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55 Lane Road,
Suite 407
Fairfield, NJ 07004
973.774.3300
www.gza.com

Conservation Management Plan

Madison Restoration Area

Blaine Rothauser (*Photographs & Text*)
Natural Resource Specialist
GZA GeoEnvironmental, Inc.
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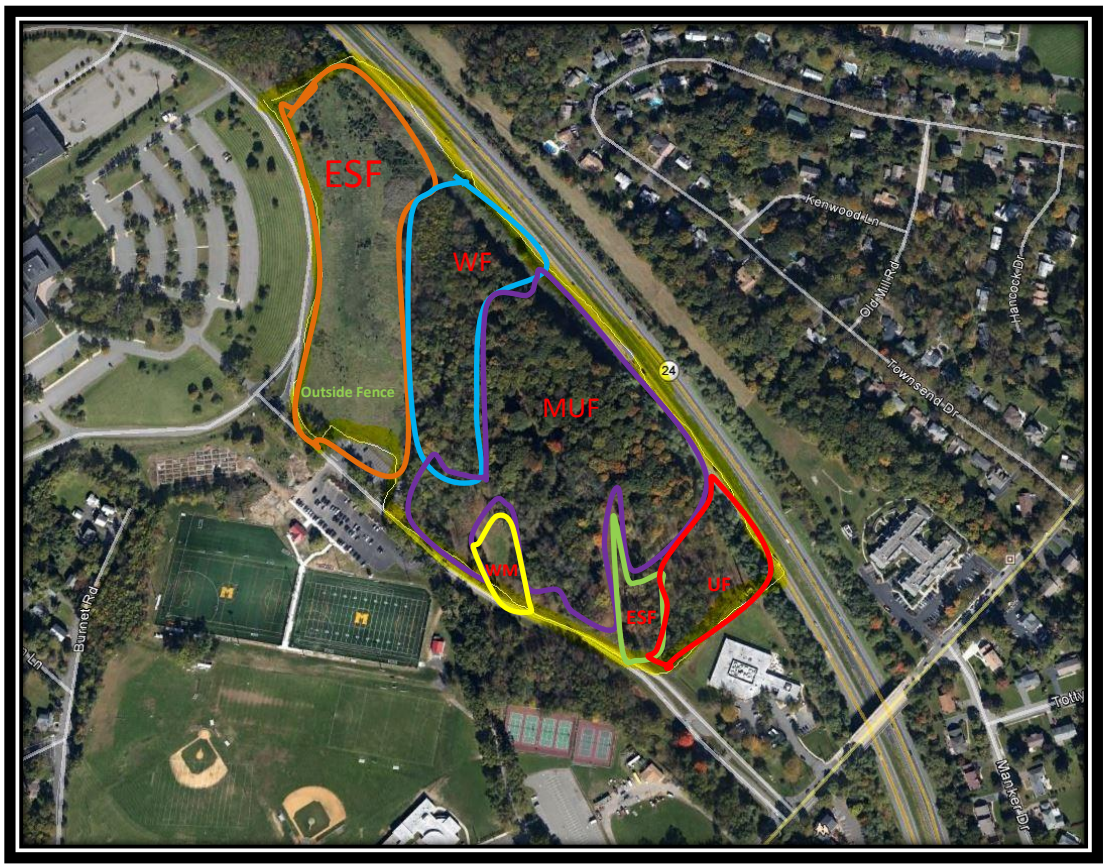
1.0 Introduction

The Madison Environmental Commission (MEC) retained the services of GZA GeoEnvironmental. Inc. in the spring of 2015 to evaluate 39 acres of open space located at 184 Ridgedale Avenue, Madison, New Jersey known locally as the Madison Recreation and Education Area (MREA), herein referred to as "site proper" or "preserve". Presently the site can be divided into sub-habitats based on vegetation community structure and degree of wetness inherent with their position in the greater landscape (Figure 1). GZA's primary focus was confined to the zone within the 20 acre deer enclosure. The remaining 19 acres of shrub/scrub field is only mentioned in the context of its influence and interface properties with the habitat within the fence region. The following environmental accounting of the preserve is the result of a comprehensive in-field analysis of the site proper. Prior to our field work a thorough desktop investigation of the MREA was performed to gain understanding of the physical and natural elements that make up the preserves current ecological condition. The information herein is based on physical, landuse, and ecologic observations of the site and surrounding landscape. This forms the basis of the habitat vulnerability assessment and management recommendations that follow. In addition GZA provides a summation of the site proper's current ecologic deficiencies and trends. No attempt has been made to address local political or civic land use concerns.

If land stewardship recommendations at the end of this report are implemented it is our professional opinion that a measurable uptick in the MREA's overall biodiversity would be realized. In turn, the preserve will function more efficiently as ecologic productivity increases in synergy with diversity.

Image 1 - Scarlet Tanager (*Piranga olivacea*)
Seen May 15th 2015 in canopy interior forest of MREA

Figure #1 Site Proper Community Structure



1.1 Inventory of Land Types/ Sub-habitat of Site Proper

- Early Successional Field (ESF)
- Mid-Seral Stage Deciduous Wetland Forest (WF)
- Mid-Seral Upland Forest (UF)
- Mid-Seral Mesic Deciduous Forest (DF)
- Mature Upland Forest (MUF)
- Wet Meadow (WM)

2.0 Site Description

The MREA is part of a multi-use recreational facility that includes two large athletic fields and a community garden (Figure # 2). The MREA's 39 total acres includes a 20-acre deer-fence-enclosed open space resource used primarily for passive recreation and environmental study (Figure # 2). The MEC cleared vegetation and created a 0.6 mile passive recreation walking trail that has its trailhead at the parking lot. Starting at the main gate (Image # 3) the trail extends into the interior wetland forest where it winds its way up slope and around the outer margin of an open meadow where it exists the site to the south onto the margin of the access road. The trail also has a side extension that leads to a gate to the west end of the site proper where it wraps back to the

parking lot through a tall grass/herbaceous early successional field. The site is significant in that it sits on top of the Buried Valley Aquifer, an important water recharge area that supplies clean drinking water for 26 municipalities. Over the past century the land that surrounds the MREA has been subject to intense land use, primarily in the form of forest clearing and human-induced landscape fragmentation. Today the MREA is a patchwork of mid to late seral[1] stage forest surrounded by a perimeter of mesic[2] grassland-shrub/scrub meadow. Included in the forested interior is approximately 6 acres of wetlands bordered directly to the north by Highway Route 24. Like so many pocket parks in the Piedmont Geophysiographic Zone[3], this fragmented land-type has given way to invasive species domination. Tethered to this floristic change is a faunal community more in line with synanthropic[4] species than those associated with greenway connected natal-habitat mosaics.

While the return of pre-colonial forest ecology is no longer a practicable expectation for the MREA, GZA recommends appropriate land stewardship whose sole purpose is to provide for a measurable improvement in the biodiversity of the park. Full assemblages of flora and fauna indicative of larger greenway connected areas cannot be expected due in large part to the limitations of restricted buffer habitat, sound and light impacts from adjacent recreation activities, and the site proper's lack of water resources. However, the site still retains many stable and productive ecologic ingredients that with proper stewardship will maintain a much higher level of natural productivity through expected increases in the sites overall biodiversity. Section 7 of the report outlines conservation management recommendations specifically designed to counteract the impairment trends that currently characterize the ecologic state of the MREA.

Image 2- Green Darner (*Anax junius*) July 29th 2015 ESF

[1] Seral – referring to a specific gradient point in ecological succession
[2] Mesic – soils that are not too dry or wet – in-between the two extremes – average soil moisture year round
3 Piedmont Geophysiographic Zone is a plateau region located in the eastern United States between the Atlantic Coastal Plain and the main Appalachian Mountains, stretching from New Jersey in the north to central Alabama in the south.
[4] Synanthropic - refers to a member of a species of wild animals and plants of various kinds that live near, and benefit from, an association with humans and the somewhat artificial habitats that humans create around them. Those habitats include houses, gardens, farms, roadsides, garbage dumps, and so on.

Figure # 2. MEC Proposed Trail Map and Site Layout

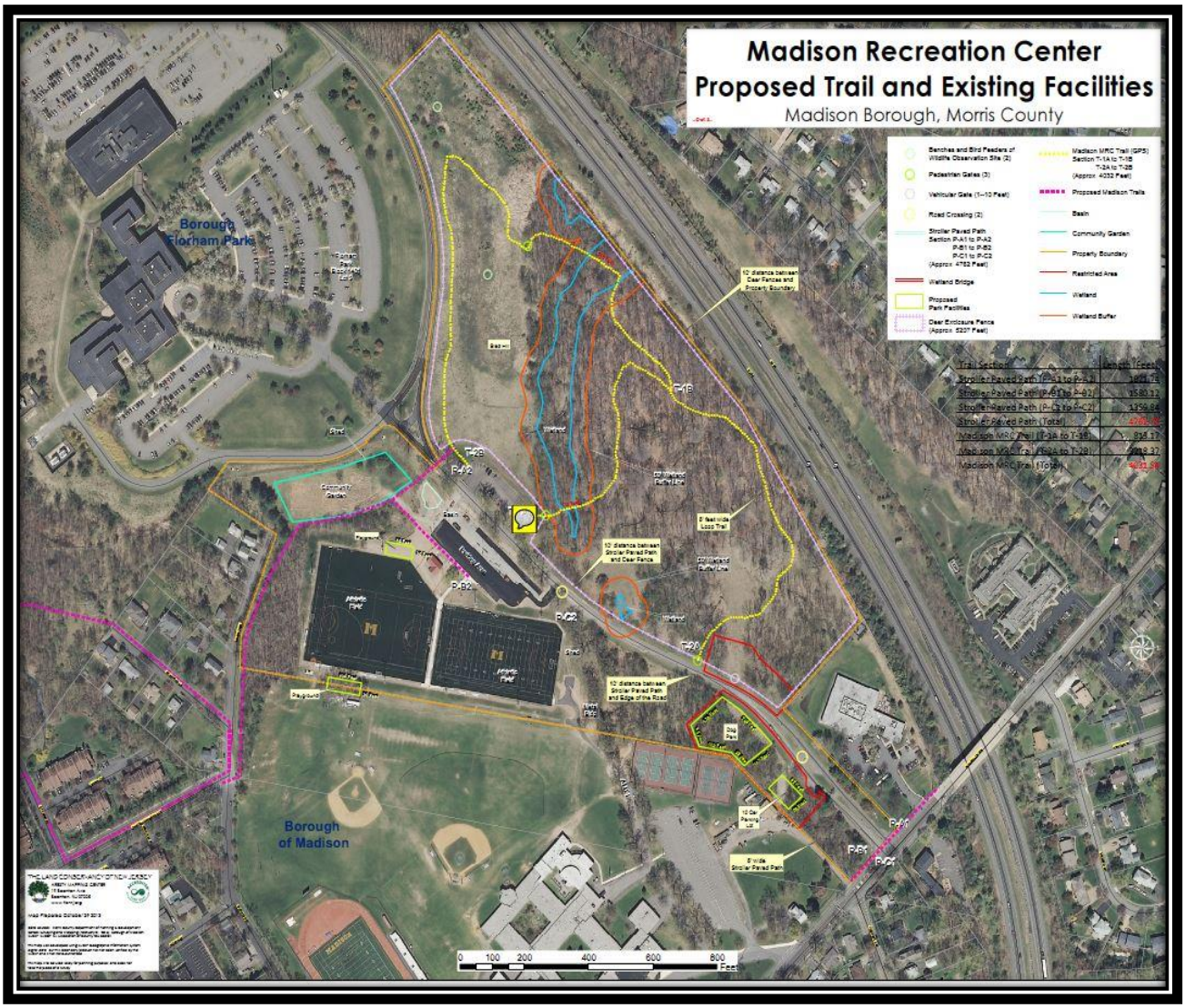


Image 3 - MREA Deer Fence – Front Gate to Trail Head

Image 4 - Trail and Boardwalk through the Site Proper Wetlands

3.0 Disclaimer - Limiting Factors:

Under the many limiting factors current urban conditions impose on the natural landscape any expectations to the success of a Conservation Management Plan (CMP) must systematically consider all existing features both physical and ecological. Aggressive Best Management Land Restoration Practices (BMPs) must be initiated in order to avoid the pitfalls of what is all too often a "triage approach" to land management; to proactive manage the ecology instead of merely reacting to crises as they emerge. The first step in this process is an inventory and understanding of the community structure for which a CMP is directed. The science of conservation biology is predicated on this principal. GZA brings this point to the reader's attention, offered as explanation for the following approach and methodology.

