow	*Corvus brachyrhynchos*	black bear	*Ursus americanus*
black vulture	*Coragyps atratus*	bobcat	*Lynx rufus*
common raven	*Corvus corax*	eastern coyote	*Canis latrans*
golden eagle*	*Aquila chrysaetos*	raccoon	*Procyon lotor*
red-shouldered hawk	*Buteo lineatus*	striped skunk	*Mephitis mephitis*
red-tailed hawk	*Buteo jamaicensis*	Virginia opossum	*Didelphis virginiana*
turkey vulture	*Cathartes aura*		

*photo obtained in the first week of 2015.

Amphibians. We have identified four ephemeral pools on the property. Ephemeral pools (also called vernal pools because of their tendency to flood in spring) are flooded for a portion of the year but regularly dry out, preventing fish from taking hold. Spotted salamander (*Ambystoma maculatum*), wood frog (*Lithobates sylvaticus*) and other amphibians depend on these temporary wetlands for reproduction (Figure 12). To date, all of the pools on our property that we have located sites are remnants of old farm uses such as cattle watering ponds. It is possible that these features were once natural ephemeral pools that were altered to support an agricultural use and have since reverted to functional wildlife habitat.

This year we discovered that Henry's Pond, while a permanent waterbody, was used by thousands of spotted salamanders and wood frogs (APPENDIX A). Given its position in the landscape and the staggering numbers of individuals observed during the spring migration Henry's Pond may be a critical habitat component for amphibians living in the surrounding upland forests. Although fashioned into a permanent pond, no fish are present, and aerial photos from the 1950s suggest that this site was formerly a shallow, spring-fed pool.


Figure 12: A spotted salamander (left) leaves the safety of its forest home to travel a minimum distance of nearly 100' across a burnt landscape to Henry's Pond. The journey is dangerous when so exposed to predators such as raccoon that may take advantage of an easy meal. Pickerel frogs (right) are not an obligate pool breeding species, but are often seen moving among the mole salamanders and wood frogs that come to these wetlands to mate.

In addition to monitoring existing pools, we continued our work to create more of these wetlands on the property. In April an environmental science class from George Mason University came to the Farm and assisted with the construction of a vernal pool in the forest above Henry's Meadow (Figure 13) (APPENDIX D). This type of volunteer labor is critical when pools need to be constructed in areas we cannot access with heavy machinery.

Figure 13: George Mason University students assist with the creation of an ephemeral pool at the Farm. Here they have excavated the frame of the pool and allowed it to fill with water from the nearby spring. This area is inaccessible to heavy machines and the many hands made the work go swiftly.

Birds. We have accumulated over 140 species on the farm's bird list since records began in 2006. This year we were able to collect photographs giving us further insight into how some of these species use the Farm. Trail cameras positioned at farm ponds gave us a candid look at the activities of waterfowl and wading birds, and revealed glimpses of fascinating behaviors in familiar species such as the great blue heron (*Ardea herodias*) (Figure 14). We also learned more about the nesting habits of the elusive American woodcock (*Scolopax minor*) (Figure 15), a species that briefly fills the sky above the farm with its spring courtship displays then seemingly disappears. Adult and juvenile bald eagles (*Haliaeetus leucocephalus*) are a fairly regular sight at the Farm but never fail to impress (Figure 16).

Figure 14 (left): Great blue heron carrying a meadow vole (*Microtus pennsylvanicus*). Meadow voles can be a significant pest of both agricultural crops and wildlife habitat plantings. **Figure 15** (top right): An American woodcock nest. In early spring the sky over the Farm is filled with male woodcock performing their acrobatic mating display silhouetted against the setting sun. **Figure 16** (bottom right): Though a fairly common site at the Farm at Sunnyside, bald eagles never fail to impress and have an uncanny knack for disappearing when the cameras come out. This is our only on-site picture of the enormous bird of prey.

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. Two years ago we created a land management planning document that identified approximately 55 acres of land we consider "marginal," being 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 F). As outlined in previous reports, 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.

Since 2012 we have cut the amount of marginal land in half through conversion to warm season grass and flower meadows designed to support ground nesting birds such as the northern bobwhite quail (*Colinus virginianus*) and the beneficial insects that pollinate our crops and control crop pests. The configuration of new meadows has broadened the corridors that connect the highest quality habitat patches on the property. Of particular importance in this regard was the establishment of approximately 15 acres of meadow at the southern extent of the Farm from unused fescue pasture (APPENDIX D). These areas comprise a large patch of unbroken meadow habitat and may be our best chance to attract breeding populations of grasshopper sparrows (*Ammodramus savannarum*) and other grassland birds that require large tracts of open space. The deep-rooted species we planted will also help buffer the stream that runs through the center of this area. Finally, given the high profile of this location as the entrance to the Farm we have eliminated the need for regular mowing to keep the area free of weeds. More details on our habitat management follow.

Conservation plantings. This year we established the most acreage of warm season grass and flowers meadows to date in a single season. We also continued with regular maintenance activities in existing meadows including burning (APPENDIX G) and suppression of invasive exotic plants, and several tree and shrub plantings were expanded and amended. In addition, we purchased 50 shortleaf pine (*Pinus echinata*) seedlings from the Department of Forestry and planted them in hedges and along forest edges. Shortleaf pine populations have fallen precipitously throughout the species' range in the southeastern US due to past over harvest while regeneration has been suppressed by competition from more aggressive hardwoods. Though this species will be an important habitat feature for wildlife at the Farm, we are primarily interested in promoting shortleaf pine for its own conservation value.

WSG Meadow Management. We seeded approximately 21 of new WSG meadow in 2014 split among four areas (APPENDIX D) and using three seed mixes. This is the largest meadow planting we have attempted at one time, bringing our total area in WSG habitat to just under 55 acres. The majority of this acreage was installed on the southern extent of the property on areas we've designated as the marginal land referred to above. This ~12 acre block is divided only by a small stream and represents the largest contiguous block of WSG meadow on the property (Figure 17). Large, contiguous acreages are preferred by meadow-specialist species such as the grasshopper sparrow. Establishing meadows on these areas also creates connectivity from Henry's Meadow on the far northern end of the property all the way to our southern border (APPENDIX D).

Figure 17: A first year WSG meadow in September. The seed mix we used is designed to create a short meadow in which many of the forbs are taller than the surrounding grasses. The misty white patches are the seed heads of bigtop lovegrass (*Eragrostis hirsuta*) which take on a sparkling quality when soaked by rain or mist.

We attempted a new meadow establishment technique on an area that was formerly a terraced peach orchard created by the previous owners. We fully removed the topsoil from the site, using it to smooth the area's topography then burying it under mineral soil along with its invasive plant seedbank (Figures 18-21). This method was particularly attractive to us because it eliminated the need for herbicides to clear the site and saved us the year or more normally required for multiple herbicide applications. Based on observations from our other meadows with similar dry, compacted soil we selected species such as blue wild indigo (*Baptisia australis*) that we knew would thrive in such poor conditions.

Figure 18: The Slope Meadow shortly after planting in late spring. The lighter bands on the top of the slope are erosion mats made of woven straw. These mats were placed on areas too steep for the drill seeder to safely operate. Seed was broadcast in these areas.

Figure 19: The Slope Meadow again in late fall. Despite a season of growth the meadow still appears bare, yet this desirable. Because of the poor growing conditions the seeds we planted will be slow to develop, but these harsh conditions also help suppress the growth of invasive species that need richer soil to thrive. The major drawback of this open structure is the risk of erosion. To combat this we over-seeded multiple cover crop grasses throughout the growing season to provide temporary cover while the meadow species develop.

Figure 20: This image, taken in June, looks west from the crest of the Slope Meadow over the Farm's mosaic of orchards, fields, irrigation ponds and wildlife habitat. The erosion mats seen in the foreground were used to stabilize the steeper sections of the meadow. The lush, but patchy green is the annual grass browntop millet (*Urochloa ramosa*) which we applied as a cover crop to slow erosion while the permanent meadow plants develop. Growth is more verdant on areas with higher amounts of remaining top soil.

Figure 21: By late summer the browntop millet has died back and the meadow species are becoming more prominent. Some progressed enough to flower like the grass-leaf blazing star (*Liatris graminifolia*) shown in the foreground. The dry, rocky character of the site creates a patchy, open structure ideal for target wildlife species such as northern bobwhite quail and other ground nesting birds.

Figure 22: A 0.25^2 m quadrat surrounding a group of seedling little bluestem. Seedlings were counted and rated on the apparent strength of their attachment to the soil. We will repeat the count in 2015 to determine mortality.

Once late fall arrived plant growth on the Slope Meadow slowed. We observed that many young little bluestem (*Schizachyrium scoparium*) did not appear to be well anchored in the soil. Some were hanging on by just a few threadlike roots. We were curious how many would survive until spring with the added burden of frost heaving that may uproot the most tenuously anchored individuals. To approach this problem we randomly established sixteen 0.25^2 m quadrats (a total of 1^2 m) throughout the Slope Meadow and counted the little bluestem seedlings, characterizing them as either well-anchored, moderately well-anchored or loose (Figure 22). We will revisit these plots in the spring to determine what proportion of seedlings survived to their second year. This information will help us better predict seedling survivability in other meadows in following years.