4.0 Methodology

GZA's senior natural resource specialist, Blaine Rothauser, performed a background data review of all land use parameters within the boundaries and surrounding landscapes of the site proper. These included a review of:

1. NRCS Soil Survey (Figure 3);
2. Landscape Data – State Wetlands (Figure 4);
3. Landscape Data – Federal Wetlands (Figure 5);
4. Landscape Data – Streams and Tributaries (Figure 6);
5. Landscape Data - Rare Species (Figure 7);
6. Sara Webb Professor of Biology and Environmental Studies, Drew University: Report: 2014, Forest Condition of MREA (Appendix A);
7. Trees of MREA, Sara Webb Professor of Environmental Studies, Drew University (Appendix A).

Upon completion and review of all materials listed above a total of nine in-field site visits were performed; one in April, two in May, two in June, two in July and two in August 2015. During diurnal study of the park all flora and fauna observed were documented (Appendix B, C & D). The flora inventory of the MREA has been uploaded to the Bowmen Hill Wildflower Preserve data base (the complete inventory as of August 2015 is found in Appendix D Flora). This master list of the parks flora is an "organic" tool for which future land stewards can add or subtract species as natural conditions and management are always in flux. In this manner the floristic quality of the park can be tracked moving forward with restoration initiatives. This tool is a defensible measure of the parks ecological health as reflected in its floristic quality index (FQI) (explained in more detail in section 6.2). Three additional visits entailed nocturnal entomological survey work. During these studies GZA field ecologists used a metal halide 1000 watt lamp to attract, count, and allow for the speciation of nocturnal insects associated with the MREA (Appendix C).

Identification of the MREA's invasive species "hotspots", characterized by one or a few distinct species of invasive flora were documented - from this point forward referred to as simply Areas of Concern (AOC).

Ancillary observations of faunal taxa were documented during all field visits. Baits, lures, bird vocalization recordings and small mammal traps were used when and where applicable. When observed, all scat, tracks, feathers, and bio-ecologic signatures were documented. The result of these baseline inventories provides an accurate "snapshot" of the preserves biota as documented in the spring and summer of 2015. These natural attributes are not likely to vacillate from the mean in the foreseeable future unless restoration initiatives like the ones offered in Section 7 of this report are implemented.

Cautionary statement: A full inventory of flora and fauna during all seasons using the expertise of natural scientists skilled in the identification of specific taxa would likely yield a much more robust list. However, the inventory herein provides a sufficient baseline for measuring the future efficacy of proposed management recommendations.

5.0. Background Review of Available Information:

A desk-top analysis of the preserve revealed valuable landuse metrics that helped to rapidly assess the sites current physical and ecological condition. Follow-up in-field site visits were performed to evaluate the accuracy of this information. The results are presented in the subsections below.

5.1 USCS Soil Survey Maps:

Soil types ranging from well-drained to poorly-drained follow a topographic gradient from a northeast point (well-drained), to a northwest point (poorly-drained) on the property. The Highpoint of the preserve is at elev. 257' (east central). The lowpoint of the property is found along the fence boundary in the northwestern section of the preserve at elev. 209'. The soil type at the low point is hydric and saturated for most of the year. The general topography of the site proper has a gradual relief that runs southeast to northwest. The soil survey indicates that the majority of the interior of the site consists of the hydric Whippany silt loam. The remainder of the property indicates soils that are characteristic of urban land. In-field observations confirm this general description with the exception that the area indicated as Whippany Silt Loam appeared to be of lesser extent based on surface hydrology. Soils at many locations lacked typical hydric indicators and supported a preponderance of upland status (USF&W FAC & FACU) vegetation in areas east of the small rivulet that runs through the property (blue line in Figure 3), suggesting non-hydric soil conditions. This intermittent rivulet originates from a culvert pipe that drains land south east of the access road into the complex (Image 5).

Figure# 3: Soil Map

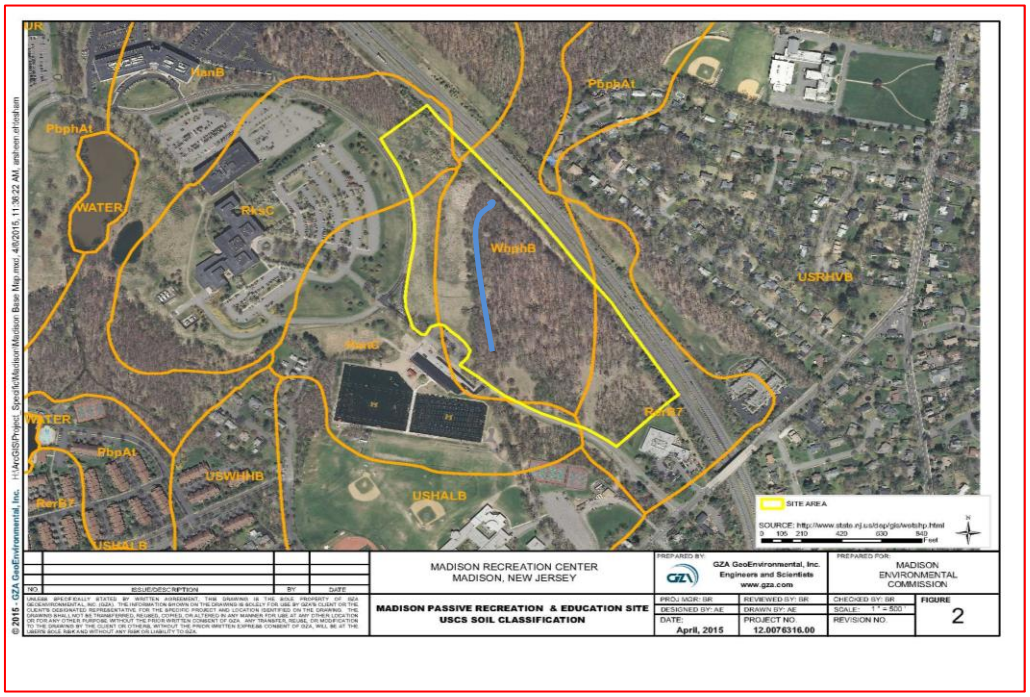


Image 5 - Culvert pipe that feeds the rivulet that winds through MREA wetlands

5.2 Review of NJ's Geological Survey

Available data indicates that surficial deposits laid down in the area of the site proper are from a post –glacial period 15,000 - 12,000 years ago. The MREA is underlain with "Raway Till". This material can be 30 feet thick – gravel, sand, silt, and clay (sandstone, siltstone). The shallowest bedrock in Madison is part of the Boonton Formation (Lower Jurassic Period, approximately 190 to 175 Ma), which is the youngest of the depositional cycles of the Newark Basin. Madison is located on the Watchung Syncline within the Newark Basin, where flexure in the bedrock between the Hook Mountain Basalt and the Highlands caused the bedding planes to dip inward on both sides. This syncline extends southwest through the Great Swamp, and north through Black Meadows and Troy Meadows. The glacial deposits had a significant impact on Madison. The bedrock surface forms a buried valley in a trend following Main Street and then Park Avenue. Within this valley is a layer of sand and gravel approximately 100 feet thick deposited either prior to glaciation or during several periods of glaciation. This feature is commonly known as the Chatham Buried Valley Aquifer. This is the source of Madison's water supply, with wells located at the Department of Public Works area, and the North Street Area. The site proper is outside of the town's well-head protection area but within the Whippany River Watershed/Black Brook sub-watershed; therefore an important water recharge area surrounded by land with imperious and compacted soil surfaces. It is important to recognize that the entire Borough of Madison is located on a land form that was once the bottom of a glacial lake. "Glacial Lake Passaic" covered all of Madison, except the highest elevations that were islands (technically called wave-cut terraces). The clay and silt layers are lake deposits formed in Glacial Lake Passaic. In some areas, such as along Ridgedale Avenue, the clay layer is missing or buried by a ridge of glacial outwash deposits running perpendicular to the terminal moraine (Madison

Borough, ERI, 2011). Today a large portion of the forested area of the MREA consist of Whippany Series soils – basically a remnant of poorly drained lacustrine (lake bottom) sediments that reminds the visitor of the sites geologic past. The significance of the geology that underpins the site is the manifestation of the ecologic community structure that have adapted to forested wetlands and the temperate deciduous uplands that buffer them. The MREA is a remnant piece of this habitat mosaic that once covered a much larger contiguous area of the Piedmont.

5.3 State and Federal Wetland

As noted in Section 1.1, the MREA consists of 5 naturally occurring land types - only one is consistent with state and federal wetland map units. These maps represent them as "deciduous forest" and "deciduous forest/shrub" wetlands; either descriptor is accurate as field-verified in the spring of 2015. Both wetland map units are consistent with each other (Figure 4 & 5). Using the Army Corps of Engineers (ACOE) three parameter approach for verifying jurisdictional wetlands GZA's in-field assessment indicates that the wetland limits are actually about 30% smaller than those indicated on the maps. This is based on the fact one or more of the three wetland parameters did not meet the standard within portions of map unit(s)[5] area:

a. The vegetation standard was frequently not met, with <50% of all flora with a hydric indicator status of FAC, FACW, OBL(ACOE wetland vegetation status indicators);
b. Soil hue and chroma did not meet the hydric soil criteria for 25% of the wetland map unit In addition no secondary indicators of hydric soils were noted in samples from this area(i.e. lack of redoximorphic accretions or depletions: concretions, or oxidized root channels). The remaining 75% of mapped wetlands do meet the criteria;
c. Hydrologic indicators were absent in about 30% of soils within the wetland map unit.

The wetland is isolated within the site proper (Image 7) but hydrologically connected to another wetland complex off-site to the northwest. Another isolated wetland was noted on site but is **not** indicated on either the state or federal maps. This area consisted of a (+/-) .25 acres of wet meadow located in the southeast section of the MREA (added as isolated wetland in Figure 5).

Image 6 – Wetland buffer outside of deer fence and forest edge

[5] all 3 wetland criteria must be met to classify an area as a ACOE "jurisdictional" wetland

Image 7 - Onsite Wetland Area

Looking NW from Trail into Forested Wetlands Invasive Japanese stiltgrass dominates the herbaceous layer

Figure #4. State Wetlands

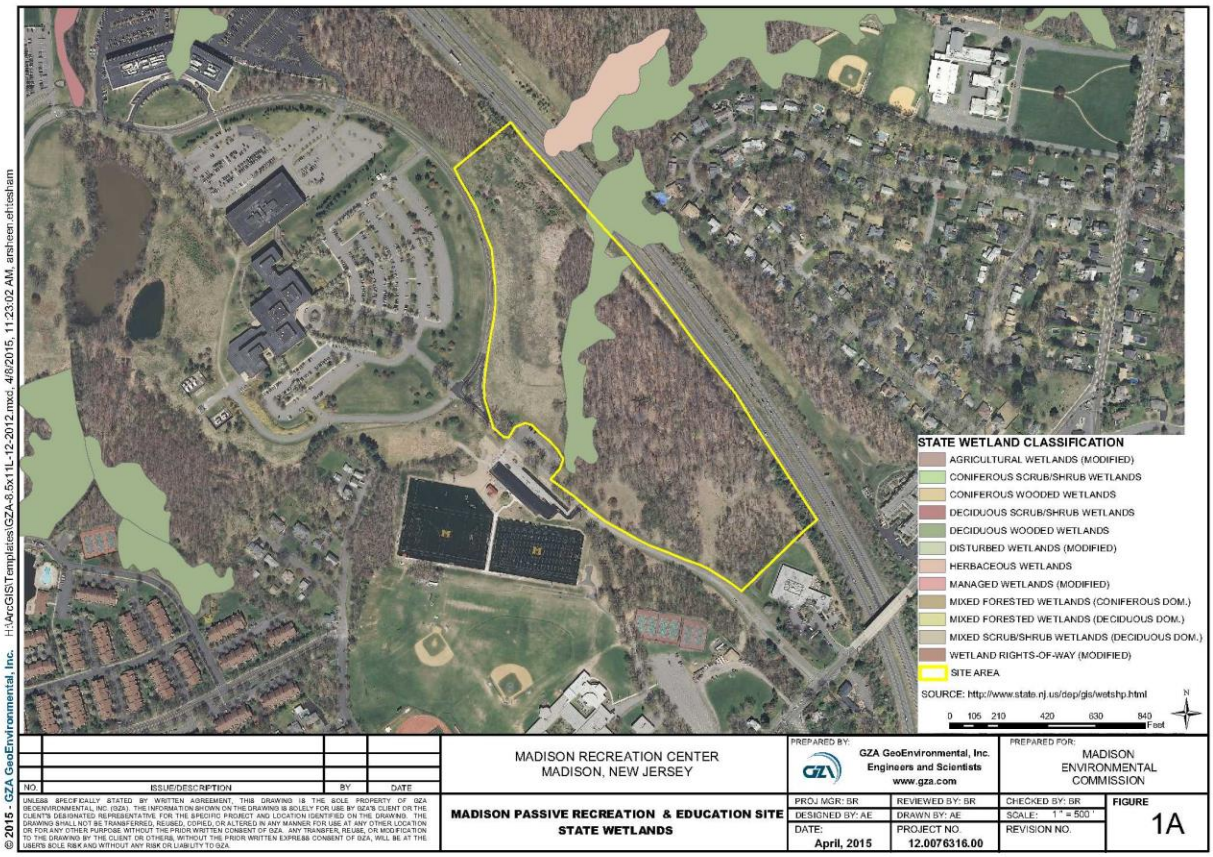
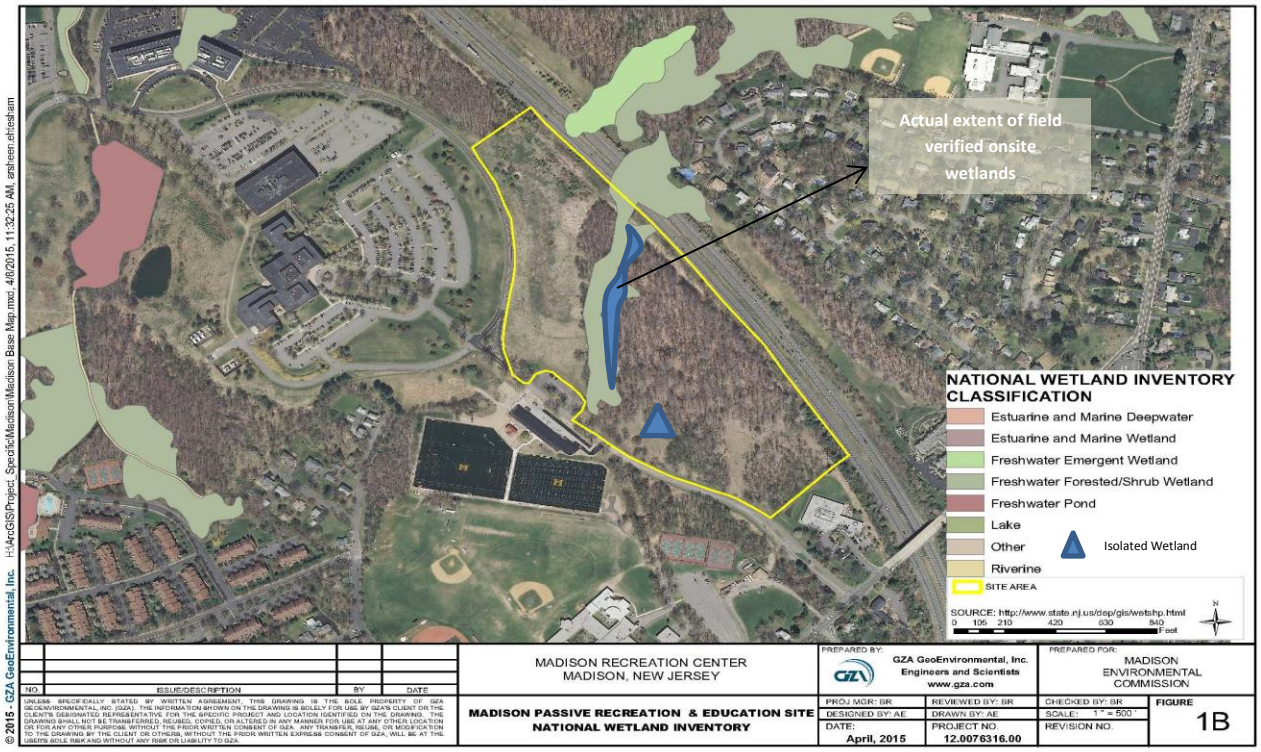


Figure #5. Federal Wetlands



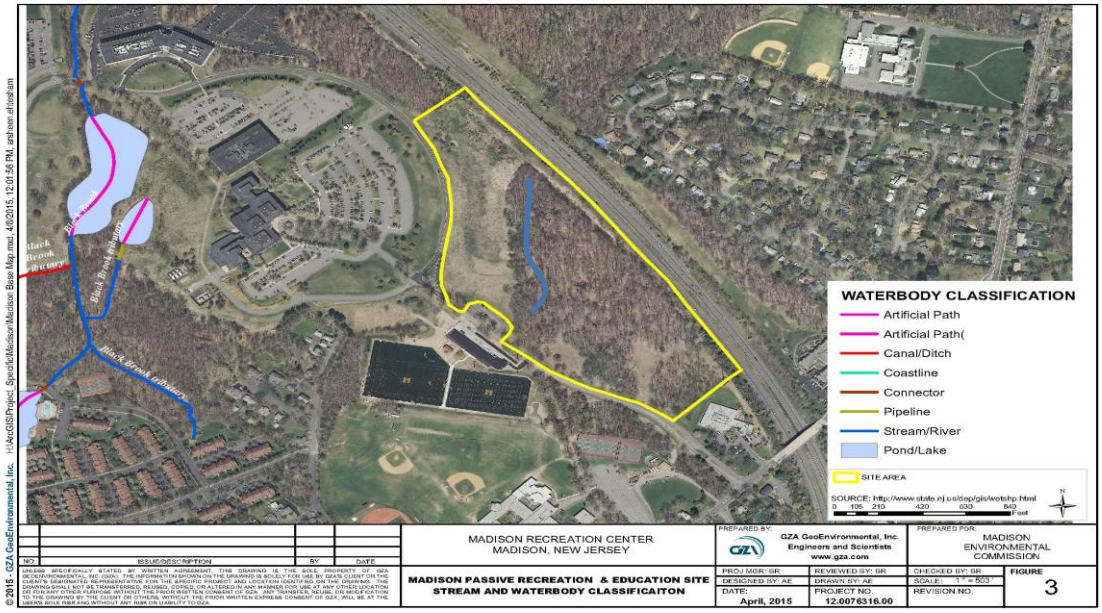
5.4 Streams, Tributaries & the Buried Valley Aquifer

The only water feature of significance on the site-proper is a small rivulet (small stream) that originates from an underground culvert pipe 220' north of the MRC access road (Figure 6). This small-width rivulet (2' ± average value) is an intermittent, unnamed tributary that hydrologically connects the onsite wetlands with those offsite via another much larger culvert pipe that crosses County Route 24 to the north. Here water flows at various times throughout the year through deciduous wetland before draining into an unnamed tributary of the Black Brook to the north of the MREA. The fact that the wetlands on the site proper and those across the highway to the north are hydraulically connected to one another via the onsite unnamed intermittent rivulet makes them one jurisdictionally-contiguous wetland. The Black Brook proper is the nearest permanent stream to the MREA; located 0.1 mile to the west of the site proper. The Black Brook is itself a tributary of the Whippany River. Therefore, the site proper is in the Whippany River Watershed, itself a major component to the much larger Passaic River Basin. The gently sloping topography of the MREA is largely permeable ground cover. Water that doesn't escape the site via surface conveyance is directed into the ground as recharge. Groundwater recharge infiltrates into the soil and seeps into underlying rocks and sediments. Aquifers occur when storage of groundwater is sufficient to produce a water supply. Madison is the fortunate recipient of this condition as it draws its water from the Buried Valley Aquifer. The Well head Protection Area(s) where the water is drawn from the ground for municipal water supply are located 0.3 mile to the north in Florham Park Borough and .8 mile to the west in Madison Borough. As more and more impervious surface is introduced through development within Madison Borough and surrounding municipalities, the more permeable-land, the source of groundwater recharge, becomes a vital resource to the future health of its residents. With the exception of the intermittent

tributary, no significant water resource is available for aquatic community development onsite, which therefore becomes an important factor in developing recommendations for the CMP.

Image 8 - Intermittent onsite rivulet – Late July 2015

Figure #6. Streams



5.5 Landscape Data – Rare Species

The NJDEP Landscape Project (LP) tracks rare, threatened and endangered (T&E) species throughout the state based on multi-source-data collections methods. The LP is a pro-active approach for the long-term protection of imperiled species and their important habitats in New Jersey. Its goal is to protect New Jersey's biological diversity by maintaining and enhancing imperiled wildlife populations within healthy, functioning ecosystems. Rare species sightings are the basis of New Jersey State Wildlife Action Plan (SWAP). The Madison EC through the process of documenting current habitat conditions and addressing site-specific ecologic limitations and impairments is a crucial first step in being compliant with the tenets of the LP and the SWAP.

To date no records of T&E species are recognized to occur directly on the site proper. The LP Map, Figure 7, is somewhat misleading as it would indicate to the lay person that some federally listed "Rank 5 species" may occur on site. However, the Federally Listed Indiana Bat (*Myoti*s sodalist) (IB) had a documented occurrence on property in close proximity with the site proper, which results in the mapping of rare species habitat. The property owned by DM Ltd., aka the Morristown Airport (MMU) in2007, is 0.3 mile northeast of the MREA. This data point of observation resulted in what is known as a Species Occurrence Area (SOA) that reflects the life history requirements of the endangered bat. The SOA overlaps with the site proper, likely due to its foraging habitat as it relates with IB life history requirements. Foraging bats on the site proper was certainly a possibility in 2007 before White Nose Syndrome (WNS), an emerging disease in North American bats which as of 2012 was associated with at least 5.7 million bat deaths. As of 2015 IB's are so rare as to be considered critically imperiled in New Jersey. Therefore, the likelihood of IB's fulfilling any aspect of their life history on the MREA or surrounding lands is highly unlikely. This same scenario is true for the newly listed Northern Long-eared Bat (*Myotis septendtrionalis*) (federally threatened status) (Image 9). Similar foraging, roosting and nesting parameters are required for both bat species. It is hoped that these two species have enough inherent resistance to WNS remaining in their collective gene pools that the populations of both species might bounce back and rebuild their numbers. The CMP for the site will address bats as a guild group of concern in the recommendation section of this report – Section 7.0.

Figure #7. Landscape Project Map for Site Proper

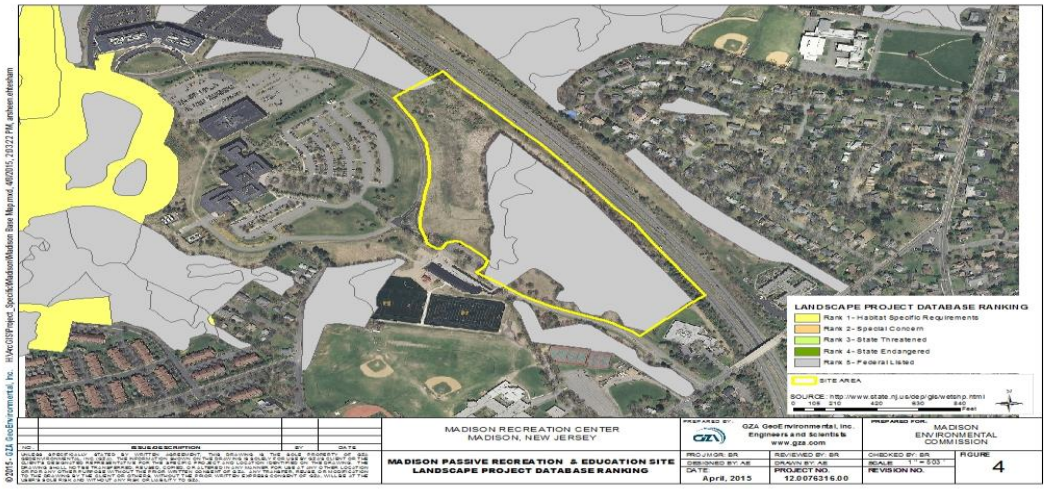


Image 9 - State Threatened Long Eared Bat (*Myotis septentrionalis*)

Some potential rare species habitat was identified on the preserve. Rank 1 species habitat designation can be assigned to patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species. However, GZA field survey in the spring of 2014 show evidence for breeding and nesting wood thrush (*Hylocichla mustelina*) a species of special concern in New Jersey Figure (Image 10) . The term "Species of Special Concern" applies to species that warrant special attention because of some evidence of decline, inherent vulnerability to environmental deterioration, or habitat modification that would result in their becoming a threatened species. This category would also be applied to species that meet the foregoing criteria and for which there is little understanding of their current population status in the state. Male Wood Thrush were seen and heard vocalizing their very clear flute-like *ee-oh-lay* on site in late May 2014 – a certain metric that breeding and nesting is taking place directly on the site proper.