A substantial amount of time was dedicated to continuing management of the Crossroads Meadow seeded in 2013 (Figure 23) (APPENDIX D). Management of invasive plants in an established meadow is difficult. Desired plants can obscure target species making full eradication nearly impossible. Also, the use of herbicide is highly limited because of the risk of damaging surrounding native vegetation. In most situations the presence of an exotic plant in a WSG meadow is not a problem. Some nonnative species, such as with common mullein (*Verbascum thapsus*), can even add a unique structural component to a meadow, in this case as both a source of food and a perch for song birds.

Figure 23: The Crossroads Meadow. While only just over half an acre in size, this meadow provides food for insects and the song birds that feed them to their young. The flowers draw native pollinators like bumblebees (*Bombus* spp.) which favor the dotted mint (*Monarda punctata*) shown in the foreground.

Despite receiving the standard herbicide treatments to clear the site we observed a post-establishment explosive spread of two very problematic exotic species: Bermuda grass (*Cynodon dactylon*) and white clover (*Trifolium repens*). Both were introduced for agricultural purposes, the grass as forage for horses in the adjacent pasture and the clover is commonly used as a component of a cover crop mixture. Both also have especially negative impacts on meadow habitat because they spread aggressively, filling in the gaps between other plants that are an essential component of meadow structure.

We used a combination of methods to control Bermuda grass and white clover. In late summer, students from the Smithsonian-Mason School of Conservation volunteered to hand pull Bermuda grass (Figure 24). Although not a long-term control option, removing the seed heads was a necessary first step toward slowing the grass's spread. Throughout the summer and into fall we also conducted multiple rounds of herbicide spot treatments. To minimize the risk to nearby non-target species we alternative used either a broadleaf specific herbicide when targeting white clover or a grass specific herbicide for Bermuda grass. Multiple rounds of treatment were necessary because of the phenology of the target plants: white clover is more active in cooler spring and fall weather; Bermuda grass comes into prominence in summer.

Figure 24: Smithsonian-Mason School of Conservation students hand pulling Bermuda grass in the Crossroads Meadow. Although mechanical removal will not eradicate the plant it was necessary to remove all of the seed heads to slow further spread and simplify follow up herbicide treatment.

In spring we began investigating the effects of disturbing the soil surface of a WSG meadow post-burning. Our first meadow projects—Henry's Meadow (2008) and the Tall Grass Meadow (2009) (APPENDIX D)—included two very aggressive grass species, big bluestem (*Andropogon gerardii*) and switchgrass (*Panicum virgatum*). We no longer use these tall grasses in our mixes in part because can rapidly outcompete smaller grasses and flowers, potentially reducing a meadow's plant diversity and thereby its overall habitat value. For example, the relatively smaller statured lanceleaf coreopsis (*Coreopsis lanceolata*) has apparently disappeared from the Tall Grass Meadow. We were curious if disturbing the soil after a spring burn would stir up viable flower seeds buried under layers of thatch.

Figure 25: Dragging the Tall Grass Meadow disturbs the top layer of soil, potentially stirring up forb seeds long buried under thick layers of grass thatch.

To create disturbance we dragged a chain harrow over sections of Henry's Meadow and the Tall Grass Meadow (Figure 25). One third of the meadows was given a light drag (tines up), only disturbing the top ~1/4 inch of soil, while another third received a heavy drag (tines down) creating furrows up to ~1/2 deep. The final third was left as a control (Figure 26). While this experiment was anecdotal, in spring we did observe a lanceleaf coreopsis bloom in the section of the Tall Grass Meadow that was dragged heavily. Also, there appeared to be more flowers present in Henry's Meadow than in any previous year, both in terms of abundance and diversity, though we cannot say if this was related to the soil disturbance or any number of other factors. This project was just the first step of a long-term experiment on the effect of soil disturbance on meadow plant community dynamics. In future years species diversity will be rigorously quantified before and after dragging a site and a more comprehensive representation of the elements affecting meadow plant species diversity will be factored into consideration.

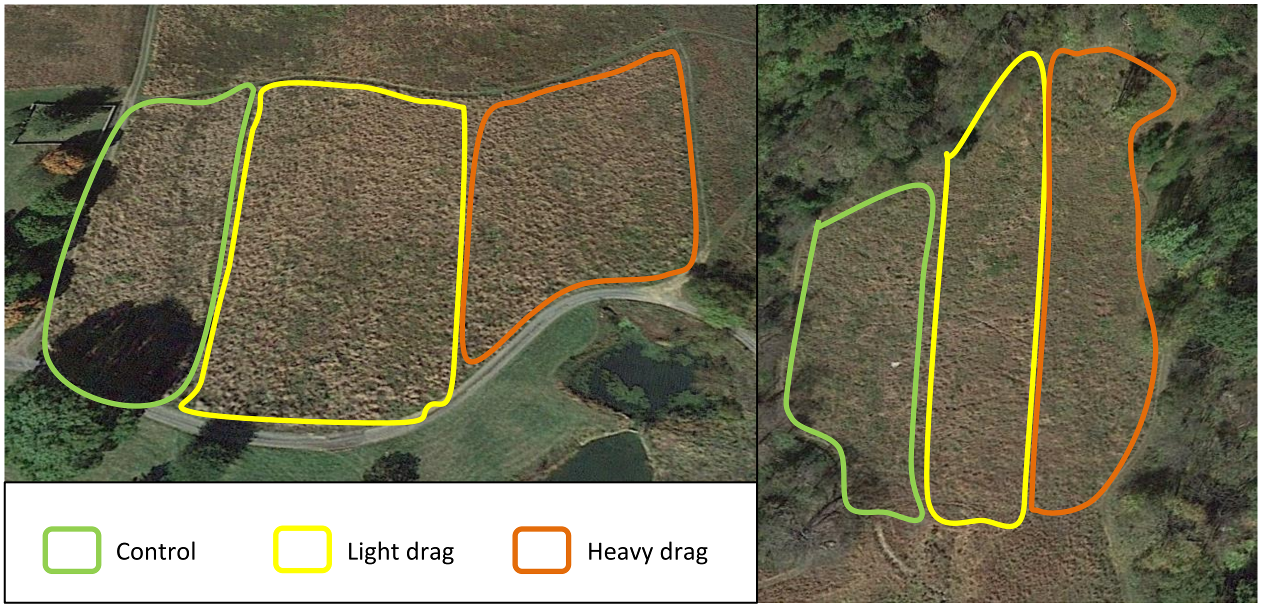


Figure 26: Treatment areas disturbed with a chain harrow in the Tall Grass Meadow (left) and Henry's Meadow (right). Areas received either a light drag (tines up) for minor soil surface disturbance, a heavy drag (tines down) to stir the top half inch of soil, or set aside as a control (no action).

Tree, Shrub and Flower Plantings. Each year we introduce select species to different areas of the Farm as plugs and containerized trees and shrubs. We make these additions with specific wildlife targets in mind, such as providing the larval host for a particular butterfly or planting species known to be associated with desirable crop pest predators.

We made substantial additions to the "Ramble" restoration area this year (APPENDIX F). Since 2011 we have managed this site to achieve a shrubby savannah character, a habitat type that is rare on the Farm. We have thinned trees to maintain an open structure and planted thickets of shrubs such as dogwoods (*Cornus* spp.), eastern ninebark (*Physocarpus opulifolius*) and grey elderberry (*Sambucus racemosa*) within a fenced area to protect them from deer until they grow large enough to persist through constant browsing pressure.

We expanded the grove of American hornbeam (*Carpinus americanus*) in the Ramble restoration area that we established in 2013 and added several new shrubs and forbs (Figure 27). We planted several calycanthus (*Calycanthus floridus*) under the American hornbeams. Thickets of calycanthus will provide dense sub-canopy cover for birds and small mammals and the fragrant flowers for which it is known will feed pollinators. We also experimented with Planting a number of ferns, including netted chain fern (*Woodwardia areolata*), which form thick colonies that create cover for wildlife and will help suppress future invasions by aggressive exotic plants.

Figure 27: A grove of American hornbeam planted in 2013. Guards protect the boles from groundhogs that would chew the bark and whitetail deer that enjoy using trees of this size to rub their antlers.

In addition to planting many new species in the Ramble, we also begin managing the nearby slope adjacent to the forest to prepare for future habitat amendments. This area was dominated by patches of blackberry (*Rubus* spp.) smothered by Japanese honeysuckle with only very modest habitat potential. Several young trees are present, mostly oaks (*Quercus* spp.) and tulip poplars (*Liriodendron tulipfera*), but their form was crippled by the weight of honeysuckle vines. We determined that cutting the entire area was a necessary first step toward improving the habitat value of this site. Throughout fall a large portion of the Ramble was cut with a brush cutter (Figure 28). Then, in early winter, we treated most of the cut area with a foliar application of a broadleaf specific herbicide to kill the still active Japanese honeysuckle (*Lonicera japonica*) while the surrounding non-target plants were dormant. The site will be planted with natives in 2015, including clumping species like sumacs (*Rhus* spp.) that will maintain a shrubby, open structure favored by many birds.