Other species of special concern Neotropical birds were seen and heard on the site during the spring migration of 2015. These include but are likely not limited to:

a. Blackburnian Warbler (*Dendroica fusca*);
b. Hooded warbler (*Wilsonia citrina*);
c. Veery (*Catharus fuscescens*);
d. Common Night Hawk (*Chordeilus minor*);
e. Brown Thrasher (*Toxostoma rufum*);
f. Cooper Hawk (*Accipiter cooperii*);

Image 10 - State Species of Special Concern – Wood Thrush (*Hylocichla mustilana*)
Taken on the MREA 5.27.14

None of the above species were noted to be utilizing the site for breeding or nesting, perhaps due in part to the sites size limitation and isolation from other greenway connected lands. However conservation management of the site proper could, over time, lead to suitability for both Veery and Brown Thrasher (see conservation management Section 7.0).

No rare flora was determined to be present during GZA's spring and early summer surveys. Native plant stock has been planted on the site within sub-habitat in accordance with USDA Plant Hardiness Zone 6b. Inoculation of this material into site specific areas has already taken place and will continue into the future based in part on conservation management recommendations herein. None of these vegetative species are considered demonstrably rare but are species that have been included whose populations are declining throughout their range (refer to flora inventory in Appendix D – planted vs naturalized species are indicated).

6.0 Findings

Ecologic Assessment of the Site Proper

In the broader context of the surrounding landscape the MREA is within the Piedmont Geophysiographic Zone; as such the complex exhibits characteristics in concert with the ecology of this demarcated precinct. The scales at which comparisons can be drawn are diminished as human zones of influence penetrate the borders of the

site proper. In response to this fact the MREA is indicative of other fragmented lands of similar size and scope within the greater landscape proper. Sequestered from more naturally vibrant greenway connected landscapes the site is an ecologically-challenged biologic-island of sorts as assessed through the eyes of a terrestrial ecologist.

6.1 Site Fauna

Field observations of fauna took place during scheduled survey events from April through August 2015. These days were spaced apart by an average of 3 week intervals. Seven of the nine field observations started at sunrise and were finished by early afternoon; the optimal ecologic period of activity for most indigenous fauna. Two of the field observation days were performed in the afternoon and were completed by dusk. Three nocturnal entomological surveys of the site were performed using high intensity light to attract nocturnal insects (see 6.4(i)).

Mammals: Small mammal traps were set in June in a variety of sub-habitat types and checked the following morning. The only mammal species caught in eight of the 15 traps set were all white footed mice (*Peromyscus leucopus*) a common native rodent (Image 11). Five were found in the forested wetlands at the base of medium sized trees and the remaining three were from the upland forested section in the eastern quadrant of the preserve. Scat and tracks of Virginia opossum (*Didelphis virginiana*) and raccoon (*Procyon lotor*) were noted in spring along the intermittent stream. Two observations of stripped skunk (*Mephitis mephitis*) occurred in summer while performing nocturnal entomological survey work, along with the vocal identification of a southern flying squirrel (*Glaucomys Volans*) - heard vocalizing distinct “cheep” call. Red fox sub-dens were noted throughout site, however none were seen directly on the site proper. Only one nocturnal observation of a red fox (*Vulpes vulpes*) was made in July crossing over the access road away from the site proper toward the athletic field complex. Red fox actively use the site proper as testified by the common observation of scat. Red Fox digging tunnels under the deer fence were noted during our survey which indicates their areas of ingress and egress. Surprisingly no eastern chipmunks (*Tamias stratus*) were observed on the site proper. MEC land stewards have only made casual, but rare observations of chipmunks; what should otherwise be a common mammal of the MREA. Limiting factors likely range from raptor and fox predation to minimal access to standing water - no standing water was present in August of 2015 and the intermittent stream was dry from the middle of June through August. Chipmunk populations on the site likely fluctuate with predator pressure and water abundance.

As would be expected in habitat patches surrounded by fragmented human-influenced landscapes cottontail rabbit (*Sylvilagus floridnaus*) and woodchuck (*Marmota monax*) sightings were common place during most field survey days. These two species were welcome additions to the overall native fauna assemblage of the preserve.

Note: The above listed mammal species will not be placed in a separate Appendix as they represent a complete list of species noted in survey work. One additional mammal not listed above is likely a common rodent of the site: the short-tailed shrew (*Blarina brevicauda*). This small mammal was found dead in the wetlands along the trail in June 2015.

Image 11 - White-footed Mouse (*Peromyscus leucopus*) common small mammal of MREA
on Pussy Willow (*Salix discolor*) plant of MREA

Avian: Neotropical bird migrants were observed foraging throughout early spring tree and shrub leaf-out periods. The same suite of birds likely use the site proper during fall migration to fuel their metabolic needs by foraging for insects in these same trees. With the exception of migration events the site proper doesn't reach the level of a priority bird habitat. This statement in no way minimizes the site as quality habitat for a healthy guild set of avian species, but simply points out that at present the site proper doesn't have the necessary size and structure to support rare bird species as recognized by state and federal agencies. As stated in the rare species section of this report, the state threatened wood thrush is the one exception, nesting directly on the site (May 2014 & 2015, *Rothauser*). Notable migrants documented: scarlet tanager (*Piranga livacea*), black throated green (*Setophaga virens*), hermit thrush (*Catharus guttatus*), warbling vireo (*Vireo gilvus*) (Image 12) white-eyed vireo (*Vireo griseus*), and magnolia warbler (*Setophaga magnolia*). The species noted in Appendix B are called out as either migrants - those birds noted only a few times foraging on the site, i.e. wild turkey (*Meleagris gallopavo*), or those species nesting or breeding on site as testified by direct observation of nests or breeding calls heard (i.e. white- breasted nuthatch (*Sitta carolinensis*). In a limited number of field observation days GZA noted only a few synanthropic species breeding and nesting directly within the demarcated boundaries of the MREA.

Image 12 - Warbling Vireo (*Vireo gilvus*) May 15th singing from canopy MREA

6.2 Flora

GZA ecologist documented all observable flora during 2015 spring and summer survey days. By design, nine field survey days were spaced out to provide for blooming periods where identification to species level was possible. Documented species can be found in Appendix D. The number of survey days provided for a solid cross section of the preserves flora but in no way was meant to be an all-inclusive list of flora on site. One third of New Jersey's roughly 2,600 species of native plants are designated as either threatened or endangered by the state's Natural Heritage Program. No state listed plant species were found during GZA survey days of study. However a robust list of what is likely the majority of plant species that exist on the site proper were documented.

Documented species were compiled into what is referred to as a Plant Stewardship Index (PSI). This site specific inventory is now warehoused in Bowmen Hills Wildflower Preserve database. The PSI is now a planning and preservation tool that allows conservation mangers a way to quantify the floristic quality of the site by means of calculating the species richness in respect to each plants degree of nativeness and specificity to the habitat in which it was found. Another way of stating this is that PSI now becomes a vital tool for assessing the quality of plant communities within the preserve. PSI speaks to the "quality of the site".

6.2.1 MREA's Floristic Quality Assessment (FQA)

"The concept of a FQA is that (1) plants differ in their tolerance to disturbance and disturbance types, and (2) native plant species exhibit varying degrees of fidelity to particular native habitats. The FQA methodology is based on coefficients of conservatism (CC) between 0-10, assigned to each native plant species by a panel of regional experts. Higher coefficient numbers are assigned to those species that are "conservative" in their requirements for stable native plant communities. Species with lower CC values are generally found in a broader range of habitats and are more likely to colonize disturbed ground, abandoned fields, waste ground and old pastures, etc.

Plants and plant communities with exacting habitat requirements score highest, and those are the plants of greatest concern because they are most vulnerable to landscape fragmentation and development. The Floristic Quality methodology is now commonly used throughout the country to assess the quality of natural and restored landscapes" (Plant Stewardship User's Guide. Bowman's Hill Wildflower Preserve. Rosenbaum, 2009).

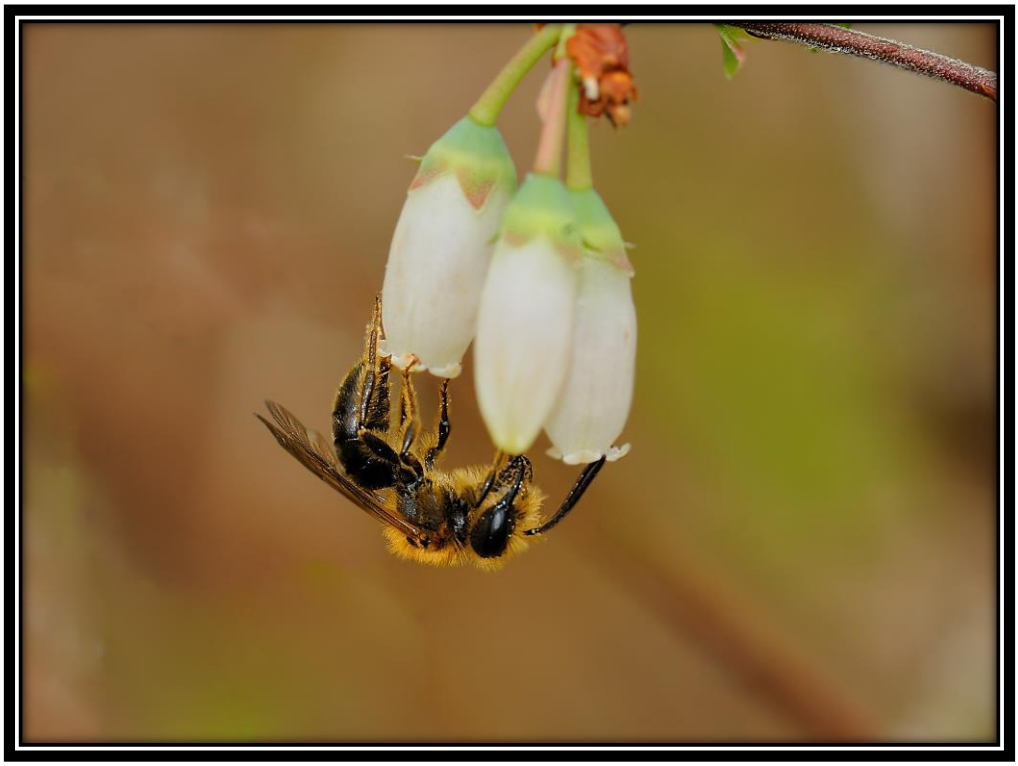


Image 13 - Miner Bee (Adrenidae sp.) nectaring in early spring on Blueberry (Vaccinium corymbosum)

6.2.2 MREA's PSI

Based on the flora documented at the MREA (spring/summer 2015) the following values provide a quantitative insight into the preserve's "floristic quality":

- Plant Stewardship Index: (31.73)

- Total Mean C: (3.08)
- Native Mean C: (4.62)
- Your Floristic Quality Index: (47.59)

6.2.3 PSI Interpretation and Discussion

The site's 20 acres is large enough and the total number of species identified, 192, is of a sample size as to make the PSI meaningful for future monitoring and stewardship. Explanation of what the numbers represent and cautionary notes follow:

- With a Native Mean C of 4.62, this metric would indicate that the preserve is a "High Quality Natural Area" as defined in the Plant Stewardship User's Guide, Bowman's Hill Wildflower Preserve, Rosenbaum, 2009. Note that the Total Mean C, at 3.08, is significantly lower, expressing a very high level of non-native species as a percentage of the flora. Approximately 25% of all species listed were non-native. It must be noted that at least 17 species of native flora was planted somewhere within the complex in 2014. These plants had a Native mean C of 6.3! This of course is a good initiative on the part of the MEC but *artificially* skews the FQI of the site. If these plants survive, thrive and in the future self-propagate then in five years the same numbers will be more meaningful, representing the preserves true coefficient of nativeness.