Figure 28: The Ramble restoration site is one of the more intensively managed pieces of wildlife habitat on the Farm. We began planting thickets of shrubs including dogwoods (*Cornus* spp.) and eastern ninebark (*Physocarpus opulifolius*) in 2011 and built a fence to exclude deer until the plants are well-established. In 2014 we cut hillside adjacent to the forest (outlined red) as this area was smothered by Japanese honeysuckle. The area was then treated with a broadleaf specific herbicide in early winter timed to control honeysuckle while minimizing risk to dormant non-target species.

In our previous reports we have highlighted our work to create "pollinator patches" near growing areas designed to provide habitat for beneficial insects such as crop pest predators and serve as a beacon to draw pollinators to crops (Figure 29). The aggressive native flowers we planted including obedient plant (*Physostegia virginiana*) and short-tooth mountain mint (*Pycnanthemum muticum*) are tough enough to persist surrounded by a sea of tall fescue turf. Many beneficial insects, such as parasitoid wasps, have short foraging ranges, therefore situating small habitat patches near crops provides a home for these important insects where they are needed most. This year we added a few new species of flower as well as New Jersey tea (*Ceanothus americanus*), a small shrub with an attractive bloom.

Figure 29: This "pollinator patch" provides habitat for many key beneficial insects. The colorful flowers also draw in bees, which may in turn help direct their traffic to the okra blooming in the background.

Increasing the Value of Cover Crops to Wildlife. In late summer students from the Smithsonian Mason-School of conservation experimented with designing diverse cover crop mixtures. Cover crops are a quintessential element of organic agriculture that improve soil by adding nutrients and organic matter while also stabilizing it between crop rotations. While a good practice, cover crop mixtures tend not to be diverse, typically only incorporating 1-3 species. Moreover, the species used are almost always exotic and have relatively little value to beneficial wildlife. To investigate the potential of improving the wildlife value of cover crops the students designed a selection of diverse mixtures by incorporating promising native species such as deer-tongue grass (*Dichanthelium clandestinum*), as well as surplus vegetable seeds including crops like carrot (*Daucus carota*) that serve a soil building function, in this case a taproot that breaks up deep soil layers. Nearly every vegetable farm will have left over crop seed in stock. Often these seeds have passed the date after which viability rates decline to the point where it is no longer economically feasible to attempt propagation. Incorporating them in a cover crop may be an economic use of this material.

The group created eight seed mixes composed of traditional cover crops, native species and surplus vegetable seeds (Table 5). The rest of the tilled area was seeded with a traditional cover mix and was used as the control. Two ounces of each mix was sown is each 4' x 4' plot in late September (Figure 30). Plot 8 performed the best overall, particularly with regard to even coverage and growth of the seedlings. This was also the most diverse plot. Future work needs to be done to further investigate how these diverse seed mixes perform in different conditions, such as seasonality and their effects on soil quality. In coming years we hope to incorporate fast growing native flowers that will provide the additional benefit of supporting pollinators between crop rotations.

Table 5: Seed mixes used in the cover crop test plots designed by Smithsonian-Mason School of Conservation students.

Plot	Seed Mix
1	broccoli, crimson clover, kale, winter rye
2	buckwheat, carrot, salsify
3	carrot, ryegrass, tricolor radish
4	buckwheat, hairy vetch, turnip
5	parsnip, red clover, tricolor radish, white clover
6	"Albert Lea Seed Forage Mix"*
7	buckwheat, deer-tongue grass, kale, red clover, white clover
8	broccoli, buckwheat, carrot, crimson clover, deer-tongue grass, hairy vetch, kale, parsnip, red clover, ryegrass, salsify, tricolor radish, turnip, white clover, winter rye
control**	hairy vetch, crimson clover, winter rye

* This product is premixed commercial seed mix.

** Students nested their test plots in a large field being prepped for a future pawpaw orchard. The cover crop being applied to the area outside their plots was used as the control.

Figure 30: Smithsonian-Mason School of Conservation Students preparing test plots for various cover crop mixtures. This area is being readied to serve as the site of our future pawpaw (*Asimina triloba*) orchard. We believe that we can design a ground cover for the orchard that will bring more benefits to wildlife than a traditional mixture of exotic species such as tall fescue and clovers.

Invasive Plant Control. 2014 marked our most concerted invasive plant control effort to date with substantially more time and energy were devoted to the eradication of a number of exotic species from several key areas of the Farm than in previous years. Of particular focus were Chinese privet (*Ligustrum sinense*), Sericea lespedeza (*Lespedeza cuneata*), Johnson grass (*Sorghum halepense*) and mile-a-minute (*Persicaria perfoliata*) (APPENDIX H). In the four years since beginning our conservation program we have refined a working methodology to address our most problematic invasive plants. Consistent across each species we actively manage is the need for routine monitoring and different management strategies at different times of the year.

We made significant progress toward eradicating **Johnson grass** (Figure 31) this year due in large part to the initiation of meadow establishment on approximately 17 acres of the worst infestation sites (APPENDIX D and APPENDIX H). This rhizomatous grass is the most extensive exotic plant we are actively controlling at the Farm. With this year's gains made through aggressive management of the highest occurrence areas, Johnson grass is now restricted to small, scattered patches. The widespread infestations that remain are concentrated around growing areas. We will continue to address these sections using a combination of mowing and hand pulling.

Figure 31: Johnson grass.

Our strategy has shifted toward eliminating remnant patches in established meadows, particularly those planted in 2014 as these still support islands of Johnson grass. Weekly surveys for seed heads are essential to prevent the species from spreading further. Because of their height and characteristic form, Johnson grass seed heads are easy to spot from a distance, even among other grasses in an established meadow. We pulled and bagged any that looked close to becoming viable during weekly surveys from August through October.

Mile-a-minute has an extremely high growth rate which can result in rapid overtake of infested areas and the smothering of existing vegetation. Since identifying the first known patch on the Farm in 2012 we consistently find new occurrences of mile-a-minute throughout the property (APPENDIX H) and have learned that routine monitoring is essential to contain its spread. Thanks to lessons learned in previous years we addressed mile-a-minute control in three phases in 2014, the first of which began in early winter.

Phase 1 — Reduction of structural complexity in treatment sites (Jan.-Feb.)
Three-dimensional forest structure (e.g. downed trees) is an important habitat characteristic for many wildlife species including weasels and grouse, but these features can also act as a trellis for mile-a-minute and other invasive vines increasing the difficulty of control. We decided to temporarily reduce the structural complexity in mile-a-minute treatment areas until the species can be eradicated: downed trees were sawed into pieces, brambles were mowed and paths were cut to create ease of access for periodic monitoring. In addition, other invasive plants including multiflora rose, ailanthus and Japanese barberry encountered during this process were treated using the cut stump method whenever possible.

Phase 2 — Monitoring and initial round of control (April-May)
Reducing structure within treatment sites resulted in much more efficient monitoring and control of mile-a-minute in the growing season owing to the ease with sites could be surveyed. Given the new openness of the worst infestation area (unit D)—and the fact that virtually no other non-target plants occur in this site—we were able to experiment with multiple control methods. The site was divided into four sampling units. In May the first mile-a-minute seedlings reached approximately 6" in length, at which point we sprayed glyphosate on the first sampling unit and applied a mixture of glyphosate and Plateau to the second. (Plateau provides pre-emergent control and was recommended to us by Shenandoah National Park staff as a promising tool for managing mile-a-minute). We hand pulled mile-a-minute from the third unit and left the fourth as a control.

Phase 3 — Comparison of control methods, follow up and monitoring (June-Sept.)
Only the unit treated with the glyphosate/Plateau mixture remained free of mile-a-minute throughout the summer. The other units experienced resurgence of mile-a-minute post-treatment and within a few weeks could not be differentiated from the control. Given the difficulty in suppressing this species we were surprised at the apparent efficacy of the Plateau mixture. Unfortunately, this is a non-selective herbicide with long-term soil activity, meaning it has the potential

to harm dormant spring ephemerals and other plants not yet emerged. As such we will restrict our use this method only to areas known to be dominated by mile-a-minute and lacking non-target plants.

Following the initial round of treatment we monitored known mile-a-minute occurrence areas monthly. To prevent any mile-a-minute from going to seed we pulled the remaining stems by hand in June and again in August targeting missed and resprouting individuals. Because of our cool summer the growth rate for mile-a-minute was over a month behind previous years, with some individuals not seeding until September. As we observed in 2013, the extent of mile-a-minute infestations appears to also be favored by wetter conditions. This underscores the importance of routine monitoring throughout the warm season and we plan to continue this practice in coming years. Areas deemed suitable will be treated using the glyphosate/Plateau mixture while the majority of treatment areas will be managed by mechanical means.

Sericea lespedeza (Figure 31) continues to be a time consuming management investment in our northern warm season grass meadows and the shoreline of the Necklace Ponds (APPENDIX H). We also found scattered stems along the wood's edge at the top of "The Slope," a newly established warm season grass meadow. This is the fourth year of active management and it appears that our work is beginning to have some effect. The previous owners intentionally planted this species (presumably as a bank stabilizer) and left it to thrive for over a decade. As such, the number of seeds remaining in the soil is tremendous and these areas required substantial management investments every year. Because of the robust seed bank we also addressed sericea lespedeza in multiple phases employing different control strategies.