- PSI of 31.7 and a FQI of 47.59 are both low numbers when compared with areas of diverse habitat and species richness. Compared to an agricultural field or a waste lot these numbers don't fall into the "Disturbed category" but would better describe a site with pockets of disturbance in early stages of forest succession. Again, these numbers drop even further without consideration of the high CC's represented by the native plantings onsite. PSI and FQI are just another way to express Total Mean C and Native Mean C respectively.

While this preserve contains notable native plant diversity, it is challenged by low herbaceous species flowering and density, a general scarcity of conservative plants species, and by inhibited regeneration of many native woody plant species. This last agent of limitation is offset by the 2014 construction of a deer fence. Probable causal agents for the degradation of plant communities in MREA are historical land uses, especially forest clearing, overbrowse by white-tailed deer, the invasion of non-native plant species, and transformation of the forest floor by exotic earthworms. These agents are generally interrelated and can form feedback loops that exacerbate the negative effects of each. The symptomatic expression of invasive plants and low native herb diversity on the preserve is likely the offshoot of years of deer herbivory compounded by the elimination of a rich humus layer by non-native earthworms. In combination these factors have increased the soil pH exacerbating the process native expression even further. Unfortunately reversing altered soil chemistry in-situ is difficult at worst and next to impossible at best (Section 7 provides restoration recommendations)

Native plants not recently planted at the MREA have CC's of < 5. Many native species have CC's less than 2. Does this make them indicators of ecological impairment? In the case of Pokeweed (*Phytolacca americana*) which has a CC of zero it is an indicator of disturbed soil conditions in which the plants thrives (Image 14). The same can be said of common milkweed with a CC of 1. However, both these plants are excellent native plants that have evolved with an entire guild-suite of species that utilize different portions of the plant for food and forage. Pokeweed found in abundance in the forest interior light gaps of the preserve is brimming with songbirds in late

august and early September when their berries ripen, supplying migrating species with a necessary food source to aid them during long migrations back to wintering grounds. This example warrants the caution: Because a preserve has room to improve on its FQI doesn't reflect the ecologic contributions of the species with low CC's.

Moderate to low floristic quality values is more an indication that the site has been subject to landscape perturbation that through time has changed the level of nativeness of a site under evaluation. Using PSI in concert with other rapid bioassessment tools is a more comprehensive approach to evaluating a landscapes true ecologic health.

Image 14 – Bluebird (*Sialis sialis*) consuming pokewee (*Phytolacca amaricana*) berry.

6.3 Observations of Impact MREA

The result of moderate to low natal[6] PSI values at the MREA is a heavily weighted response to the site being currently surrounded on all sides by human-induced conditions (anthropogenic zones). To the south the site is bordered by an access road and heavily-lighted athletic fields associated with Madison High School. To the west the site is buffered by shrubby old field habitat and corporate centers, to the east the site is bordered by shrubby fields and an assisted living facility. It should be noted that much of this area is fenced-in to keep people out of an area contaminated by arsenic-laden soil. The northern border of the site is encumbered by County Route 24, a four-lane commuter thoroughfare.

[6] Natal in the context of PSI means the real values when evaluated without the recent native plant inoculations on site

In combination, this land use change, both recent and historic, has resulted in direct and indirect impacts to the ecology of the site proper. These include but are not limited to:

a. Light signatures given off at night from adjacent athletic fields creates an anthropogenic form of pollution that preclude site-specific species habitation of the site proper;

b. Similar to a. above - noise pollution from adjacent roads, highways, and athletic fields create sound signatures which preclude the use of the site from noise-sensitive species. An example could be the common nighthawk (*Chordeiles minor*) a unique member of the nightjar family (*Caprimulgidae*) whose sensitivity to light and noise near potential nesting habitat is well documented (Savignac 2007);

c. As mentioned in 6.2.3 invasive plant development from surrounding un-naturalized areas has changed the soils pH, diminished nutrient capacities and in some instances sterilized areas through alleopathy[7]. Garlic mustard is one site-specific example of an allelopathic plant; producing chemicals that inhibit the growth of other plants and mychorrizal fungi needed for healthy tree growth and tree seedling survival. Garlic mustard, along with the highly invasive Japanese stiltgrass (*Microstigegium vimineum*) has virtually sterilized the forest interior of the MREA, creating a large AOC that in turn has rendered the site incapable of supporting spring ephemeral wildflowers (this issue will be addressed in the management recommendations in Section 7);

d. Mugwort (*Artemisa vulgaris*), pervasive in open-edge disturbed soil areas (basically the periphery of the site proper), is also known for its allelopathic qualities. Mugwort presence in the landscape is a prime example of how a fragmented position in the broader landscape negatively impacts the ecology of "island habitats" (Image 15). Mugwort presence around the outer perimeter of the eastern side of the deer fence defines another AOC associated with the MREA;

e. Deterioration of the understory layer through years of exposure to white-tail deer browse caused by increased deer density – a result of forest fragmentation. The loss of shrubs in the forest interior of the MREA further exacerbates this large AOC already identified in c. above. Keeping the deer fence that was installed in 2014 maintained is of paramount importance for the future success to conservation management;

f. Increase in synanthropic species, i.e. red fox, turkey, european starlings, skunks, raccoons, etc., species that do well under human created conditions. This human induced species guild outcompetes sensitive native species resulting in suppressed food webs more vulnerable to environmental perturbations;

g. As a result of historic land use change the sites hydrologic regimes have converted consequently. The evidence of this can be found by comparing soil and wetland maps which indicate a (+/-) 30% increase of wetland limits over in-field observations of hydrologic indicators and wetland-vegetation. Historic indications that the sites hydrology was more extensive than at present is the incidence of pin oak

[7] Allelopathy refers to the beneficial or harmful effects of one plant on another plant, both crop and weed species, from the release of biochemicals, known as allelochemicals, from plant parts by leaching, root exudation, volatilization, residue decomposition, and other processes

(*Quercus palustris*), a facultative wetland tree that currently is established as a mid-seral stage remnant of a wetter past. Many of these trees are found in areas where hydric soils and indicators are absent;

h. Low spots in the landscape of the site proper are confined to temporary depressions throughout the lower elevations of the site; ephemeral by definition none would meet the required parameters necessary to call them "vernal ponds", as they don't remain with standing water long enough to establish an aquatic community capable of self-perpetuation. This current condition will be a primary area of focus in our conservation management recommendations in Section 7;

i. Dog walking, on and off-leash, and feral cats are problematic in any area where the human footprint meets a natural area. The degree and extent of the problem is hard to quantify but studies show that when pocket parks are located in areas where free-roaming dogs and cats are present the incidence of native wildlife decrease – often times substantially (Lenth, Brennan, Knight, et al 2006). Increasing numbers of dogs in natural areas could have varied and complex ecological effects, potentially influencing community dynamics in myriad ways including indirect effects that could cascade down through trophic levels (Kay 1998). One example, common to both canids and felids, is scent marking. This alone helps sterilize the natural community structure of a park as important food-chain species like chipmunk avoid habitation where dog and cat presence is high. Accipiters, woodland raptors, like the special concern cooper hawk (*Accipiter cooperii*) are in decline in part because of food chain interferences caused by the offshoots of fragmentation - of which dog and cat presence is part. Domestic and feral cats kill many more wild birds in the United States than scientists thought. The latest research on the subject indicates that cats rank as the biggest immediate danger that living around people brings to wildlife. America's house and feral cats, kill between 1.3 billion and 4.0 billion birds in a year, says Peter Marra of the Smithsonian Conservation Biology Institute in Washington, D.C., who led the team that performed the analysis. Previous estimates of bird kills have varied, he says, but "500 million is a number that has been thrown around a lot." (Milus, *Science News* Jan. 2013);

j. Only one feral cat was noted during our limited study time but land stewards associated with the MREA have indicated that feral cats are commonly observed and that the preserve is becoming an ad-hoc dog park for the greater community at large. If the primary goal of conservation management for the MREA is to maximize biologic diversity and increase the ecologic efficiency of the site than prohibiting its use by dogs and humanly capturing and euthanizing feral cats should be a priority action item (Image 16);

The above referenced points might cause some to a take a moment of pause and be dissuaded into thinking that the MREA has far too many negative attributes and human-induced impacts to make conservation management of the site a meaningful endeavor. While many of the obstacles are daunting none of them are insurmountable. If collective understanding of the site and dedication to purpose is prioritized the MREA has unlimited self-restorative potential. Without question this requires a committed effort from the stakeholders. The fact that these open space areas are in short supply throughout the Borough of Madison and the surrounding municipalities (Appendix A, Webb Report 2014) makes the continued initiative a worthy endeavor.

Image 15 - Southern Edge of Site Proper along Access Road

Mugwort (*Artemesia vulgarae*) dominates Woodland Edges (Non-native Mugwort *Artemisia vulgaris* Dominates)

Image 16 - Feral cat in field

6.4 Positive Natural Attributes of the Site Proper:

Currently the site has many positive natural attributes. Nurtured and expanded, these qualities, will, over time, offset and exceed the negative anthropogenic impacts as outlined in Section 6.3; in affect setting the standard for proper land use management of a preserve of its size in the region.

Positive natural attributes associated with the MREA at the time of this writing include but are not limited to:

a. A significant diversity of tree species mainly consisting of hardwoods (only one species of conifer noted – white pine *Pinus strobus*). Many trees indicative of older growth/mature forests. However an average mid-seral succession is documented. Significant 80' plus tulip trees, black oak, sugar maple and beech are present. Although the understory has not recovered since a deer exclosure was installed in 2014 the presence of seedling oak, hickory and maples were noted during our field surveys. A sign that the process of forest regeneration can proceed without the pressures associated with white tail deer herbivory;

b. New tree species have been inoculated into the site proper through the efforts of volunteers. These all have CC values of over 7: pawpaw, persimmon, sassafras, river birch, black willow, and hackberry once established will attract a plethora of native faunal associations guaranteed to increase ecosystem services;

c. Wind blows and tip-up-mounds created by the intensity of past superstorms, "Sandy" and "Floyd" have created natural light gaps and microsites throughout the preserve. One of these light gaps in the interior of the site proper has become a seedling ground for sugar maple and American beech while currently rife with large stands of pokeweed (*Phytolacca* americana). This native plant has high wildlife food potential and will surely be visited by migrating neo-tropical birds in the fall during their migration (image 14);

d. Areas within light gaps are littered with dead wood. Dead wood throughout the site proper is one of MREA's most unsung and striking features. Dead wood ecology plays a multitude of important functions that are high on the priority list of the terrestrial ecologist – including but not limited to: (1) increased soil fertility, (2) chaotic structural habitat formation is essential for a myriad area of faunal species, (3) large dead trees as they decompose become perfect nursery logs for seedling trees and other flora (4) Insect species from a dizzying array of families will utilize and become part of food webs throughout the decaying cycles of large nurse logs, (5) erosion and sediment control, especially in areas of slope, (6) coppice growth initiated by dead wood, (7) temporary aquatic habitat formation noted in our survey where wind blows have created large bowls at the base, (8) carbon sequestration is steady and consistent throughout the process of decomposition. The fact that the MREA is so rife with chaos of dead trees and associated branches makes it a talking point for future outreach and education (Image 17);

Image 17 - Dead Wood "Natural Brush Pile"

Invasive Japanese Barberry (Berberis thungbergii) Shrubs Dominate Area

e. The site proper is punctuated with ecotonal habitats - transitional areas where one type of habitat integrates to another. Ecotones often cited by ecologists to be the areas where the highest productivity and diversity is found. On the site proper four distinct ecotones have been identified: (1) wetland meadow to forest, (2) interior upland meadow to forest, (3) wetland interior forest/upland forest, and (4) shrub/scrub field to forest. These ecotonal edges are areas of habitat diversity, each with their own assembly of flora and fauna that help increase the sites overall biodiversity index. One example is the upland interior meadow opening located in the eastern quadrant of the preserve. Standing dead trees amongst maturing hardwoods are lined with native and non-native shrubs. Although the field is dominated by the invasive plants birds-foot trefoil (*Lotus corniculatus*), multiflora rose (*Rosa multiflorus*), native meadow plants – asters, composites, goldenrods - persist. Within the entire complex this sub-habitat was the area noted to have the highest levels of avian activity. Eastern bluebird(*Sialia sialis*), Northern Flicker (*Colaptes auratus*) (seen leaving a cavity of a standing dead tree), willow flycatcher (*Empidonax traillii)*, brown thrasher (*Toxostoma rufum*), song sparrow, European starlings (*Sturnus vulgarus*), American robins (*Turdus migratorus*), northern cardinal (*Cardnalis cardinalis*), eastern phoebe (*Sayornis phoebe*), downy wood pecker (*Picoides pubescens*), white breasted nuthatch (*Sitta carolinensis*), white throated sparrow (*Zonotrichia albicollis*), chipping sparrow (*Spizella passerina*), and cooper hawk (*Accipiter cooperii*). These were the bird species seen on only two of the survey days (late April and mid June 2015); representing about 2/3 of the avian species utilizing the site proper during our surveys. The fact that a solid cross section of species were noted in a small period of survey time is a good indication that this interior forest patch is a significant component of the local biodiversity and a target location for conservation management and enhancement;

f. For a small woodland preserve the MREA has the benefit of three interior forest zones of influence: (1) wetland interior forest, (2) mesic interior forests, and (3) upland hardwood mix forest. All three zones are easily traversed by an existing loop trail and can be used in the future for outreach and education;

g. A significant pocket of exposed isolated wet meadow; approximately 35’ by 60’ has naturally developed on the southern portion of the site proper. This field is dominated by dogbane (*Apocynum cannibinum*), joe-pye weed (*Eutrochium purpureum*), milkweeds (*Asclepius sp.*) and other high quality native insect attracting meadow plants. In essence this small area has become an ad-hoc butterfly and insect garden. One hour in June 2015 GSA ecologists counted 36 species of insects associated with small area. One noteworthy species is the dogbane beetle (*Chrysochus auratus*) seen directly on the host plant that bears its name (Image 18);

h. The MREA acts as quality buffer habitat with the “Black Meadows”, a large wetland complex just north of the site proper. County route 24, a four lane thoroughfare is the only partition that fragments the two sites. Migrating birds will utilize peripheral quality habitats more frequently than smaller habitats interstitial with residential and industrial landscapes.

Image 18 - Dogbane Beetle (*Chrysochus auratus*)

i. A survey of the site proper's Nocturnal Lepidoptera (moths) entailed 18 total hours of observation time over a period of three evenings during spring and summer months. Nocturnal Lepidoptera are indicator species of ecologic health as individual species have evolved highly specific roles that characterize food chain and energy flow dynamics within the preserve. In this limited time frame a total of 111 species were attracted to a 1000 watt metal halide lamp and identified to the species level. The survey data point was the park entrance to the MREA. This area is described by a deciduous forest edge adjacent to shrub/scrub fields and turf. If additional survey work were to commence in other areas of the preserve a more accurate and augmented list would likely emerge. In consideration of the limited survey time 111 species of nocturnal Lepidoptera represents respectable species richness. A total of 17 families were confirmed whose life history run the gamut from plant pollinators to coarse organic leaf shredders. In all stages of moth life history this insect group helps to support ecosystem services in a myriad of ways. Although no rare moths were noted during survey periods a solid cross section of native species were documented (Image 19).

Image 19 - Ultronia underwing (*Catocala ultronia*) – July 29th

7.0 Conservation Management Recommendations

The following conservation management measures are delineated to provide the MEC land steward with a list of recommendations that address the preserves primary impacts of concern:

7.1 Priority Invasive Species

If the priority consensus from all stakeholders responsible for the future management of the MREA is that biodiversity and ecologic function be maintained to the maximum extent possible then no higher priority should be placed on the removal and/or control of invasive plant species. Invasive species intrusion throughout the site is without question the greatest limiting threat to the future ecologic stability of the preserve.

GZA has identified ten target invasive species that have found the MREA highly amenable to their life history requirements, which without control, can be expected to increase to the detriment of the local biodiversity. While 43% of all flora on the site proper is non-native: see Appendix D). The following list of plants is in the order of greatest negative ecologic impact to the site proper. These are the MREA's Priority Species of Concern (PSC):

1. Garlic mustard (*Allaria petiolate*) found throughout the MREA in shade and sun where soils have been subject to disturbance – (i.e. most of the site proper). Garlic mustard displaces native plants by aggressively monopolizing light, moisture, nutrients and space – Native spring ephemerals don't have a chance once garlic mustard takes over;

2. Japanese stiltgrass (*Microstigeum vimineum*) is found as a dominant herbaceous component throughout the MREA in shady interior woods. Stiltgrass and garlic mustard are equally the two most invasive species on the preserve and should be the sites "Most Wanted" in terms of priority control (Image 20);

3. Mugwort (*Artemisia vulgaris*) is found in all sunny areas of the site along the periphery of the deer fence. This aggressive Euro-Asian import takes away habitat for native goldenrods and asters (Image 15);

4. Japanese barberry (*Berberis thunbergii*) is found throughout the preserves forest interior. This is a PSC for the obvious reason that it has displaced and out-competed native shrubs for space. Once established its wildlife food value is much lower than that of its native counterparts. It's presence in the system is a major contributor to the reduction of soil fertility onsite;

5. Multiflora rose (*Rosa multiflora*) is found throughout the site in all areas of disturbed soil conditions (the majority of the site) where partial and full sun dominates. The upland open field in the eastern quadrant of the site proper is a hot spot for multiflora rose. Like its interior forest shade counterpart, Japanese barberry, multiflora rose takes away large chunks of space that would otherwise be occupied by a native shrub community;

6. Wineberry (*Rubus phoenicolasius*) is found sporadically throughout the site in patches where open woods, fields and forest edges exist. Although not as prodigious as Multiflora rose, wineberry can, and does, form large thickets. Not without its merits, wineberry has wildlife forage and cover value. However, native species that have co-evolved with associate fauna with similar beneficial properties are being sacrificed as wineberry outcompete them for sun and space. Mechanical pulling is an effective treatment only if the land steward is prepared to immediately replant native berry producing shrubs and brambles;

7. Japanese knotweed (*Reynoutria japonica*; formerly *Polygonum cuspidatum*) is found in sporadic patches along outer periphery of deer fence and has established along open sunny disturbed edges. Not yet a monopoly, Japanese knotweed is highly aggressive and can easily take over even in areas where other PSC have established. Brought into the site in disturbed soils this aggressive floral hellion should be controlled whenever and wherever it "pops up";

8. Birdfoot trefoil (*Lotus corniculatus*) dominates the open upland field at the east end of the site proper. This noxious herb forms dense mats choking and shading out everything its path. A nitrogen fixing plant, Birdfoot trefoil does help condition the soil but in so doing creates thick deep root mats that aid the plant in outcompeting all else – if meadow restoration is considered this plant must be systematically removed;

9. Oriental bittersweet (*Celastrus orbiculatus*) is found around all edge habitats throughout the preserve. These vines aggressively climb up the sides of trees and overtime can break limbs and even collapse the tree under its own weight;

Image 20 - Japanese stiltgrass in interior forest wetlands

10. Norway maple (*Acer platnoides*) has established itself throughout the interior forests northern section of the preserve. If left uncontrolled this European import will slowly but surely overtake native trees like the already well- established sugar maples (*Acer saccharum*).

7.2 Remaining Invasive Plants of Concern

Many other invasive plant species of concern (SOC) have taken a foot-hold on the site proper. All are non-native considered invasive as documented by the New Jersey Invasive Species Strike Team (NJISST). All have yet to reach a level where it threatens the natural dynamics of the site. However all of these plants should be targeted for treatment and eradication. It will be a self-fulfilling prophecy that if the PSC are removed from the site proper the following SOC will quickly move in to fill the void - these include the following:

- Tree of heaven (*Aliantus altissima*) found in open edge sections of the preserve;
- Chinese bush clover (*Lespedeza cuneata*) found in open woods, especially as a sub-dominate species to the PSC Birdfoot trefoil in the eastern section of the preserves open field;
- Spotted knapweed (*Centaurea bieberteinii*) found in well drained disturbed soil areas. Removing garlic mustard and Mugwort without immediately planting back native material will allow for the quick spread of this noxious alien invader;
- Canada thistle (*Cirsium arvense*) found mainly on eastern side of preserve in open hard-packed soil areas. Not yet reached the level of PSC but can and will quickly take over if not controlled;

- Purple loosestrife (*Lythrum salicaria*) is fortunately very spotty throughout the site in open areas of depressed wetlands. Will likely not spread out of control if subject to spot removal by hand pulling;
- Bush honeysuckle (*Lonicera spp.*) is an upright, multi-stemmed shrubs of weedy thickets found throughout the preserve. Spot removal by mechanical means will work best at this stage in the plants invasion on site;
- Autumn and russian olive (*Elaegnus spp.*) are deciduous shrubs that have taken advantage of the sites disturbed soil past history. They are found mainly in edge habitats on site mixed in with multi-flora rose, bush honeysuckles, and barberry.

Unfortunately the vegetation of the entire preserve is influenced by exotic species making conservation management more a challenge for this site. However, a 20 acre preserve like the MREA is controllable in terms of the logistics required to control invasive species and make meaningful improvements. Costs associated with the task of invasive species removal (mainly tools and herbicide) are manageable.

7.3 Invasive Species Control

Appendix F provides a list of both PSC and SOC, with information on the ecologic threats the species impose, the means by which the plant spreads, the best management control methods necessary for their eradication, and most importantly, recommendations on native replacement species. **Caution**: strict attention must be given to this last statement in order to assure success of the project. Without immediately planting back native material the initial effort of removal will have been in vain. New native material must be nurtured until such time that the inoculation of native flora can reach a growth stage that outcompete the non-native plants. It also requires annual vigilance and spot treatment of these very same invasive plants from reestablishing a foothold back into the site. As time and effort progress this process is less and less labor intensive. Native plants have amazing powers of resiliency once the advantage of a competitive growth stage is acquired. The fact that a deer exclosure is in place and well maintained assures that native species community structure can proceed unabated from the pressures imposed by white-tail deer[8].

Herbicide treatment is going to be the most time and cost-effective process for invasive species eradication. The treatment requirements for individual PSC and SOC in Appendix D will provide information to formulate a time line and treatment schedule for the necessary work. GZA recommends that the three main invasive interior forest species be targeted first – garlic mustard, stiltgrass and Japanese barberry. Concurrently, or later in the season, but before flora goes to seed, the eastern fence edge invasive community could be targeted: oriental bittersweet, mugwort, multiflora rose, bush honeysuckles, thistle, knapweed, Japanese knotweed, tree of heaven, and wineberry. All of these species can be treated with glyphosate. With a volunteer group that cuts the stems first, followed by back treatment by a licensed applicator, quick and efficient eradication is possible. Careful attention to application requirements is essential. Many of the listed species will require a second application of herbicide treatment and potentially follow-up spot treatment the second year to assure a complete cull. It is highly recommended that one or two stalwart volunteers be recruited for these efforts and possibly trained and certified to apply herbicide safely and correctly. Anyone involved in the process should be trained and proficient at species identification.

[8] Adult deer need 3.5 pounds of browse each day and will consume more (up to 9lbs !!) when natural fodder is available the population size is about 70 per square mile on average for Morris County, resulting in the potential for significant ecological damage.

7.4 Native Meadow Creation

The open meadow in the eastern section of the preserve (Image 21 - designated as Early Successional Field in Figure 1) is a unique natural feature of the MREA, that once cleared of non-native invasive species could be restored as a native wildflower meadow. Native meadows actively attract a myriad array of invertebrate species important to the sites food chain stability and natural functioning. Invertebrate species are currently in decline worldwide. Many species in the families *Bombidae* and *Halictiidae* are suffering throughout the northeast. It has been statistically proven that native flora get more insect visits and higher productivity from native plant communities than those dominated by non-native flora (Cerqueira 2005).

Providing an area within the site proper specifically designed to attract and support native pollinators is a task list item worthy of high priority consideration. **Native meadows provide:**

- Natural Beauty with Low Maintenance – native eildflowers can bloom from spring till fall;
- Wildlife Habitat – An immediate uptick in invertebrate interactions will be recognized in addition to secondary species rarely seen in this section of the preserve – i.e. hummingbirds, bluebirds, herptiles, and small mammals.;
- The perpetuation of another interesting sub-habitat within the Preserve (outreach and education opportunity).