Figure 31: Sericea lespedeza in flower. This species can form a dense ground cover, smothering native plants.

<u>Phase 1</u> — Herbicide application (June-July)

We performed multiple rounds of herbicide treatment at these sites with a broadleaf specific herbicide to minimize non-target damage to surrounding grasses. The first application was conducted in June when we determined that majority of sericea lespedeza had emerged. The follow-up application in July targeted individuals missed the first time around.

<u>Phase 2</u> — Mechanical removal (Oct.-Nov.)

Despite two herbicide applications a significant number of stems remained going into the fall. Most of these were either small (<12" tall) or obscured by other vegetation, thus missed during the herbicide treatment. To prevent these stems from seeding every individual was pulled and bagged. Each plant was carefully dislodged—uprooted when possible—deposited in a bucket, dumped in a burn pile and buried to prevent wind or animals from spreading the seeds. While we are not sure of the exact dry weight of material removed, in total 17 sixty gallon trash cans were filled with sericea lespedeza stems from over 4 acres of established meadows.

Our observations at the end of the growing season cemented the fact that sericea lespedeza infestations will require a multipronged control strategy to comprehensively eradicate the species from the property. Though time consuming, removing every stem in fall is required to exorcise sericea lespedeza from the seed bank. We will continue with this two phase tactic in following years, but will begin experimenting with new herbicides and mixing rates in 2015.

Chinese privet is a large shrub traditionally used in hedges, and based on its concentration along the borders of neighboring properties we believe that like Johnson grass and sericea lespedeza it was intentionally introduced to the property. Chinese privet grows so thickly that it can suppress the growth of other plants. Coupled with its ability to grow in full-shade, this species may be negatively effecting wildlife habitat in infested areas of the property.

Because its occurrence on the Farm is somewhat localized we determined that eradication of Chinese privet was a possibility (APPENDIX H). Chinese privet can be treated in winter by cutting the stems and applying herbicide directly to the stump. Employing this method in the cold season also reduces the risk of non-target damage to nearby dormant plants. Because of the density of stands we counted on the need for follow up work later in the year after the initial sweep of large individuals.

<u>Phase 1</u> — Cut stump treatment (Jan.-March)
We began removal efforts in January. Work was divided between a sawyer and one to two personnel clearing cut brush and applying herbicide. Stems were cut with a chainsaw then a small amount of herbicide was painted on the stump using a felt brush. Although it is typically recommended to apply this herbicide using a spray bottle, we felt that using a brush would allow us to better control the placement of the chemical and reduce dripping onto the soil. Any stem larger than the diameter of a pencil was treated. The brush was removed from the management units and burned to prevent it from trellising invasive vines. All management units (~26 acres) were processed by the end of February.

<u>Phase 2</u> — Follow up monitoring (Nov.-Dec.)
The initial round of treatment was largely successful. Most treated stems were killed, though we observed that a fair number of larger individuals had resprouted during follow up surveys of the management areas in November (Figure 32). Also, many small stems that had not been treated remained and dense patches of seedlings had emerged in some of the heavily infested areas treated in winter. Most of these seedlings and young stems can be easily hand pulled (Figure 33) and we cleared several patches in this manner with assistance from this semester's Smithsonian-Mason practicum students.


Figure 32 (left): A Chinese privet sprouting from a previously treated stump. Larger individuals can require multiple rounds of treatment. **Figure 33** (right): Most small Chinese privet can be hand pulled with ease. Given enough personnel this is an extremely effective control technique.

In winter 2015 we will conduct the necessary follow up work in areas addressed in 2014. Control methods will be more diverse in the second round of treatment owing to the predominance of small stems and sprouting stumps. Given the new conditions, we plan to experiment with a variety of treatments and compare their efficacy. In preparation, we established 10 sampling plots in unit B for before and after comparisons post treatment. Each plot was characterized in terms of its current Chinese privet density, and Chinese privet stems per square meter were counted in each plot. To more accurately determine the long-term effects of treatment stems were categorized as either seedlings or stump sprouts from previously treated individuals.

Figure 34: One of the farm staff helping to band a fledgling American kestrel.

Nest boxes. We began 2014 with more artificial nesting habitat for birds than ever before (APPENDIX I). While we try to promote all native birds we are especially focused on growing populations of species that provide pest control services to the Farm. Most of our nests are designed for song birds that consume insects in our agricultural fields, many of which may be crop pests. We also have several boxes for birds of prey that hunt voles, mice and other rodents that cause significant crop damage.

This May we banded 15 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 34). In our three years of banding it is noteworthy that we have yet to recapture a marked individual. If these birds survive to maturity they must be dispersing to new areas meaning the Farm may be a population source for the North America's smallest raptor and a species of recent conservation concern.

We finally had long-term resident barn owls (*Tyto alba*) in two of our nest boxes that had been in place for three years. Arriving in 2013, a pair was using a box in an abandoned silo while one individual occupied the 4-Barn (Figure 35), though it preferred to perch outside the box. Unfortunately, the birds appeared to have moved on after a couple months. Barn owls are voracious predators of small mammals and even a single pair can have a considerable effect on rodent populations. We are disappointed the birds did not stay, but take this as a good sign that we may be able to attract permanent residents in the future. The barn owl's small cousin the eastern screech owl (*Megascops asio*) continues to make use of a box for winter roosting but as yet have not nested.

Figure 35: A barn owl that had temporarily taken up residence in our storage barn. Apparently a lone bird, it is possible that a mate was occupying the nest box while this one preferred the open air of the rafters.

Figure 36: Eastern bluebird eggs in one of our nest boxes.

We are up to 20 boxes in our array of nests designated for eastern bluebirds (*Sialia sialis*) and tree swallows (*Tachycineta bicolor*) (Figure 36) (APPENDIX J). Many of these boxes are embedded in and around vegetable production areas to position the birds where their prey base has the best chance of containing of crop pests. Despite more nests being available we recorded the smallest number successfully fledged chicks since we began keeping track in 2012. In total, 56 fledglings were confirmed, compared to 58 in 2012 and 65 in 2013 (Table 6). Of these, 31 were eastern bluebirds and 25 tree swallows (Figure 37). Predation appears to be the cause of mortality, not environmental factors. Fledglings from at least three boxes were predated by snakes, one box was destroyed by a bear along with the eastern bluebird eggs inside and a third clutch of young birds was attacked and killed by an unidentified insect parasite. In addition, house sparrows (*Passer domesticus*) aggressively took up residence in two boxes, which required weekly cleaning to remove nest materials.

Table 6: 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	0	3	**3**
2	no	no	4	0	**4**
3	yes	yes	0	0	**0**
4	yes	no	0	6	**6**
5	yes	no	0	0	**0**
6	yes	yes	0	0	**0**
7	yes	yes	0	0	**0**
8	yes	no	0	0	**0**
9	yes	yes	0	0	**0**
10	no	no	9	0	**9**
11	no	no	0	5	**5**
12	no	no	0	0	**0**
13	no	no	0	3	**3**
14	no	no	0	0	**0**
15	no	no	3	0	**3**
16	no	no	0	0	**0**
17	no	no	5	0	**5**
18	no	no	10	0	**10**
19			0	3	**3**
20			0	5	**5**
species totals			**31**	**25**	**56**
change from 2013			*-48.4%*	*+24.0%*	*-16.1%*

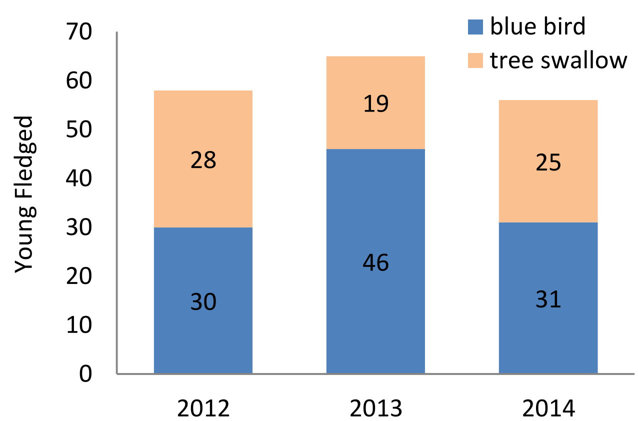


Figure 37: Fledgling eastern bluebird and tree swallow production in nest boxes from 2012 to 2014. More boxes were available in 2014 than in any year prior, yet fewer young were produced. Multiple predation events were the cause.

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.

Over the last four years we have experimented with marketing herbs, fruits and ornamental species that occur naturally on the property or were introduced through our restoration efforts. We have found that promoting "wild products" is a useful avenue through which to introduce our consumers to the importance of biodiversity on farms by highlighting the aesthetic and culinary value of native species. Adding wild products to our inventory of cultivated fruits and vegetables also directly contributes to farm revenue, subsidizes the cost of maintaining the habitat that generated these products and helps sustain our conservation program. And, while difficult to measure, marketing these items sets us apart at farmers' markets and may attract new customers to our business.

Revenue from wild products was down by $1,227.35 in 2014 compared to 2013, a nearly 17% decline (Table 7). This year we did not harvest wildflowers from our WSG meadows, a component of our wild product inventory that generated $1,184 in 2012 and $1,240 in 2013. Given this trend, we can assume that had we sold wildflowers in 2014 sales figures would be on par with 2013. When we began cutting bouquets of flowers from restoration areas our primary goals were to determine consumer interest in native flowers as ornamentals and explore the limits of how much this product could contribute to farm revenue. By 2014 we had three years of sales data from several farmers' markets and decided that at this point we had collected enough information. Although relatively lucrative compared to our other wild products, the labor involved with harvesting flowers was out of balance with the returns. In order to ensure our take of these flowers was not significantly affecting the composition of their source habitat our harvest technique was intentionally inefficient with a large proportion of travel time to prevent over harvest in any one area. The volunteer labor that compensated for this in previous years was not available in 2014. However, at this point we have a fairly solid concept of how much money the sale of wildflowers can bring to the Farm, and we know too that consumers prefer many of these species. In the coming years we may add some of these natives to our inventory agriculturally produced flowers, thereby increasing harvesting efficiency while providing the preferred plant associations for important pollinators and crop pest predators adjacent to other crops.

Table 7: Line item comparison of wild product sales from 2011 – 2014.

Product	2011	2012	2013	2014	total
Apple Blossom	$0.00	$0.00	$45.00	$30.00	**$75.00**
Coreopsis	$0.00	$402.00	$350.00	$0.00	**$752.00**
Dried Grasses	$0.00	$80.00	$20.00	$30.00	**$130.00**
Mojito Mint	$0.00	$231.25	$557.00	$273.00	**$1,061.25**
Honey	$0.00	$122.00	$4,256.00	$4,194.00	**$8,572.00**
Honey Capping Wax	$0.00	$0.00	$0.00	$300.00	**$300.00**
Paw-paws	$349.00	$1,140.30	$391.60	$880.25	**$2,761.15**
Peach Blossom	$0.00	$0.00	$39.00	$60.00	**$99.00**
Serviceberries	$0.00	$0.00	$60.00	$60.00	**$120.00**
Spicebush Berries	$0.00	$144.00	$328.00	$152.00	**$624.00**
Spirea	$0.00	$0.00	$290.00	$20.00	**$310.00**
Wild Rudbeckia Mix	$0.00	$0.00	$240.00	$0.00	**$240.00**
Wild/Cultivated mix	$0.00	$0.00	$312.00	$0.00	**$312.00**
Wildflower Mix	$568.00	$782.00	$338.00	$0.00	**$1,688.00**
total	**$917.00**	**$2,901.55**	**$7,226.60**	**$5,999.25**	**$17,044.40**

Like many fruit trees, paw-paw (*Asimina triloba*) yield can vary widely from year to year, and 2014 was a bumper crop. 2013's poor production, as well as the favorable precipitation patterns during fruit development, contributed to a strong year for North America's largest native edible fruit. Harvesting paw-paws from the wild groves on the property is difficult (Figure 38), but the effort is worthwhile given high consumer demand. In spring we began the first steps toward establishing a paw-paw orchard. We purchased 160 seedlings of four cultivated varieties and when they are large enough will be transplanted in their permanent home among the cherries, apples and pears. Unlike other fruit trees, paw-paws have virtually no issues with pest or diseases, meaning no sprays required. Agriculturally produced paw-paws will also dramatically reduce harvest labor. Compared to apples, peaches and other traditional fruit trees of our region, paw-paws need very few material inputs yet can be sold at a premium given access to direct-to-consumer outlets like farmers' markets. The paw-paw is a prime example of a native species with high agricultural potential.

Figure 38: Harvesting paw-paws can be dangerous work. Our most productive wild grove occurs on a steep hillside. Boulders litter the ground making navigation of the grove difficult. This harvest technique employs a bucket taped to a pool skimmer to reach fruits high in the tree (left). If the fruits detach with a gentle shake they are ripe. We can collect up to 60 lbs of fruit in just a few hours using this method.

Sales of mojito mint (*Mentha x vilosa*) dropped by approximately 50% from 2013. This hybrid mint, while not truly native, is a variety that occurs on the property, likely introduced as a landscaping species. Its distribution is mostly limited to a dense patch along a rock wall and harvesting this herb is fast and easy. Mints can contract a form of powdery mildew on their leaves at certain points during the growing season, typically under cool and wet conditions. This began early in 2014 and, perhaps due to our cooler and more frequently wet summer, lasted until fall. Because of this we could not harvest mojito mint for the majority of the growing season.

Income from spicebush berries (*Lindera benzoin*) also fell by half in 2014. After harvest, these strongly aromatic berries are dried and packaged (Figure 39). Many costumers at farmers' markets who try these surprisingly versatile berries rave about their flavor in dishes ranging from pastries to pickles. Encouraging the initial buy, however, requires a bit of explanation and underscores the importance of providing a narrative for these novel products to better reach consumers. Significantly more berries were sold when the conservation manager was present at market and available to answer questions on the ecological importance of the spicebush and why this wild species deserves a place on the table.

Figure 39: The spicebush (left) is a ubiquitous understory shrub of eastern forests. The red energy-rich berries are an important food source for wildlife, particularly song birds in fall migration. When dried, the aromatic berries impart a unique flavor to a variety of recipes (right).

We experienced another year of heavy losses in our honeybee (*Apis mellifera*) apiary. We had 11 colonies going into winter but by spring only four remained. No signs of colony collapse disorder symptoms or high loads of parasites were present and all of the lost colonies had sufficient food stores. Frigid temperatures and frequent high winds were likely the cause. We had experimented with strapping insulation to a number of hive boxes but did not see any pattern of survivability in insulated verse uninsulated colonies. Many bee keepers in the region also took losses, with many losing 100% of their colonies. Despite these challenges honey remains a popular product (Figure 40).

Figure 40: Our bottled honey (above) and the honeybees that produce it (right). The queen (appearing left of center on the cluster) is marked with a pink dot making it easy to locate her. In just a couple months her daughters can fill that frame with 6-9 lbs of honey.

Rather than purchase more nucs (short for nucleus, the term for a young colony), we made splits from the surviving hives. This technique involves taking a few frames filled with eggs, young larvae and bees from a strong colony and placing it in an empty hive box. The workers will sense the lack of a queen and grow one of their own, thus beginning a new colony. By making splits we increased our colonies to eight by the end of fall. Despite winter losses our honey sales for 2014 were nearly on par with 2013 (Table).

Consumer interest in wild products varies between markets. Sales of herbs, honey, fruit and other items remained the highest at Dupont Circle (Figure). This trend underscores the importance of determining regional interest in the products of wild biodiversity on farms.

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

Product	Dupont	Reston	CSA	Events
Apple Blossom	$30.00	$0.00	$0.00	$0.00
Dried Grasses	$0.00	$0.00	$30.00	$0.00
Mojito Mint	$213.00	$57.00	$3.00	$0.00
Honey	$2,926.00	$928.00	$262.00	$78.00
Honey Capping Wax	$300.00	$0.00	$0.00	$0.00
Paw-paws	$654.50	$209.00	$0.00	$16.75
Peach Blossom	$60.00	$0.00	$0.00	$0.00
Serviceberries	$60.00	$0.00	$0.00	$0.00
Spicebush Berries	$152.00	$0.00	$0.00	$0.00
Spirea	$20.00	$0.00	$0.00	$0.00
total	**$4,415.50**	**$1,194.00**	**$295.00**	**$94.75**