Image 21
Open Field of Invasive Flora Spring 2015

7.4.1 Option #1 Complete eradication of all open field species followed by native meadow establishment:

Establishing a wildflower meadow takes some planning and patience. One short cut in the process recommended after sterilizing the areas propagule[9] is to hydro-seed or broadcast seed the site with a local provenance pollinator meadow seed mix. Pinelands Nursery in New Jersey has developed a very specific seed mix that would be perfect for this application (http://www.pinelandsnursery.com/2014/12/seed.html). The variety of plants in this treatment will address many ecological and aesthetic considerations necessary to create a viable and lasting native meadow. Once established it is quite likely that this will be the natural centerpiece of the site that helps fulfill the outreach and education mission statement of the preserve.

[9] Propagule is any plant material –in the case of the MREA this is the meadows organic layer and top soil - used for the purpose of plant propagation

7.4.2 Things to consider during the process:

- Blooming periods of the plants that provide for full-season availability and coverage;
- Height of plants should be varied – chaos mimics natures design scheme – your goal should not be to create an English garden. Sporadic placement of different species well better serve the invertebrate community and the overall ecologic service of the meadow;
- Be aware that some wildflowers are annuals, some perennials and a few are biennials. Annuals complete their life cycle in one season and die. They are only replaced if they reseed themselves. Perennials will come back from the roots each year, and may also reseed, producing more plants. Biennials require tow growing seasons to complete their life cycle and then die, but may reseed themselves.;
- Selecting a location is as important as anything else. The most important consideration is sunlight. The more sun, the better. Wildflowers perform best in full sun, but can grow with six to eight hours of direct sunlight per day.
- Species mix should be chosen for Plant Hardiness Zone 6B;
- Plants should be from local genetic stock when and where applicable.

7.4.3 Planting Considerations for Meadow

Using a commercial seed mix for native meadow creation could be enhanced by mixing seeds from other native nurseries that better represent Morris Counties upland communities (see Appendix E for a list of Nurseries that sell native stock). Selecting natives ensures that the plants are adapted to the region and should perform well.

Species that GZA has identified to be indigenous to the region with a preference for sun and partial shade includes the following:

- Mayapple (*Podophyllum peltatum*) found in one partially shaded area on site but could be good as an edge planting in other partial to full shade areas of the meadow;
- Narrow-leaved mountain mint (*Pycnanthemum tenuifolium*) – could be collected from local seed stock (Great Swamp Nation Wildlife Refuge Fields is rife with this plant) and planted in areas where soil moisture is highest. This is an incredible insect magnet – especially small mining, sweat, and carpenter bees;
- The seed mix already contains common milkweed but other less common milkweeds could be planted: White milkweed (*Asclepias variegate*), Red Milkweed (*Asclepias rubra*), and purple milkweed (*Asclepias purpurascens*), and orange milkweed (*Asclepias tuberosa*); all of course excellent plants for a myriad of insect species especially monarch butterflies, a species in severe decline:
- Any upland goldenrod species besides Canada goldenrod (*Solidago canadensis*) (already established) i.e. Blue-stemmed goldenrod (*Solidago caesia*);
- Blue-eyed grass (*Sisyrinchium angustifolium*) – good micro-insect attracting plant of interest
- Hay scented fern (*Dennstaedtia punctilobula*) – if planted around the edges of the field can control tree seedlings from establishing, helping to keep the area in meadow – also a very attractive species when confined – can be planted in any dry light gap forest interior along with NY fern (*Thelypteris noveboracensis*);

- Steeplebush (*Spirea tomentosa*) – an excellent butterfly and insect attracting plant for mid-to late summer color and bloom;
- Carolina rose (*Rosa Carolina*) would be an excellent choice to add as sporadic shrub cover in the interior of the meadow – great for shrub nesting birds like gray catbird and mockingbird. Fragrant and beautiful when in bloom this showy shrub will attract wide range of pollinators;
- Gray beardtongue (*Penstemon canescens*) – a late spring early summer blooming native wildflower especially attractive to native members of the insect family *Bombidae* (Bumble bees).

7.4.4 Preparing the site:

The most important part of the process is the preparation of the meadow. This requires a good native landscape contractor or a very diligent volunteer base willing to be consistent with the necessary process of initial watering. Once created very little effort beyond the spot removal of invasive species will be required to maintain the habitat. In order to plant a wildflower meadow, the site must be prepared properly to avoid having problems with weeds and other grasses. Any existing grass and weeds must be removed. The easiest way to do this is to treat the site with a systemic, broad spectrum herbicide such as glyphsate (e.g. Roundup ©). After the grass is dead vegetation is raked and removed and the site is lightly tilled to a depth of not more than one inch. Don't till deeper than one inch to minimize the release of dormant weed seeds that are buried in the soil. Scraping the ground with an iron rake is typically sufficient.

Once the site is prepared, seed and mix with some inert material such as sand or loose potting soil and broadcast the mixture over the area. The seeds must be pressed into the soil by rolling or by pressing a board down onto the seedbed. You can just walk over the entire area to pack down the soil. The objective is to have good contact between the soil and seeds. Some seeds will still be visible when you are done.

The area needs to be kept moist for four to six weeks to ensure germination and allow the plants to establish themselves. Do not allow the area to dry out while the seeds are germinating. Do not saturate the soil either as this can drown the seedlings. Once the plants are established (one to two inches), you can gradually reduce watering to only when the plants begin to show stress.

Upland wildflowers prefer dry sites so resist the temptation to keep watering to make them grow. At this stage, some unwanted weeds and grasses may appear. Remove these as they appear to avoid problems later. If you are not sure what you are looking for, plant some of your seed mix in a container and use that to compare to what grows in the seedbed. There are herbicides available that kill only grasses and are safe to apply over the top of the wildflower plants (which are broadleaf plants).

7.5 Option # 2 Spot removal of invasive species and replanting with native meadow species:

The open field meadow surveyed in late August 2015 revealed an established community of native flora that was earlier masked by an invasive species community structure. Canada goldenrod (*Solidago canadensis*) and grass-leaved goldenrod (*Euthamia* tenuilfolia) covered a significant area of the open meadow. Two other interesting flowers were also in bloom; purple-leaved willow herb (*Epibolium coloratum*) and blue vervain (*Verbena hasata*). As such the field in late August was a-buzz with the ceaseless activity of invertebrates. Other species of both native and non-native species were in bloom or fruit at this time but the fore mentioned species

were visually dominant over all others. In a few casual hours of vigilant observation over 31 species of beetles (*Coleopterans*), flies (*Dipterans*), true-bugs (*Hemipterans*), wasps/bees/ants (*Hymenopterans*), moths/ butterflies (*Lepidopterans*), and grasshoppers (*Orthopterans*) were noted nectaring on, in effect pollinating, the tiny flowers (Figure 22). The fact that the non-native species are found in association with native species in almost equal measure makes for an interesting management decision.

Another option for consideration that may be less intensive and more cost effective is strategic herbicidal treatment of existing invasive species that are mainly found in a patchwork throughout the meadow. These include phragmites, multi-flora rose, Chinese bush clover, bird-foot trefoil, Canada thistle and callery pear (*Pyrus calleryana).* Immediately upon removal, native stock, as suggested in section 7.4.3 above, could be immediately planted where invasive patches were eradicated. This technique would require a diligent technician familiar with native plant identification to ensure that collateral damage to native plants is avoided. This process would be an annual endeavor until such time that the native meadow community is in a state of self-perpetuation. Of course all recommendations that involve invasive species control are never truly self-perpetuating. Some level of invasive species control will be warranted as follow-up to the original treatment. The strategy of course is to establish a stewardship plan that schedules monthly spot treatment where invasive species are never allowed to gain a foothold by going to seed or fruit.

Image 22 - Ailanthus Webworm Moth Nectaring and Pollinating Grass-leaved Goldenrod (*Euthamia graminifolia*)
August 23rd 2015

7.6 Interior Forest Preserve Management

For a preserve of its size (<30 acres) the MREA's interior forest management is limited in potential scope. Management recommendations include the following:

- Before any attempt is made to reestablish a native community structure back into the system it is imperative to rid the site proper of all PSC. In the case of the sites forest interior this means removing as much stiltgrass, garlic mustard and Japanese barberry as is logistically possible by following the recommendations in Appendix F. Shrub and herbaceous layer revegetation can than proceed. The beauty of performing conservation management in the interior forest section of the MREA is that invasive shrubs can be methodically and mechanically removed in one day under the guidelines of a good plan. GZA suggests a "corporate day of caring" where a group of 20-30 ready and able bodied people go out to the site with the tools necessary to liberate the forest interior of all non-native bush honeysuckle, wineberry, Japanese barberry, and Russian olive. Another option is to hire a contractor that has experience and understanding of the target shrub species and retain their services. Herbicide treatment will be necessary for the eradication ground cover species. Necessary follow-up herbicidal treatment to all target species will be required if an effective cull is to be expected. Hiring a licensed applicator or having an in-house volunteer trained in herbicide application would be warranted during this phase of the project;
- Norway maple has been found in sporadic locations in the northeastern quadrant of the park. These trees, if left untreated, will out-compete sugar maple for space as they both enjoy the same mesic soil conditions. The ecological impacts, loss of natural habitat and reduction of species diversity, are a result of Norway maple's ability to create dense shade from its overlapping broad leaves/canopy. They also negatively affect the natural successional changes of forest habitat by the release of allelopathic chemicals from their shallow rooting system. These chemicals inhibit or prevent the establishment of other plants within the root-zone thus eliminating competition for water, nutrients, and light. These impacts to native vegetation are also amplified by its ability to uptake large amounts of water from the soil. The lack of adequate groundcovers can promote erosion and loss of soil, which has the potential to cause water quality and turbidity impacts to surface waters and wetlands. Furthermore, Norway maple has fewer diseases and pest insects that than our native sugar maple, which gives it a competitive edge over sugar maple. GZA ecologists suggest that these trees be girdled and left to create dead snags - good insect and cavity nesting trees will form over time. The light gap ecology that follows will help diversify the MREA's overall habitat structure. It will be incumbent upon the stewardship practitioner to be vigilant each year to pull any seedlings or coppice growth associated with this aggressive and ecologically damaging species.
- In areas where light gaps in the forest exist, native oak, hickory and sugar maples could be planted as a way to increase diversity away from a current red maple dominant interior. Healthy trees at the sapling stage are warranted to ensure proper vigor and success. It's recommended that swamp white oak (*Quercus bicolor*) and mockernut hickory (*Carya cordiformis*) be planted in the wetter, lower elevation light gaps, and shagbark (*Cary ovata*) and mockernut hickories (*Carya tomentosa*) planted in open areas on the mesic slope. These trees will increase habitat options for local wildlife. The loose, flaking bark of these tree species in mature form can over time potentially act as roosting habitat for bat species currently in decline. All of the former are mast (fruit and nut producing) trees, beneficial to a wide array of local wildlife;
- Northern Catalpa (*Catalpa speciosa*) has established itself in light gap areas of the interior forest. This tree has little to no known wildlife food value. Native to the northeast, it was once confined to only a small range in Tennessee. The tree should be removed when identified to allow normal native succession to proceed. Should only be allowed to exist on the edges of the site proper where it's more aesthetic growth form can be readily appreciated;
- Brush and dead wood piles should be encouraged throughout the forest interior when and where applicable. Wildlife of all kinds will benefit from the chaotic procession of natural and conservation management events;