COMMUNITY OUTREACH AND COLLABORATION

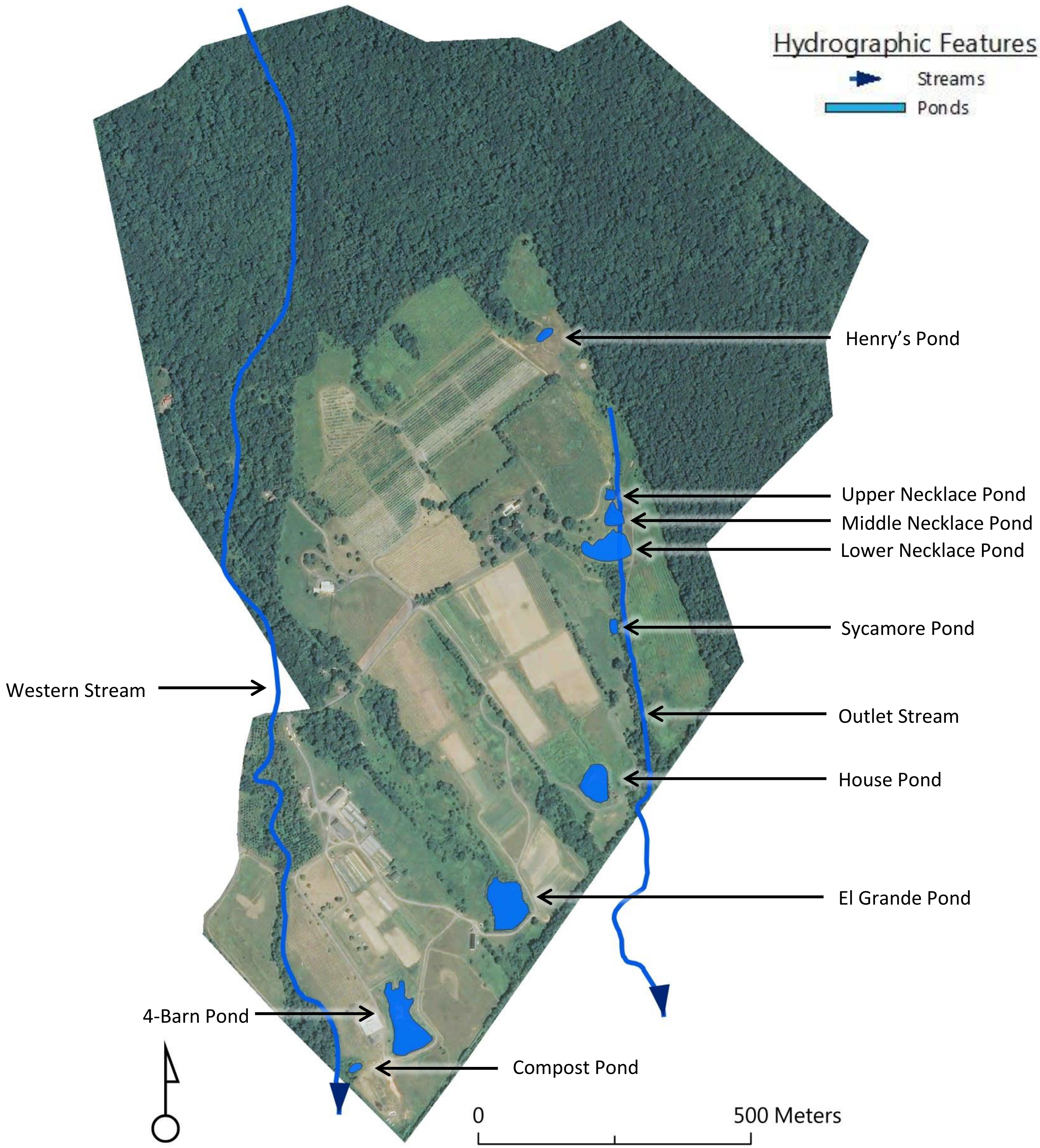
The Farm's partnerships with local non-profits, research institutions and ecological service providers continue to be fruitful. Participation in the SCBI's Virginia Working Landscapes Project has helped us broaden our inventories of birds, pollinators and meadow plants, and access to the project's database 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 our intern 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.

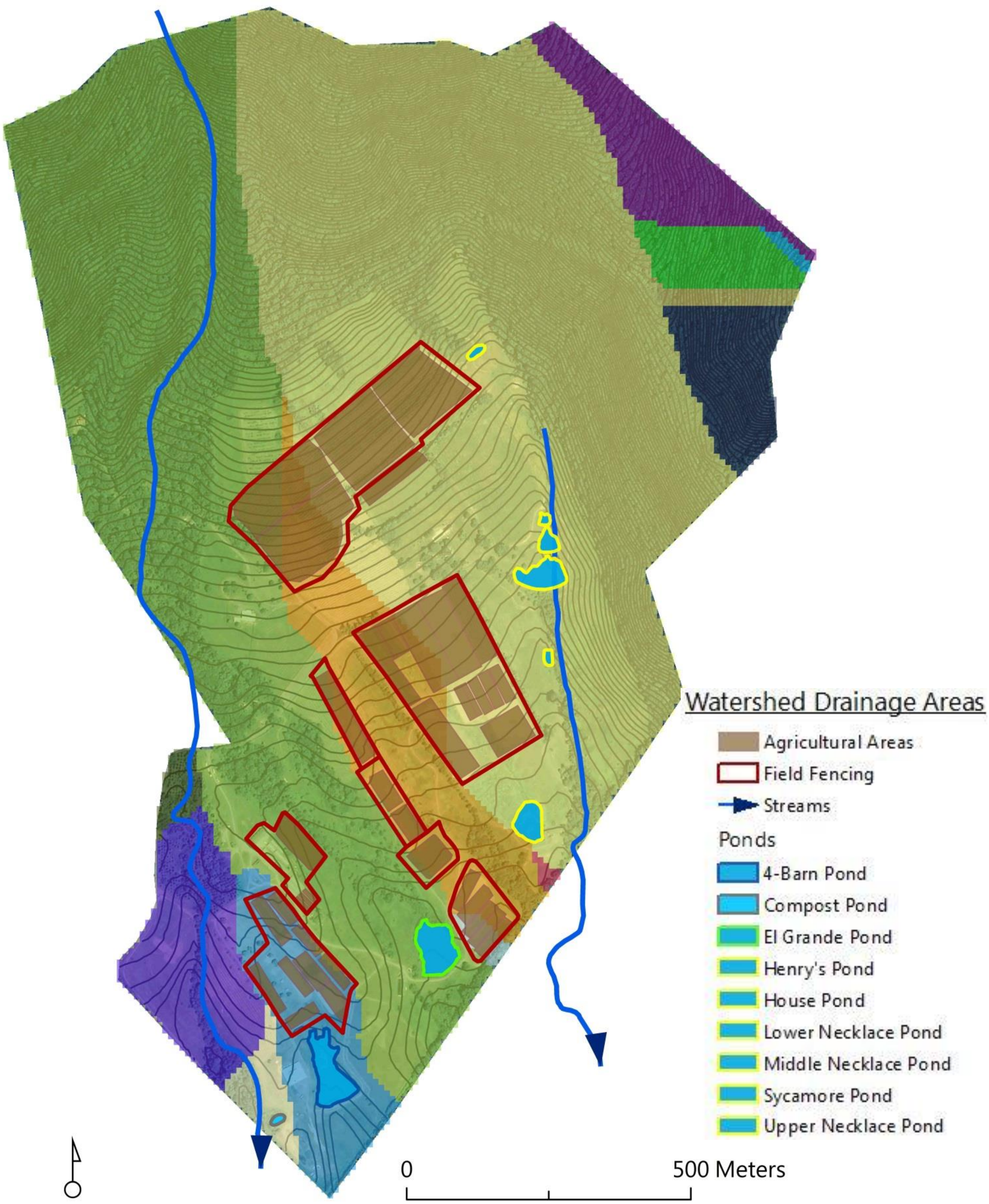
Other key partners include:

- **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

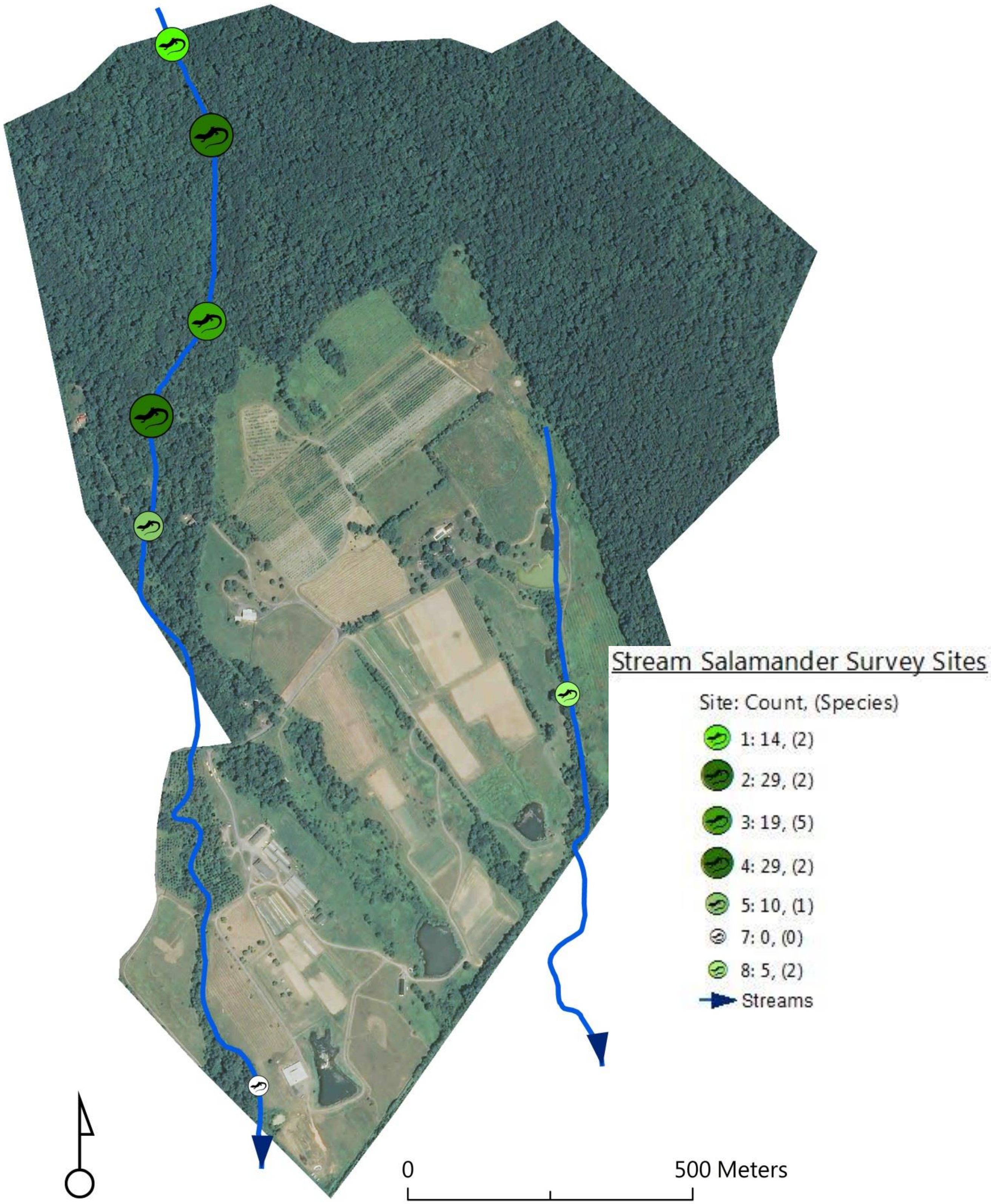
Appendix A: Hydrographic features at the Farm at Sunnyside.



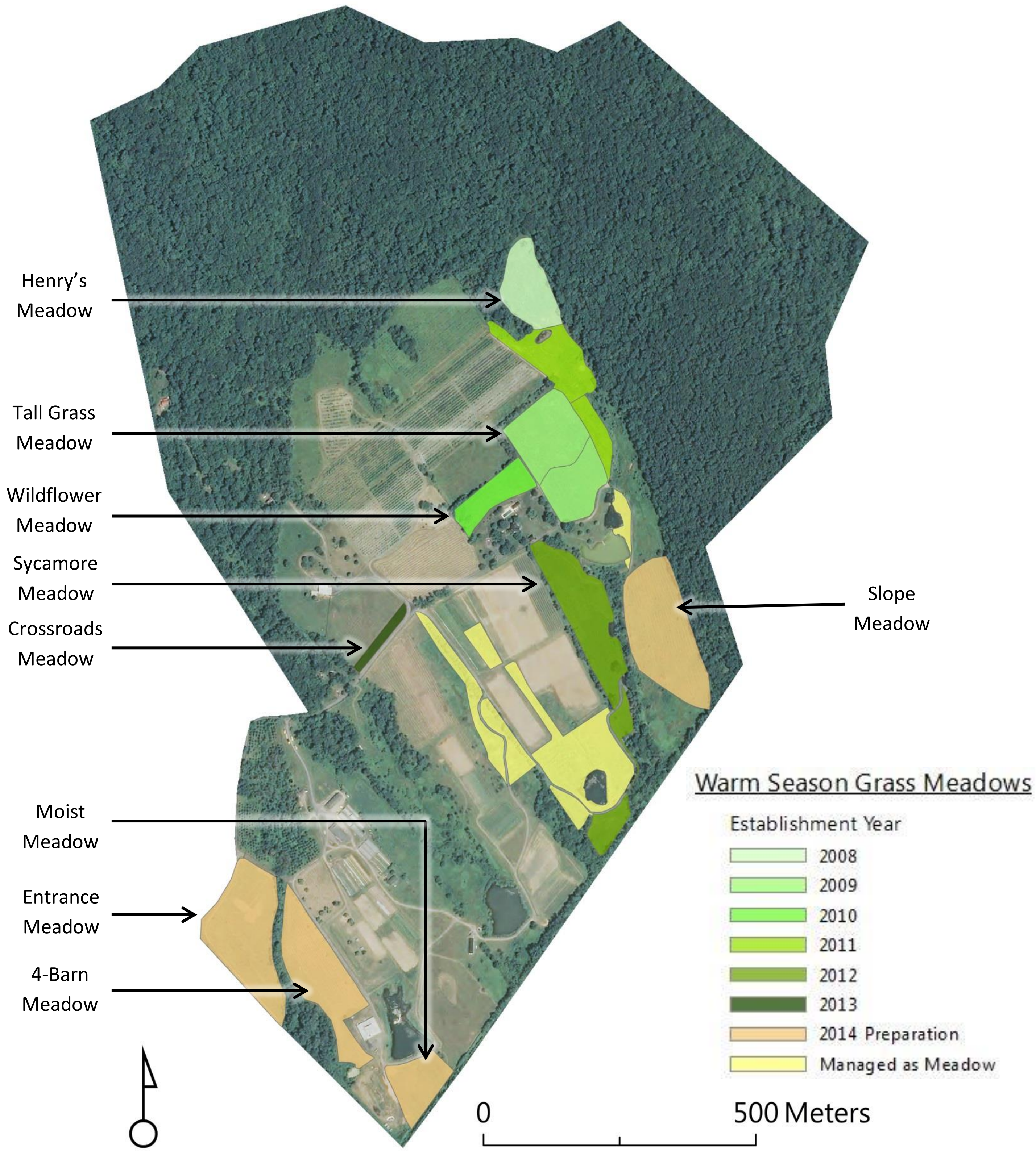
Appendix B: Drainage area map showing the catchment area of individual farm ponds.



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



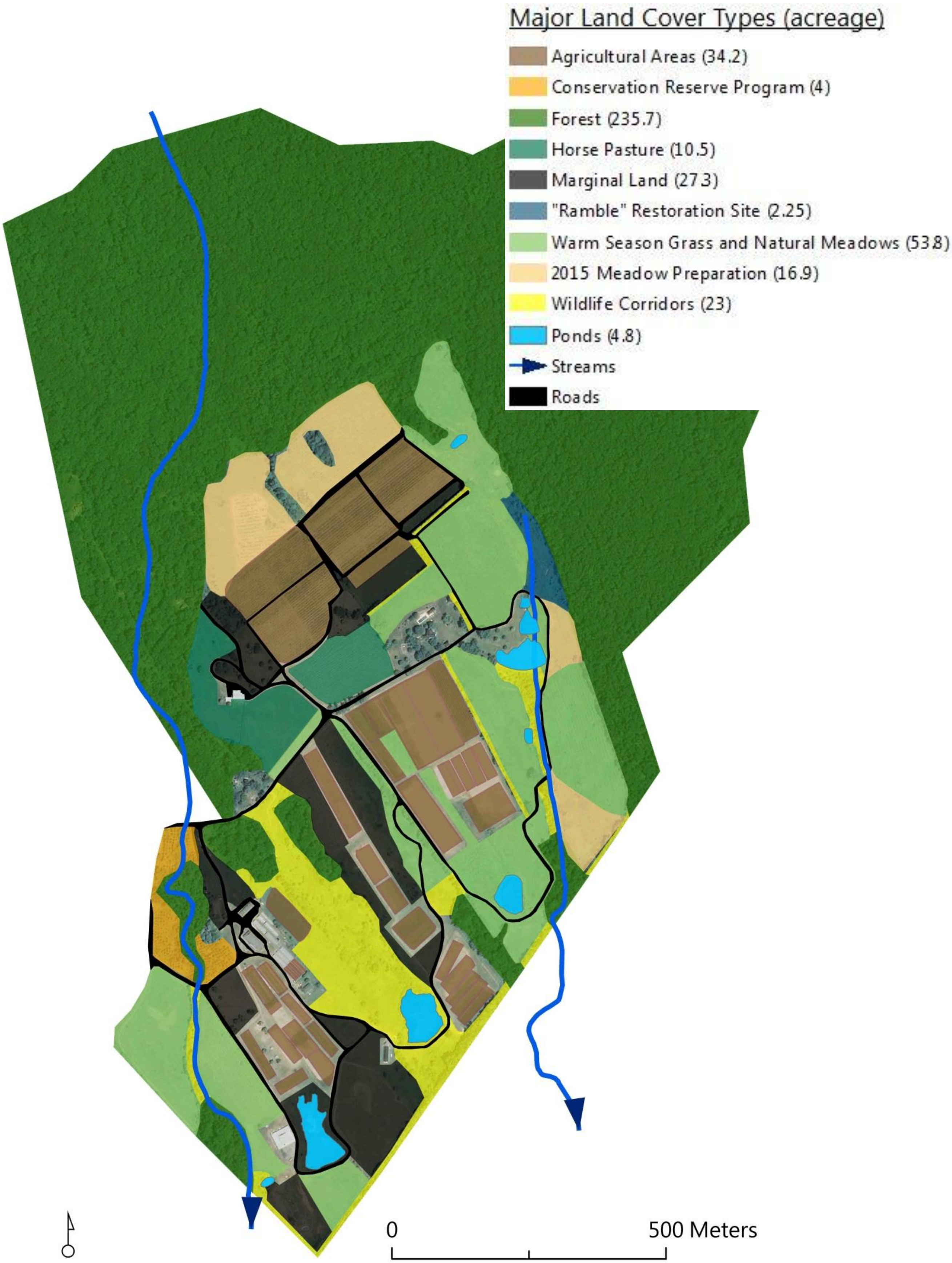
Appendix D: Warm season grass and flower meadows. The map also shows areas that are managed with fire to improve their wildlife value (yellow) and areas being prepared for establishment in 2014. The Annual North American Butterfly Count was conducted in the Tall Grass, Wildflower and Sycamore meadows.



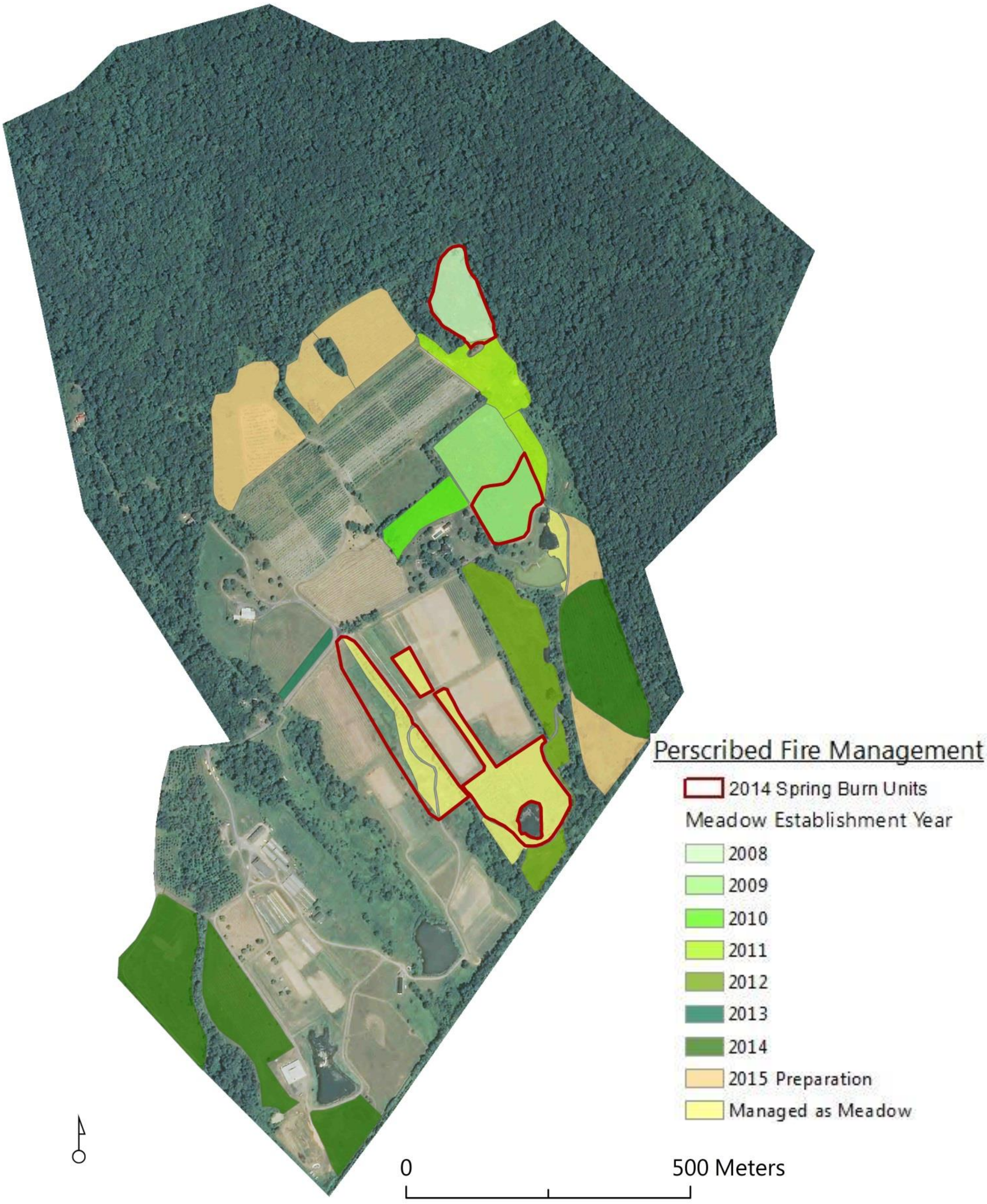
Appendix E: Results from the 2014 North American Annual Butterfly Count conducted by the Old Rag Master Naturalists.

Group, Species	2013	2014
Swallowtails		
Zebra Swallowtail	0	2
Black Swallowtail	21	0
Eastern Tiger Swallowtail	958	5
Spicebush Swallowtail	72	4
Swallowtail spp.	101	8
Whites & Sulphurs		
Cabbage White	12	14
Clouded Sulphur	19	13
Orange Sulphur	24	16
Cloudless Sulphur	7	1
Sulphur spp.	4	0
Harvesters		
American Copper	0	1
Hairstreaks		
Red-banded Hairstreak	2	0
Blues		
Eastern Tailed Blue	23	25
"Summer" Spring Azure	2	1
Brushfoots		
Variegated Fritillary	1	0
Great Spangled Fritillary	24	7
Silvery Checkerspot	47	2
Pearl Crescent	7	0
Red-spotted Purple	1	0
Common Buckeye	0	1
Brushfoots spp.	25	0
Satyrs		
Common Wood-Nymph	0	1
Northern Pearly-eye	1	0
Milkweed		
Monarch	2	0
Spread Skippers		
Silver-spotted Skipper	120	31
Horace's Duskywing	0	2
Hayhurst's Scallopwing	4	0
Common Checkered-Skipper	1	0
Common Sootywing	1	1
Spread Skippers spp.	6	2
Grass Skippers		
Least Skipper	4	10
Peck's Skipper	0	2
Sachem	4	7
Zabulon Skipper	10	1
Dun Skipper	1	
Grass Skippers spp.	19	2
Hummingbird Moths		
Northern Clearwing	1	0
others		
Long-Winged Dagger Moth	0	1
total	**1524**	**160**

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

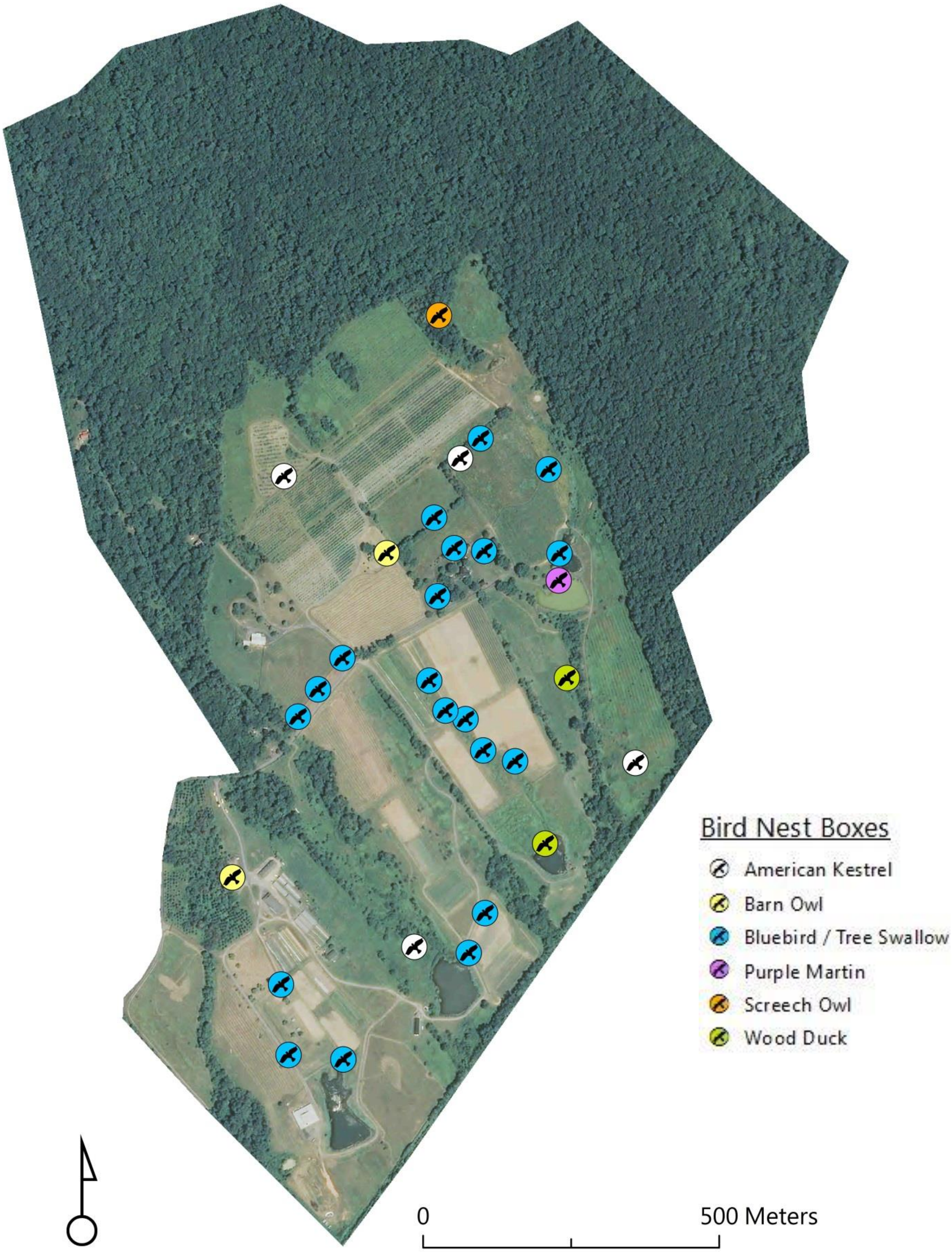


Appendix G: Prescribed fire management units burned in 2014. Note that less than 1/3 of existing meadow acreage is burned in a year as to not eliminate too much habitat at a given time.



Appendix H: 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 infestation areas overlap.

Appendix I: Bird nest box locations.



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