- Left in the wake of white-tail deer browse is the virtual elimination of the sites understory. In combination with non-native species intrusion these perturbations are unquestionably the two most imposing limiting factors responsible for the sites ecologic-sterilization. In response non-native deer resistant shrubs dominate this AOC. Once these species are removed through the recommendations specified herein, these areas will have to be immediately replanted with native stock. Using a variety of mast –producing native shrubs a range of species will inevitably benefit. Top on the list of wildlife beneficiaries to a forest interior dominated by native shrubs will be the Neotropical songbirds – some of which will hopefully become site breeding and nesting birds. An example of a species that is currently not seen on the site proper that would likely benefit from a complete native shrub layer in the wetland portion of the forest interior is the state species of concern veery (*Catharus fuscescens)*. The site meets the minimum standard in size to support a potential breeding pair. Shrub density and shrub species type is likely the limiting factor that precludes veery nesting here currently. The fact that the site proper exhibits damp, deciduous forest habitat with generally younger stands of second-growth is already in concert with the species life history requirements. The missing piece is a native dense understory of shrubs – a high priority task list restoration initiative;
- The choice considerations for this essential assignment are many. Careful attention to the specific needs of trees and shrubs must be given to ensure that the time, effort, and expense of process is maximized. GZA ecologists recommend that for mesic open-edge areas of forest the MEC consider planting flowering dogwood (*Cornus florida*), highbush cranberry (*Viburnum trilobum*), silky dogwood (*Cornus amomum*), red mulberry (*Morus rubra*), arrowood viburnum (*Viburnum dentatum*), chokeberry (*Aronia sp.),* elderberry (*Sambucus candensis*, and black gum (*Nyssa sylvatica*) - this fantastic native tree in particular is in short supply on site and should be inoculated into the forest community in any suitable area. Forest interior partial shade tolerant recommendations include but are not limited to: alternate leaved dogwood (*Cornus alterniflora*), service berry (*Amelanchier sp.*), sweet bay magnolia (*Magnolia virginiana*) – in lower elevation wet areas, witch hazel (*Hamamelis virginiana*), highbush blueberry (*Vaccinium corymbosum*), maple-leaved viburnum (*Vaccinium accerfolium*), and deerberry (*Vaccinium stamineum*). The fact that a very well-made deer exclosure is already installed helps assure the success of this very important task list item;
- As noted in the concern section of this report the spring ephemeral native plants of early spring have been eliminated by decades of anthropogenic intervention. Now that a deer exclosure is in place this important spring community of flora can be reestablished. Spring Ephemeral considerations for shaded forested interior sections could be planted in areas of high soil fertility. Spring beauty and trout lily are already on site and established and barely hanging on in areas that haven't yet been invaded by stiltgrass and garlic mustard. These two plants will easily expand their footprint once the eradication of those two aggressive ground covers is removed. White baneberry (*Actaea pachypoda*), wild leek (*Allium tricoccum*) sarsaparilla (*Aralia nudicaulis*) wild ginger (*Asarum canadense*) pennsylvania sedge (*Carex pensylvanica*) broad-leaved reed grass.(*Cinna latifolia*), canada mayflower (*Maianthemum canadense*) are a few examples of species that could be planted along the trails for their aesthetic appeal and the edification of future outdoor recreation enthusiasts. Careful attention to localized genetic stock must be given to the process. Native "clean" soils free of invasive seed intrusion must be used to get the spring ephemeral community started unrestricted by unnecessary competition;
- Planting back along the intermittent stream with shade-tolerant facultative wetland species will help sure-up the site as an "ad-hoc" offsite rain garden. The site proper does receive runoff from adjacent athletic fields and access road. Restoring the onsite wetlands and stream edges will Increase the efficiency and natural uptake of excessive nutrient loads from these non-point sources; a practical use consistent with local water quality management. Planting a riparian community of native grasses, herbs, and shrubs from

a local stock will provide for a unique assemblage of invertebrate to establish and a tool for education and outreach. Many plants suited for riparian edges exist. Monkey flower (*Mimulus ringens*), Northern Willow herb (*Epilobium cilatatum*), rice cutgrass(*Leersia oryzoides*), swamp milkweed (*Asclepius incarnata*),winterberry holly (*Ilex verticulatta*) blue flag iris (*Iris versicolor*), cardinal flower (*Lobelia cardinalis*), New England aster (*Aster novae-angliae*), silky dogwood (*Cornus amomum*), sweet peeprbush (*Clthra alnifolia*), spicebush (*Lindera* benzoin), swampa (*Rhododendron* viscosum) and turtle head (*Chelone glabra*) are all recommendations for site specific consideration. Careful attention to degree of wet tolerance and sun must be considered before final planting decisions.

7.7 Final Management Recommendations

The following are a list of final management recommendations for the MREA site.

- Anywhere one habitat type comes in contact with another (the ecotone) soft edge creation should be considered. Stratifying from field to shrub to forest will help buffer and create forage opportunities for the maximum variety of species. Soft edges through thick native shrub buffers will benefit edge-nesting avian species like the state species of concern brown thrasher. Early succession edge specialists like the rufous-sided towhee (*Pilpilo erthrophthalmus*), indigo bunting (*Passerina cyanea*), blue-winged warbler (*Vermivora cyanoptera*), and rose-breasted grosbeak (*Phecticus ludovicianus*) could all benefit from this initiative as well. These species all require high quality and intricate habitat structure for breeding, nesting, and foraging – currently limited at the MREA;
- Keeping trail creation confined to the periphery areas of preserve will keep noise signatures from penetrating the sensitive forest interior. An exception might be where the trail that runs to the east of the open meadow. Here a side trail that dead-ends in the middle of the field could be created. This will allow the public to interface with the natural meadow community without disturbing meadow edge nesting birds;
- Trails that are in place currently are wide beyond what is necessary for the casual visitor to comfortably traverse the site. Narrowing the walking trials by half will still allow for a person to comfortably walk throughout the property and allow more opportunity for native plants to establish. This practice is in concert with the CMP's primary function as a native restoration site;
- The northern border of the property is parallel to the noise signature associated with County Route 24. A partial solution to this disturbance could be to plant a hedgerow of native white pine (*Pinus strobus*). Over time, and once established, this "hedgerow" could become a natural sound barrier to the highway noise. Native shrub plantings between and around these trees will help augment and ameliorate noise in open areas under the lowest branch level of white pine branching once they reach a mature growth stage;
- The lack of moving and standing water in the MREA has already been identified as a limiting factor for the preserve to support any form of an aquatic community. One simple solution to this problem is to construct vernal ponds of varying sizes. These could be made by simply bringing in a backhoe to remove soil to depth of ground water. The soil survey indicates that ground water is found below 24 inches in the Whippany Silt Loam areas of the site (Figure 3). These ponds could be a combination of small and large depressions (10' X 10'/ 30'X30'). The concept of creating vernal habitat is predicated on attracting those species that require a predator free environment long enough to allow amphibian larvae to quickly reach an adult stage. The only amphibian noted in GZA's terrestrial surveys of the MREA is the documentation of a few green frogs (*Rana clamitans*) (found in a small area of ponded water associated with the outfall of the intermittent stream in a shaded area of phragmites directly adjacent to County Route 24 – Image 23). This doesn't preclude other

species of anuran[10] from eventually finding these ponds and breeding in them. If created these ponds offer the possibility of inoculating them with egg masses from local genetic stock – wood frog (*Rana sylvatica*), American toad (*Anaxyrus americanus*), grey treefrog (*Hyla versicolor*) and spring peeper (*Pseudacris crucifer*). An interior forest wetland area could be designated in close proximity to the trail in order to provide public accessibility. In turn this newly created specialized habitat will become another opportunity for outreach and education – a potential premier natural highlight to the MREA's inventory of sub-habitats;

- Signage prohibiting dog walking on the preserve should be placed at the entrance to the park (see 6.3(i)). If the maximization of biodiversity is a primary goal of the CMP than keeping dogs away from the preserve should be a paramount task list item for the MEC;

Image 23 - Green Frog

- The open meadow located in the east quadrant of the preserve would be another area of consideration for the creation of a conventional "meadow pond". The pond could hold standing water all year if dug out deep enough and lined with a specialty material – i.e. Firestone 45 mil EPDM flexible pond liner. An aquatic community would inevitably evolve over time and could be a focal point within the preserve for natural history study. The pond could be lined with emergent wetland plants that would add additional interest and structure to the meadow. Biodiversity of the site would reap immediate benefit through the natural development of a terrestrial open meadow aquatic community;

- Creating structural diversity, chaos regimes as its sometimes referred to, wherever possible throughout the site proper. All brush clearing of invasive material that is not in seed or fruit should be made into brush piles. This will act as an ancillary habitat for small mammals and birds. *All invasive species removal should be performed prior to the target plants going to seed or fruit.* The Madison Department of Public Works could bring in old stone and brush for this purpose. Wood chip piles can also be placed near open meadow habitat. This material is known to attract invertebrates and mammals of all varieties. Loose clean soil and sand mix is a perfect substrate for many ecologically beneficial wasps and bee species. Dumping large soil piles and mounds made from clean fill will support a surprising array of invertebrates and also

[10] Anuran – refers to all species of frogs – Order *Anura*

allow for a different community of native grass and meadow flora to arise and thrive . Vigilance is required to remove invasive plants from these newly created sub-habitats as they propagate;

- Plywood boards, sheet metal pieces and rock piles could be sporadically placed in southerly exposed areas of the preserve. These could be placed out of the "public eye" and used for the purpose of attracting herptile species to the preserve. The eastern garter snake (*Thomnophis sirtalis)* was the only species of herptile documented in our field surveys of the MREA. If appropriate habitat structure was enhanced the possibility exists that other Piedmont obligate snakes could take up residence at the MREA. Black rat snake (*Elaphe obsolete obseleta*), milksnake (*Lampropeltis traingulum*) and black racer (*Coluber constrictor*) (Image 24) are three species that were not seen during survey periods but would likely inhabit the site if conservation management as outlined in these recommendations were followed;

Image 24 - Black Racer - a species that could benefit from conservation management strategies

- Bats in the order Chiroptera are an important part of the ecological diversity. Unfortunately their population has been compromised by a disease, White Nose Syndrome (WNS) that causes them to prematurely leave their hibernating caves too soon in winter and die of exposure. It has been estimated that 5.6 million bats have perished in this manner in only short period of time. The only bat species noted in our survey was likely a few big brown bats (*Eptesicus fuscus*) that were forging over lights at night in the parking lot of the MREA. The landscape project data that GZA analyzed prior to field investigation had documentation for Indianan bat (*Myotis sodalis*) in close proximity to the MREA. This species was already federally endangered prior to WNS and as of this writing critically imperiled in New Jersey. The northern long-eared bat (*Myotis septentrionalis)* has recently been listed as a federally threatened species throughout its range and its presence in New Jersey is considered extremely rare. The remaining species of bats indigenous to the state are all in need of protection and anywhere habitat can be improved and space, structure, and forage provided, then this type of management would be in concert with the State Wildlife

Action Plan (SWAP) of New Jersey. SWAP is a strategic and cost-effective mechanism to preserve the state's wildlife resources for the future. Recovery of species that have reached threatened or endangered status is typically more costly than preventative actions that keep species populations from reaching such declines. Proactive management actions identified in the SWAP are intended to keep species from becoming federally (and state) threatened and endangered. To this end all of the above mentioned strategies for conservation management of the site proper have been specifically recommended with tenets of SWAP at the forefront. GZA recommends that bat houses be purchased or constructed and strategically placed in open habitat edge-areas of the preserve. It is recommended that these boxes be at least 15' above ground facing southeast to maximize exposure to the sun. Even though the site is currently not a prime bat habitat due to the fact that the majority of species are in decline, maintaining it as such assures that the habitat is at its biological maximum if and when their numbers bounce back.

8.o Final Comments

Open space land that has not been developed and allowed to succeed in a natural state is a rare commodity in Madison Borough. Its position in the greater landscape is especially relevant as it provides a "green" buffer to ecologically significant greenway just north of Highway Route 24. The well-constructed deer exclosure currently provides a unique opportunity to natively restore the core of the property and turn back the clock to a time when natural systems were in ecologic equilibrium with their surroundings landscapes. However, in the 21st century it is unrealistic to expect that after conservation management and restoration of the site that the landscape will return to a condition of precolonial nature. Even if all of the recommendations herein are followed to the letter only a remnant of the ecological "wholeness" of the site that once-was could ever be realized. Too many limiting factors are in play that will prevent a complete reset from occurring. But even a partial reset will pay huge ecological benefits as measured by the sites predicted increase in biodiversity. In turn, higher levels of biodiversity strengthens the overall landscapes ability to cycle nutrients, support water quality, reinforce food chains, and fortify the site as a small buffer-piece within a much larger greenway that is the Black Meadows ecologic complex.

The recommendations in section seven do not have to be done all at once to achieve success. These initiatives can be performed incrementally. It is strongly recommended that the MEC methodically document all future restoration tasks. This will help refine all subsequent initiatives. In this manner the MEC allows room in the maintenance schedule to refine its management plan as the process of land use restoration moves forward.

Image 25 - Buck Browsing Outside of Deer Fence, August 2015

NOTES: