CHARLES H. ROGERS WILDLIFE REFUGE

PRINCETON, NJ

AN ECOLOGICAL ASSESSMENT

AND

PRELIMINARY RECOMMENDATIONS

2007

By Stephen K. Hiltner

EXECUTIVE SUMMARY

BACKGROUND: This report was commissioned by the Friends of Rogers Refuge (FORR) and funded by a grant from the Washington Crossing Audubon Society. Excerpts from this report were presented at the October 15, 2007 meeting of the WCAS.

ROGERS REFUGE—PAST, PRESENT AND FUTURE: Given the drop in variety and numbers of birds visiting the refuge over the past 30 years (part of a regional and global trend), the goal of this study and recommendations is to determine how best to restore and maintain the quality and variety of habitat in the refuge and improve facilities, information, and access for birding.

RECOMMENDATIONS:

1. **Improve water flow and retention, particularly in the Lower Marsh**

    1) **Restore flow of excess pump water from upper marsh to lower marsh**: Excess pump water exits the marsh to the west via a ditch, returning directly to the river rather than feeding the lower marsh. **Recommendation:** Use sandbags to block ditch. Open up and slightly deepen partially blocked ditches leading to lower marsh via culverts. Remove gravel washed into lower marsh from road.

    2) **Redirect creekbed feeding marsh from the north**: One of two main routes for runoff from the Institute Woods has changed course and now flows down a trail and the driveway for Well #1, bypassing the upper marsh. **Recommendation**: Determine whether creek should feed upper (preferable) or lower marsh, and redirect to prevent further erosion of trail and driveway. The initial effort could be done with handtools, reinforcing with sandbags if necessary, but use of a backhoe, optimally in coordination with #1 above, may be necessary.

2. **Re-expand Upper and Lower Marshes**

    1) **Reverse thirty years of tree encroachment:** Green Ash, Box Elder, Red Maple and American Elm are displacing herbaceous and shrub growth in a 100 foot band around much of the perimeter, continuing to shrink the marsh and compete for sunlight and water. **Recommendation:** Girdle Green Ash and Box Elder around much of the perimeter. Replant with wildflowers and live stakes of native shrubs.

3. **Reduce present and future impact of invasive species**
    1) **Reduce or eliminate Reed Canary Grass infestations in lower and upper marshes**. This species is notoriously difficult to control, but will otherwise continue to displace natives over an expanding area.
    2) **Treat any surviving Phragmites.** Strategically timed followup is key to preventing the Phragmites from regaining a foothold in the Refuge.
    3) **Reduce infestations of Purple Loosestrife, Multiflora Rose, Lesser Celandine and other invasives listed.** Timing is important to minimize the difficulty of this task.
    4) **Prevent cattails from reducing plant and habitat diversity:** Already occupying a third of the marsh area, cattails could pose a threat to the plant and habitat diversity in the marsh if they are allowed to continue spreading unchecked. **Recommendation:** Possibly treat new colonies getting established in areas formerly free of cattail. Monitor spread of existing colonies, possibly by placing birdhouses on the edge of the colonies during the winter and measuring advance at end of growing season. Well-timed mowings can greatly weaken cattail stands.

4. **Improve access and visitor experience**
    1) **Create destinations and additional bird observation platforms**. Two additional locations for observation platforms are offered.
    2) **Open bird viewing vista(s) on east side of lower marsh**: There is currently no easy access to the lower marsh to view birds in the morning without facing the sun. **Recommendation**: Two short roadbeds deadend on opposite sides of the lower marsh. Girdle or cut down Ash/Box Elder trees blocking views from the east side, and develop trail through east end of the lower marsh from one roadbed to the other.
    3) **Design and seek funding for a boardwalk through east side of lower marsh**. The route could begin as a foot trail (4.2, above) allowing birders to check on whether the proposed route is a good one for birdwatching.
5. **Plant areas made bare by invasive plant removal**: Former Phragmites areas not inundated by pump water have not grown back in native species. **Recommendation:** Plant native wildflowers and live stakes of native shrubs, preferably with local genotypes; protect from deer browsing.

6. **Minimize impact of deer over largest possible area.** Deer may affect success of any effort to enrich understory with plantings of native wildflowers and shrubs. **Recommendation**: Protect individual transplants. Consider more costly deer fencing only if revegetation efforts with limited protection are unsuccessful.

7. **Birdhouses:** Birdhouses in the Refuge need repair, cleaning and repositioning.

8. **Encourage creation of a Friends of the Institute Woods:** The Institute Woods currently has no organization giving input on how management could reduce the negative impacts of heavy deer browsing and invasive plant species.

NATURALIST'S BACKGROUND

The author, Stephen Hiltner, has a Bachelor of Science degree in botany, and a Masters of Public Health degree in Water Quality, both from the University of Michigan. At various times over the past 30 years, he has taught organic gardening, worked as a horticulturist at the University of Michigan, planted and maintained prairies and wetland gardens in public parks, founded and led the Ellerbe Creek Watershed Association in Durham, NC, created urban nature preserves for public use, and conducted plant inventories in urban refuges in Michigan, Wisconsin, North Carolina and New Jersey. He has also written stewardship plans for Mountain Lakes Preserve and Harrison Street Park, both in Princeton. He currently serves as Natural Resources Manager for Friends of Princeton Open Space, and is a member of the Princeton Environmental Commission, for which he is overseeing the updating of the Princeton Environmental Resource Inventory.

ACKNOWLEDGEMENTS

This ecological assessment and preliminary recommendations for stewardship was made possible by a grant from Washington Crossing Audubon Society. In addition to that organization's support, I would like to acknowledge the assistance of members of the Friends of Rogers Wildlife Refuge in the preparation of this report. Fred and Winifred Spar, Tom Southerland, Laurie Larson and Tom Poole all provided valuable input and editorial comment. A map of the Refuge and its trails included herein was produced by Jim Williams. Three historic photos were provided by Tom Southerland. For the description of the Refuge, and its history, I borrowed portions of text from the Township website and emails from FORR members.

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BACKGROUND

Location, Ownership and Ecological Value

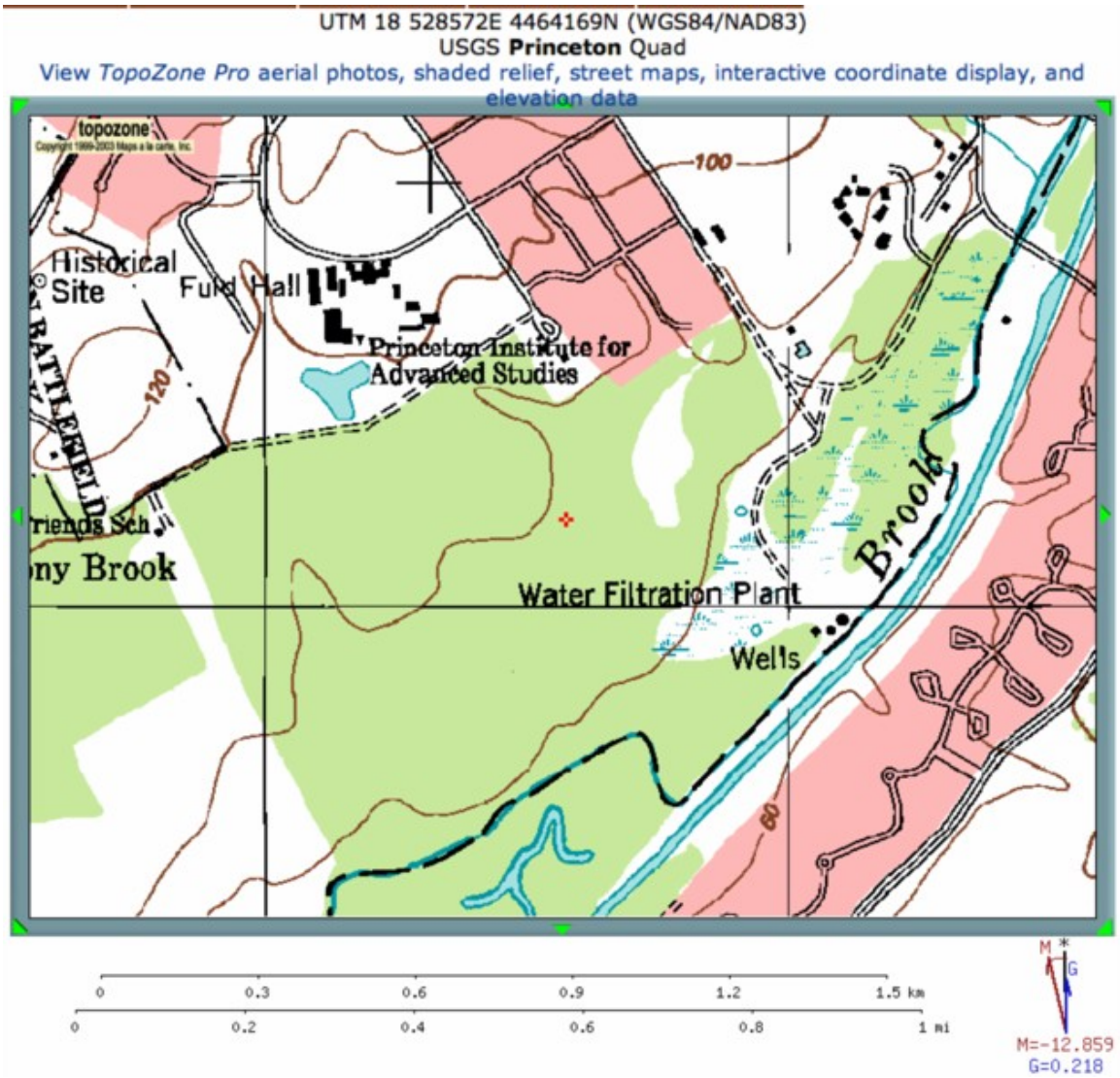
The Charles H. Rogers Wildlife Refuge is located on the outskirts of Princeton, at the end of West Drive, off Alexander Street. While its central feature is a marsh, the 39-acre refuge also contains woods and a few areas of dense shrubs. The 300-acre Institute for Advanced Study Woods borders to the north. The Stony Brook flows along its southern boundary. The Rogers Refuge is a significant migratory trap for passerines and an important nesting habitat for more than 90 species of birds, while scores of others pass through the refuge. Over the years more than 200 species have been recorded here.

At the height of migration season, as many as 20-25 species of warblers have been seen in a single day. As a consequence, many bird watchers and nature groups visit the area every spring. The Refuge is also home to significant plant diversity, with more than 80 native species.

Created in 1968 through a conservation easement with a predecessor company to New Jersey American Water, the Refuge was later named to memorialize Charles H. Rogers, a nationally known ornithologist who played a key role in establishing the sanctuary. The Refuge is maintained by the Township of Princeton, with support from New Jersey American Water and the Friends of the Rogers Refuge. It has also benefited from the contributions of many individuals and organizations, including the Partners for Fish and Wildlife Program of the U.S. Fish and Wildlife Service, which is supporting a Phragmites control project, and the Washington Crossing Audubon Society, which has provided a grant to help fund the development of these plans for improving habitat management and observation areas.

Additional historical information can be found in Appendix 5.

A representation of the boundaries that are shown on the Tax Map Dec. 1, 1994.



Rogers Wildlife Refuge is located at the end of the road, marked as the Water Filtration Plant. Princeton lies to the north and east. Alexander Road cuts across the upper right corner of this map.

FRIENDS OF ROGERS REFUGE (FORR)

Friends of the Rogers Refuge has been actively involved in supporting and maintaining the Rogers Refuge since its founding. Tom Southerland and Tom Poole helped create the refuge and have been responsible for innumerable birding activities in the area over the last three decades; Fred Spar is chair of FORR and a member of the Board of Trustees of Friends of Princeton Open Space; Laurie Larson is vice chair, and, among many other past and current bird-related activities, was NJ Breeding Bird Atlas Coordinator in 1993-97 for the region that included Princeton. FORR has helped spur recent improvements to the Rogers Refuge, which are listed below.

Restorative Efforts to Date

In the spring of 2005, a malfunctioning pump left the marsh dry in the heart of spring migration season. Since then, through the efforts of the Friends of the Rogers Refuge and support of the Township of Princeton and New Jersey American Water, progress has been made to restore the Refuge's habitat and improve facilities for visitors.

- **A new pump and a new flexible, weather-resistant pipe,** purchased and installed by the Township in spring, 2005, is proving dependable and of ample size to keep the upper marsh inundated even through droughts.
- In March, 2006, local builder, Jim Donahue, completed construction of a larger, well-designed **observation platform** to replace its aging predecessor.
- In July, 2006, through a "Partners for Fish and Wildlife" program with the U.S. Department of Fish and Wildlife, a **Phragmites remediation** program began. The highly invasive reed was cut in July, then treated with the herbicide Rodeo on September 20. Results were excellent, with nearly all Phragmites killed. A followup treatment with Rodeo was made August 31, 2007 to treat scattered surviving remnants.
- In 2006 and 2007, the water company made some **repairs to the road**, which has had an ongoing problem with potholes, and placed **new culverts** under the roadbed to prevent washouts.
- In 2007, an information **kiosk** was built and installed by Brian Allenby, an Eagle Scout candidate, who also improved access to the observation platform.

SOME GOALS FOR ADDITIONAL ACTIONS

- A variety of restored habitats—wetlands of varying wetness and compositional structure, with gradations from open herbaceous to forest.
    1. Restore water flow to Lower Marsh
    2. Control invasive species
    3. Restore understory

- Control of deer browsing impact over as large an area as possible.
- Improve visitors' experience, particularly access for birding
    1. Improve connections with adjoining Institute trail system
    2. Fund and build one or two additional observation platforms
    3. Develop access to Lower Marsh, most likely through the funding and construction of a boardwalk
    4. Fund and install interpretive signage.
- A plan for ongoing care

Philosophical Prelude

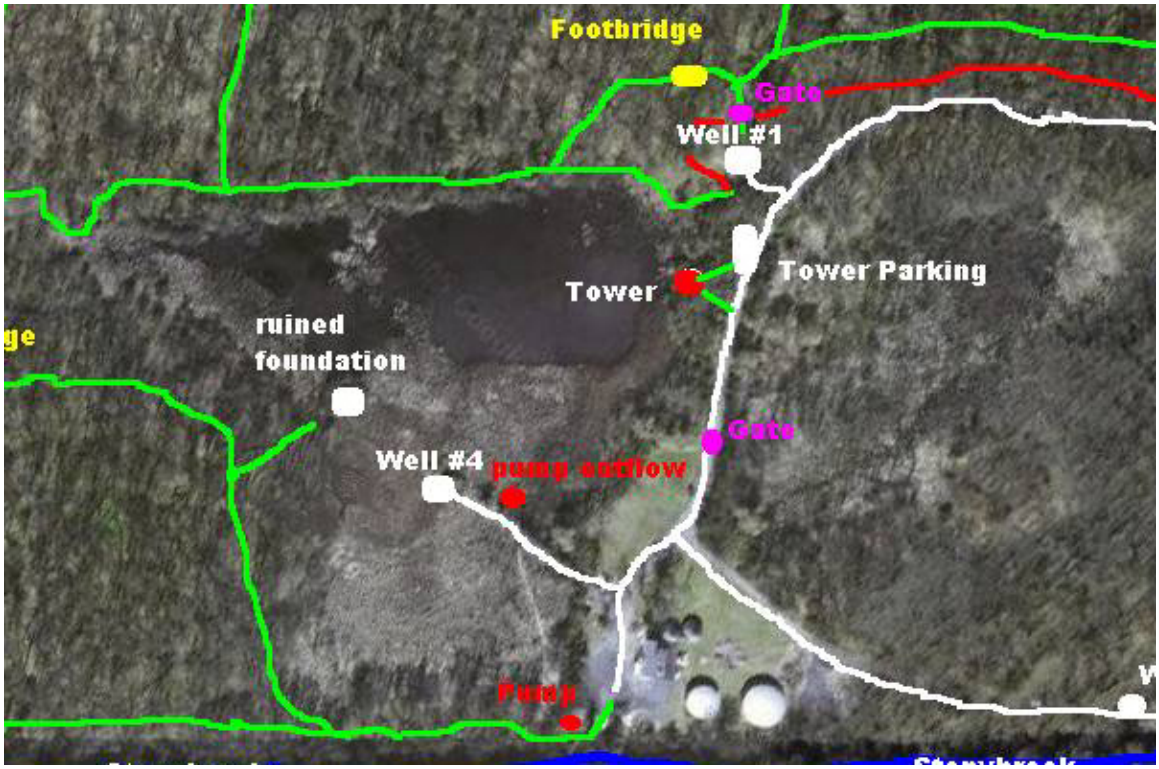
The common assumption is that human intervention tends to degrade habitats, and that land can heal once protected from development and other incursions. Many destructive interventions, however, continue even after land has been "preserved." Legal protection does not undo the imbalances caused by invasions of exotic species, the lack of predators to prey on deer, past soil disturbance and alterations of hydrology, or the historical and ongoing suppression of natural fires. The self-healing capacities of nature remain thwarted by this legacy of entrenched imbalances, a number of which continue to be enforced and even exacerbated from beyond preserved land's borders.

Sometimes partly compensating for these perpetuated imbalances are active human interventions that have an inadvertently positive effect. Annual mowings of right of ways, by preventing tree growth, allow shade-intolerant native herbaceous species a place to grow. Some kinds of farming can contribute to sustaining open habitat for grassland birds. Mowing and farming, in these instances, are substituting for the natural fires (and in the much more distant past, megafauna) that would historically have created sunny openings for these species.

Rogers Refuge is the result of another kind of active intervention that had as a byproduct a positive ecological effect. Beginning around 1960, the water company pumped river water onto the floodplain in the hopes that it would percolate down to replenish the company's wells. Instead, the water remained on the surface, where it formed perfect habitat for marsh plants and birds. Through the urgings of local birders, the pumping that failed in its intended purpose was continued in the service of the extraordinary biodiversity it attracted. Given how often human intervention has proven harmful to habitat, this serendipitous exception is to be cherished and sustained.

HYDROLOGY

Rogers Wildlife Refuge lies in the floodplain of the Stony Brook. The Refuge receives some natural inflow from adjacent uplands in the Institute Woods and, very infrequently, overflow from the Stonybrook. These inflows are augmented greatly by water steadily pumped into the marsh from the Stonybrook from March to December.

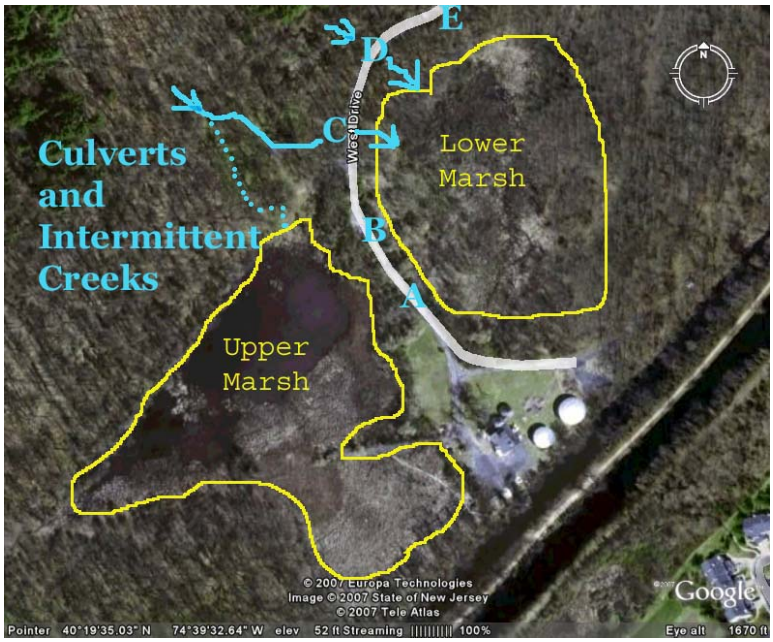


Text below refers to well numbers on this map, created by Jim Williams.

SURFACE INFLOW

This assessment is still in need of field observations during very heavy runoff. Because of a dry summer this year (2007), most of the water from occasional heavy rains was absorbed by upland soils, limiting the quantity of runoff. However, by mid-December the upland soils approached saturation, making possible some observation of runoff after substantial rains. Future witnessing of very heavy runoff will help augment this section of the assessment.

UPPER MARSH



INFLOW: The Upper Marsh receives some runoff from the Institute land. There are two woodland swales leading to the marsh from the northwest, but neither one has yet to be observed carrying surface runoff. A creek with some residual flow after rainstorms approaches from north of Well #1, but changed course some years ago. It now carries water across and down the main access trail connecting the Refuge with Institute Woods, then down the middle of Well #1's driveway. Most of that water then heads east to drain into the Lower Marsh through a culvert installed earlier in the year. Only a small portion flows west into the Upper Marsh. The dotted line in the map shows the path the creek used to take to reach the Upper Marsh.

Though in December, 2007, the Upper Marsh had substantial open water, crowded with geese and ducks, the lack of obvious surface inflow suggests water levels are sustained by a mix of underground seepage and minimal evaporation and outflow in the winter.

OUTFLOW: There are four exits for water from the Upper Marsh. The main exit is a ditch draining westward into the Stonybrook. Even when the pump is off in the winter, some slight current can be detected in this ditch. During very heavy rains, the three other exits—two heading to the Lower Marsh and one heading south directly into the Stonybrook—evidently get flow, though a clearer understanding of proportion awaits adequate rains. In the past, especially heavy runoff would overwhelm the two culverts leading to the Lower Marsh (A and B in the above map), and send stormwater over the road, causing erosion. New, larger culverts have reduced this problem.

Lower Marsh

INFLOW: Four culverts channel water to the Lower Marsh. Two (C and D on the map) have residual flow during wet seasons. One of these, the culvert located down from Well #1 (C), handles runoff from the creek that used to flow into the Upper Marsh. Both of these enter the Lower Marsh from the northwest. The other two culverts (A and B) are designed to receive water from the Upper Marsh, though the ditches on either side of the culverts need to be cleared of obstruction and slightly deepened.

OUTFLOW: Surface water exits the Lower Marsh to the east. There is no clearly defined exit channel, but rather a number of shallow, indistinct flows.

In this photo, looking westward ("upstream") towards the Lower Marsh, frozen standing water shows the slight depression that constitutes one of the exit paths for water from the Lower Marsh. Given how shallow these multiple exit points are, it would be very difficult to increase inundation in the Lower Marsh merely by blocking these exits.

There are, however, deeper ditches along the Stonybrook whose role in draining broad, wooded peripheral areas to the east and south of the Lower Marsh would be worth investigating when sufficiently heavy rains arrive.

Ephemeral Creek Entering from the Institute Woods

The feeder creek entering the refuge from the north, near Well #1. The creek changed course some years ago, and now flows down the trail leading to the refuge from the Institute (see Accessibility section, "Connection With Adjoining Preserved Lands"), flooding the deadend driveway to the well house during and after substantial rains. Slopes suggest it could be rerouted either to the west (to drain into upper marsh) or further to the east (to avoid the trail and driveway and drain into Lower Marsh through a recently installed culvert). If further east, then the trail will cross it. Rerouting the creek to the west would require more earth-moving, and permission from the Institute since the diversion would be on Institute property. Rerouting further to the east would be done south of the Institute fenceline, where the runoff first intersects the trail. Handtools might be sufficient, though access with a backhoe would not be difficult.

The lack of very heavy rains has prevented observation of the creek flow, but various factors will need to be taken into account in deciding whether to redirect the flow into the old creekbed that flows into the Upper Marsh. Priority should be given to restoring the creeks original flow westward into the Upper Marsh, since the trail currently being compromised is the main route by which birders access the Institute Woods from the Refuge.

- The change of course is on Institute property, and so will require permission to shift the flow westward into the Upper Marsh.
- Periodic observation over the winter is needed to determine where runoff is needed most.
- The water company installed a culvert that now directs flow from the ephemeral creek under the road into the Lower Marsh, though the larger culvert may still be overwhelmed during very heavy rains, possibly continuing erosion of the road that has been a problem in the past.
- Redirecting flow back to the Upper Marsh could increase sedimentation there.
- The job of redirecting flow may require more than manual labor, and would need to be maintained.

Recommendations for Improving Water Flow:

- Use sandbags to block exit ditch on west side. This will not only improve flow to the Lower Marsh but also expand the fringes of the Upper Marsh to the south.
- Clean out ditches leading to and from the culverts linking the Upper and Lower Marshes (the water company has already agreed to do this)
- Position depth gauges in Upper and Lower Marshes so that water levels can be measured. These can be handmade or purchased.
- Observe water flow when heavy rains are producing abundant runoff, for insight into additional ways to improve water flow and retention in the Marshes
- Possibly redirect ephemeral creek to the west of Well #1, to protect trail and restore this source of runoff into the Upper Marsh
- Add additional sandbags to southern exit of Upper Marsh, to reduce loss of stormwater runoff during heavy rains.

The Pump

The pump augments surface flow into the Marsh. When the old pump malfunctioned in 2005, leaving the marsh dry in the heart of spring migration, the township responded to FORR's request and purchased a new one. It is left on approximately from March 1 through to December 1, though in fall of 2007 it malfunctioned in early October and will be repaired over the winter. A previous malfunction occurred when a turtle got stuck in the mechanism. The water company pays for the energy required to run the pump, while the Township performs any periodic repairs.

Along with the new pump, new firehose-like tubing was installed to replace leaky PVC pipe.

Water depths in marsh

Water depths were measured in late summer. When the pump is in operation, water is consistently one foot deep in the core area of open water in the Upper Marsh, with two to three feet of dense silt underneath. The portion of the upper marsh closest to the river, south of the access to Well #4, no longer benefits from leaks in the pump's delivery pipe, and so is dryer than in the past. Given the flatness of the marsh perimeter on all sides except to the north of the Upper Marsh, small changes in water level can dramatically change the extent of inundation.

Consistent water inputs from the pump allow species like pickerelweed (shown) and wild rice to flourish.

This photo was taken in mid-December, after the pump had been off for two months. During winter months when evaporation is minimal, it appears that a combination of groundwater seepage and minimal evaporation and outflow helps sustain significant areas of open water in the Upper Marsh when the pump is turned off.

Flow of Pumped Water in the Refuge

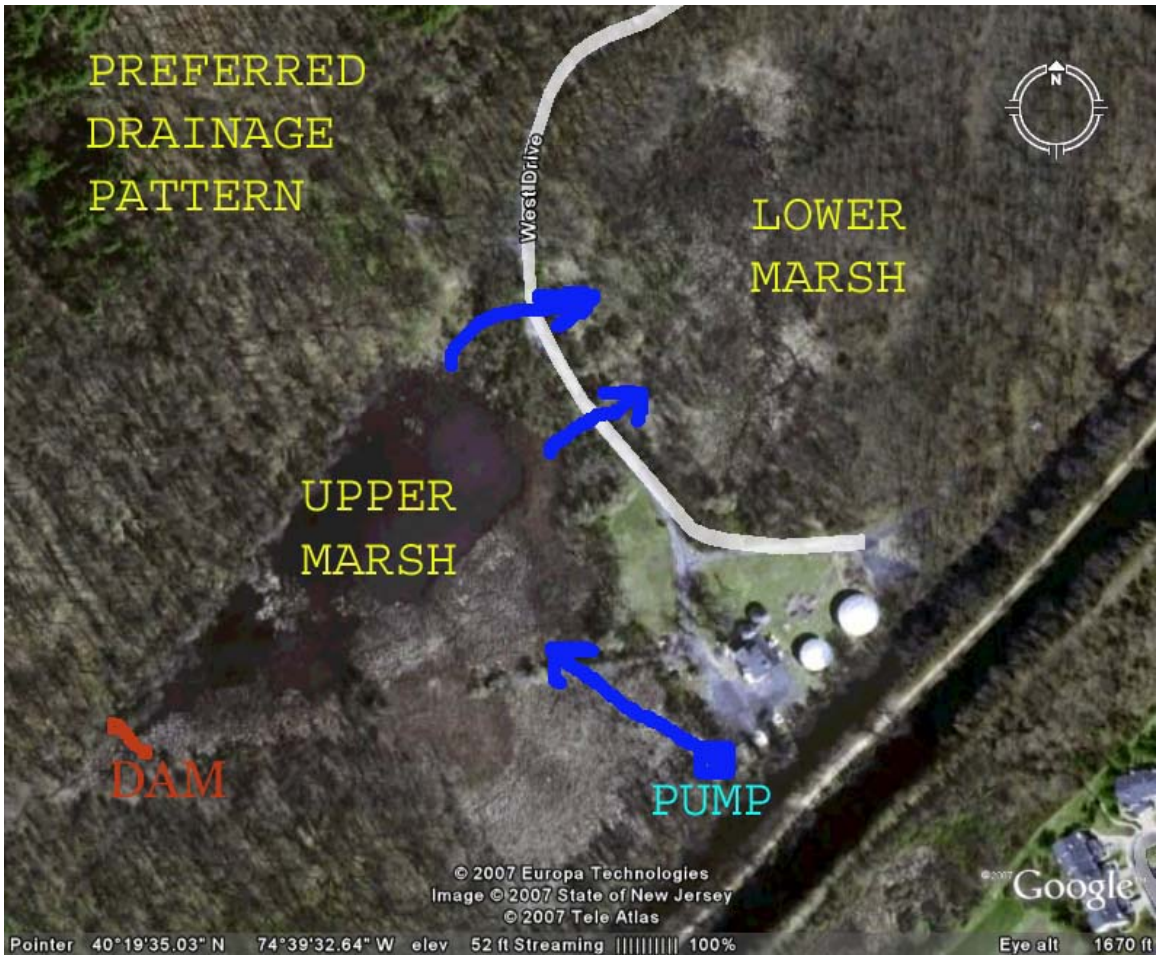
NOTE: The maps below show water flow during dry periods when the pump is in operation.

A great deal of pumped water is draining straight back into the river from the Upper Marsh, exiting westward via a ditch that is likely becoming deeper with time. A negligible amount of water flows through the culverts leading from the Upper to the Lower Marsh, due in part to partially blocked ditches on either side of the culverts.

Increasing Flow of Pumped Water To Lower Marsh

A major goal of FORR is to increase water flow to the Lower Marsh, which is dryer than in years past. The most obvious way to achieve this end is to redirect the large quantities of pumped water currently draining back into the river via a ditch on the west side of the Upper Marsh.

A makeshift dam was placed across the ditch to see how water levels and flow in the marsh would be affected. Even a temporary and imperfect dam across the exit ditch had a clear effect on water levels in the Upper Marsh and showed the potential for diverting excess pumped water into the Lower Marsh. Water levels in the two culverts leading to the Lower Marsh rose—2" in the southern culvert and 7" in the northern culvert, as of September 27, 2007. In addition, water in the Upper Marsh expanded noticeably into perimeter areas. There was no precipitation during this period to augment flow from the pump.



It may be possible to channel sufficient pump water into the Lower Marsh so that the Upper Marsh would maintain its current depth, and the Lower Marsh would again have areas of shallow water. Blocking the exit ditch with sandbags to form a dam, along with clearing the ditches leading eastward to and from the culverts will provide a definitive test of how much of the Upper and Lower Marsh the pump can keep inundated.

PUMPED WATER FLOW AND HABITAT VARIETY

By preventing loss of pumped water to the west, and thereby increasing the amount of pumped water extending into the Lower Marsh as well as the fringes of the Upper Marsh, a greater variety of different water levels can be achieved, creating a greater variety of niches for plants and birds.

Steady Vs. Interrupted Flow—An Option To Consider

The new pump's greater dependability has resulted in more consistent water levels in the marsh. The replacement of the leaky pipe has reduced the amount of water inadvertently ending up in the portion of the marsh closest to the river (south of Well #4). These changes are viewed as positive, but may have some minor downsides that are worth exploring. Species such as snipe and spotted sandpipers would benefit from varying water levels that would create periodic mudflats. Areas no longer fed by a leaky pipe need to be monitored for adverse changes in plant composition.

A question to be considered in coming years is the relative benefits of consistent pump water flow vs. occasionally interrupting flow by periodically turning the pump off for brief periods during the growing season. The timing and duration of this would need to be carefully considered. In the meantime, the safest approach is to provide as many variations in habitat as possible, given a steady flow of pumped water.

BIRD LIFE

Though Rogers Refuge hosts remarkable native plant diversity, it is primarily known for the birds it attracts. Over 200 bird species are listed in the appendix as having been seen at the Refuge over its 40 years of existence. The consistent abundance of migratory and nesting birds documented in the 1960s has not, however, been sustained. Birders who have frequently visited the Refuge over many years all agree there has been a change. Below are two accounts, the latter of which suggests that it is still possible to see a remarkable variety of warblers on a given day during spring migration in May, but that the abundance is not repeated day after day as in the past.

From Tom Southerland's Records:

"The fallout of warblers, vireos and other migrating passerines in the refuge was most impressive in the 60s into the late 70s. Just taking the above date (10 May 1964), we saw in the morning the following birds at the pumping station: Blackburnian, Blue-winged, Tennessee, Chestnut-sided, Wilson's, Myrtle, Magnolia, Yellow, Black and White, Canada, Parula, Bay-breasted, Black-throated Blue warblers (13 warblers in all) plus Ovenbird, A. Redstart, "Maryland" Yellow-throat and Blackpoll. Also seen amongst others were Scarlet Tanager, Black-billed cuckoo, Yellow-throated Vireo and Gray-cheeked Thrush. And on 11 May 1968 at the pumping station we had 17 warblers."

"Three days earlier on 7 May 1964 before starting work at the University we saw ten warblers that included a Nashville Warbler. (Note that in the 60s and 70s if we were in town in late April through mid-May during the work week, we would often bird just in the Refuge in the morning and leave the area about 8:30 a.m. and often) Even as late as 17 or 18 May 1978, we stopped at the Refuge in mid-morning en route to North Carolina's Outer Banks with a non-birder Jim Merritt who was at the University to go on a pelagic trip. Jim, a writer, a lover of nature and a well-known trout fisherman was going along with us to do a story on the pelagic trip. The warbler fallout at the Refuge was simply unbelievable. So unbelievable that it was extremely difficult to leave the small area located almost 50 yards down the dirt road from the Charles H. Rogers sign. (Since 2002 or 2003 it is lucky if we see six warbler species in May so we now rarely go out in the morning. And even we include the Institute Woods seeing over ten different warblers requires much effort.)"

"Now the variety of breeding birds is also down. Take the *Empidonax* flycatchers. The Least Flycatcher is now seen only in migration but it used to be a dependable breeder just off the path to the pump house out into the marsh. After it stopped breeding, the Willow Flycatcher became a dependable breeder in the lower marsh but it, too, stopped breeding (probably 1997). Breeding warbler numbers are down, particularly the American Redstart and Yellow Warbler. Eastern Towhees were once common breeders around the Refuge and at least two were within the boundaries but no more."

Winifred Spar's Account

Although there has been a marked decline in the number of species and total bird count over the past two decades, it is still possible to see a dozen or more species of warblers as well as numerous other passerines on a good fall-out day in May at the Rogers Refuge and adjacent Institute Woods. On May 5, 2006, for instance, I saw parula, redstart, ovenbird, common yellowthroat, and Nashville, Canada, worm-eating, black-and-white, black-throated blue, black-throated green, yellow-rumped, blue-winged, chestnut-sided, and magnolia warblers within a few hours along the main road and by the stream near West Drive. On other days that month, I saw Louisiana and northern waterthrush, palm, pine, yellow, Blackburnian, and blackpoll warblers and heard singing prairie and hooded warblers. On May 13, 2007, Fred and I saw 15 species of warblers and heard a sixteenth, along with grey-cheeked thrush and a calling Virginia rail at the back of the swamp. The next morning there was a singing Kentucky warbler, a long-absent former nesting species, by the stream. Blue-winged warblers, few and far between for several years, returned in good numbers in 2006 and 2007, perhaps as a result of more wet areas produced by the new pump.
(Additional comments by Tom Southerland can be found in the Appendix section)

For this assessment, Laurie Larson provided data from a 1995 study of breeding birds in the Institute Woods and Rogers Refuge. 53 species of birds were "confirmed" breeders (by the standards of the Breeding Bird Atlas), with an additional 15 species categorized as "probably breeding." (A complete list can be found in the Appendix section.) Repeating the same study this coming year, 13 years later, would shed light on changes that are at this point anecdotal.

A DECLINE IN VARIETY AND NUMBER

FORR members unanimously speak of a marked decline in bird species and numbers visiting and nesting at the Refuge. Though the cause may lie in changes in habitat beyond the boundaries of the Refuge—a housing project across the Stonybrook, and loss of habitat in the birds wintering territories and along migration routes—the purpose of this study is to identify changes in the Refuge itself that may have contributed to the decline.

One place to start is by considering the breeding habitat requirements for birds noted above as no longer breeding at the Refuge:

American Redstart: breeding habitat is open woodlands or scrub
Least flycatcher: Brushy areas with scattered trees
Willow flycatcher: deciduous thickets
Yellow warbler: open, often wet, woodland or shrub
Eastern towhee: habitat is brushy areas

Words like “open”, “brushy” and “scattered” trees more aptly describe the Refuge of past decades, before dense tree growth encroached. The Upper and Lower Marshes are now surrounded on three sides by dense, young trees occupying a band that varies from 90 to 240 feet in width. The trees are primarily green ash and box elder varying from 2 to 10 inches thick. Shade beneath these trees is so dense that only a very sparse herbaceous layer survives, with some areas bare dirt.

In some areas, remnant tussock sedges give evidence that this band of dense young woods was once more open.

Cater to Birds By Catering To Plants and Insects

Literature on creating conducive habitat for birds tends to focus on backyard habitat, and the various shrubs, wildflowers and grasses that can produce berries, fruits, nuts and seeds. Though the importance of insects in the diet of birds is sometimes mentioned, discussion of how to generate insects specifically as a source of food for birds is harder to find. The importance of oaks to spring migrations of warblers is easily observed, but not because of any food the oak directly produces. Rather, it is the inchworms that feed on the oaks that are in turn fed upon by birds. Hickories and to a lesser extent poplars serve a similar function.

One approach, then, to catering to the needs of birds is to provide food for the insects they eat. This means not only protecting the oaks but also attracting pollinators by utilizing (and creating additional) sunny areas for planting and encouraging as broad a spectrum as possible of wildflowers and shrubs.

Recommendations:

- Open up canopy in perimeter of young trees that have encroached on the marsh by girdling selected trees, especially Green Ash and Box

Elder around perimeter of the lower marsh. This will also provide snags for woodpeckers. A collaboration with the township may prove feasible, with FORR marking trees for the township to girdle.

- Establish rich herbaceous and shrub layer in sunny areas.
- Consider repeating study of nesting birds

Bird Houses

There are many birdhouses at the marsh—twenty or so scattered along the fringes and in the interior. Many need maintenance and could benefit from repositioning. Proper spacing to take territorial requirements into account is important, as is height, proximity to woods and perches, and orientation. It's doubtful that they have been cleaned annually.

Some could be used to measure the spread of cattails in the marsh, by placing them at the edge of the cattail clones.

From Tom Southerland, Re bird boxes:

"We can always use more Tree Swallow boxes on the upper (wet) marsh. While we used to have two Purple Martin boxes on the upper marsh , they stopped using it. Laurie Larson notes that the non-return of the martins coincided with the developing of Canal Point that replaced fields and orchards. Also, Tom Poole and I got the Institute to place one on the field near the Princeton Battlefield several years ago, but there have been no takers. This is not to say that a new attempt in the future might work, but believe we should table any efforts until we can do some more homework. Laurie Larson suggests putting up an Eastern Screech Owl box and I agree. She also suggested several bat boxes—great idea because of nighttime mosquitoes."

According to Laurie Larson, purple martins disappeared from the Refuge when houses were built across the river. Functioning houses exist at Terhune Orchard, the Pole Farm and at the Watershed farm. According to Fred Spar, wood ducks currently nest in trees, and do not appear to need houses installed for them.

Recommendations:

- Any relocation of boxes needs to be done by mid-March.
- Contact scout organizations to see if they are willing to perform ongoing maintenance. Clean and repair birdhouses and resituate poorly placed birdhouses along leading edge of cattail colonies in order to measure next growing season's advance. Some houses can be paired in order to accommodate non-competing species. Tree Swallow boxes lining the north edge of the Upper Marsh need to be randomly set out in the marsh as they were originally.
- Ask Institute if purple martin house could be relocated to Refuge for another try. It is currently not in use at the Institute.
- Screech Owl boxes

FLORA

PLANT COMMUNITIES AND HABITAT QUALITY

Recommendations for controlling invasive species over several years, shade reduction, establishment and/or expansion of native herbaceous and shrub layers, including priorities, sources of funding, methodology, and options and cost estimates for getting the work done by volunteer or professional means:

PLANT INVENTORY

An inventory of plants growing in the Refuge was conducted during 2007, with multiple visits over many months. **Eighty native and twenty exotic species were identified**. (The identities of a number of additional species of sedge, grass, wildflowers, and two unusual woody species have yet to be determined. It is also as yet unclear if the stunted specimens of ash are green ash or possibly black ash.) The inventory can be found in Appendix 1, and is also posted on the Bowman Hills Wildflower Preserve website (www.bhwp.org).
(Photo shows *Helenium autumnale.)*

QUANTIFYING FLORISTIC QUALITY OF A SITE

The website above automatically gives the inventory a number—a Coefficient of Conservatism—which can be useful in signifying the floristic quality of the site. The inventory was given a Floristic Quality Index of 35.11 and a Plant Stewardship Index of 28.37.

These values were arrived at as follows: Expert field botanists were brought together to decide on a "coefficient" for each species native to New Jersey and/or Pennsylvania. The coefficient is a number between 0 and 10, with a low number signifying a plant that is highly adaptable to a broad range of conditions, and a high number signifying a plant that is more "conservative," with "a high degree of fidelity to a narrow range of habitats." An inventory containing some plants with high coefficients suggests a habitat that is less disturbed and of higher floristic quality.

Once an inventory is completed, an average coefficient value for all the plant species found is calculated to get the Mean value. If exotic plant species are included in this calculation, the value will be lower, since all exotics are assigned a 0 coefficient.

Native biodiversity—the number of different native species found on a site—is factored in by multiplying the average coefficient by the square root of the total number of native species found. The Plant Stewardship Index is lower because it more heavily

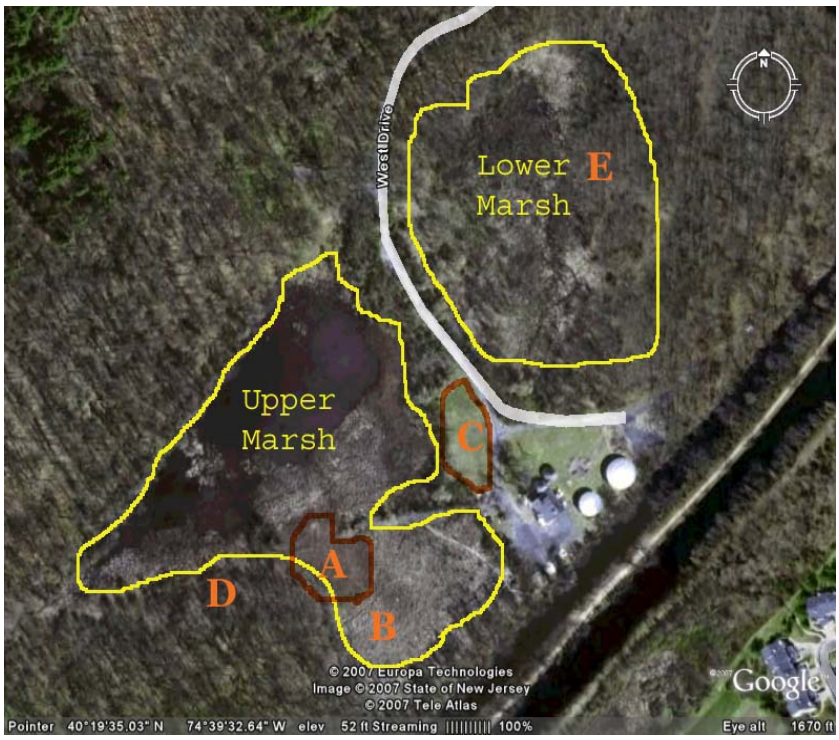
weights the presence of exotic species. No account is made for how numerous a plant species is in the inventory area.

Compared to other inventories posted on the Bowman Hill website, the Refuge ranks very high. Though the range of posted Floristic Quality Indexes range from 0 to 60, the great majority are well below 35.

Though using the index to compare one site to another still has an element of controversy, the numeric value is useful for long term monitoring of the site. As species are added or fade from the refuge, the change in species composition will cause a shift in the Index values, allowing some evaluation of whether habitat quality is changing for better or worse over time. There are also a number of species, particularly sedges and grasses, that were found but not identified. Addition of these species at a later date will help refine assessment of the Indexes.

A shrub encountered in the lower marsh may or may not be very rare. According to David Snyder of the NJ Natural Heritage Program, there are two varieties of the native shrub, Spiraea alba. Most likely, the species found is Spiraea alba, var. latifolia, which is the less rare species, but the shrub will need to be checked again for distinguishing characteristics when it flowers in 2008. More information can be found in Appendix 6.

PLANTING ADDITIONAL NATIVE PLANTS IN THE REFUGE



The refuge could benefit greatly from plantings of native wildflowers, grasses and shrubs.

Wildflowers like Joe-pye-weed, Ironweed, Hibiscus moscheutos and swamp sunflower are present in small numbers in the Refuge, but relatively large areas of well-suited habitat are available for planting, as indicated on the map.

With wet ground a given, sunlight and deer browsing will be the limiting factors. Sunlight is plentiful in locations A, B and C, and can be provided by girdling young, encroaching trees in locations D and E.

A: A white-flowering smartweed dominated here after Phragmites was treated in 2006. The area can easily be planted with more diverse wildflowers and shrubs.

B: Additional area for wildflowers and shrubs.

C: Currently mowed turfgrass that, with water company permission, could be planted as a wet meadow.

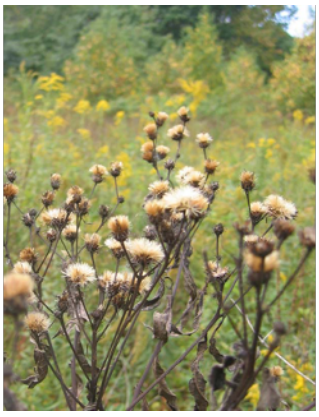
D: Formerly open marshland. If the young ash and box elder are girdled, it will be important to install native wildflowers and shrubs to fill the void.
E: Same as "D", but in Lower Marsh. Girdling of trees will provide sufficient sunlight to revive Tussock Sedges and support plantings of wildflowers.

The order of priority for planting is A, B, E, D, C

LOCAL GENOTYPES

A plant species will exhibit variation in its genetic makeup across its natural range. Plants grown from locally collected seeds and live stakes help preserve any special qualities that may have evolved in this part of the species' natural range. By contrast, plants purchased from nurseries are often from far-flung genetic stock with the potential to crossbreed locally and dilute any historic local characteristics. (Photo shows Groundnut, a native bean.)

ACQUIRING AND PLANTING NATIVE WILDFLOWERS AND SHRUBS



Wildflowers, Grasses and Sedges: Seeds have been collected from various locations in Princeton, and can be grown to sufficient size in the spring for planting in the field in May or early June. Past experience suggests that wildflower seeds will take about one week to sprout, and three weeks to grow to a size sufficient for transplanting into the Refuge. Species include Ironweed (shown in photo), Joe-Pye, Swamp Rose Mallow (Hibiscus), Swamp Milkweed, Cutleaf Coneflower, Helenium, Groundnut, Tall Meadowrue, Late-Flowering Boneset, Virginia Rye, Bottlebrush Grass, Indian Grass, Fringed Sedge and Soft Rush. Seeds have already been collected and await planting in spring, 2008.

Shrubs: Three species—Buttonbush, Silky Dogwood, and Elderberry—can easily be planted as "live stakes", which are two foot long cuttings of dormant stems, cut locally in middle to late winter and stuck in the ground right end up. The soft wetland soil should make it easy to get a good section of live stake into the ground for rooting, with two or three nodes of buds above ground for sprouting leaves.

These initiatives can be done by volunteers with professional supervision. Seedlings can be grown in backyards, with possible utilization of the greenhouse located at Princeton Township's Mountain Lakes House.

PROTECTING SEEDLINGS AND LIVE STAKES FROM DEER BROWSING

Inexpensive, lightweight protection for individual "live stakes" of shrubs, and wildflower seedlings, can be fashioned out of strong plastic deer fencing cut to size, wrapped into a cylindrical shape and stapled to a wooden stake. This is a far less costly approach than deer exclosures, and since existing mature wildflowers and shrubs in the Refuge are able to persist and flower without protection, these individual "exclosures" have a good chance of success.

MISCELLANEOUS OBSERVATIONS

Native Regrowth in Areas Formerly Dominated by Phragmites

Killing off of the Phragmites has opened up large areas for recolonization by native species. The wetter area, near the tower, is now packed with natives—arrowhead, wild rice, pickerelweed, tickseed sunflower and many others. Growth in the dryer area, closer to the stream, behind Well #4, is much less diverse, with one species of white-flowered smartweed dominating.

Cattails and the Role of Scattered Trees in Allowing for Native Diversity

Cattail exhibits two manners of growth in the Refuge. In some areas, its stems are widely spaced, allowing other species to coexist. In other areas, cattail forms dense stands that exclude most other plant species. The difference seems to be the amount of shade. Areas where cattail stems are widely spaced are partially shaded by stunted ash trees. Dense patches get full sun. This suggests that the ash trees play a role in sustaining greater plant diversity. This role needs to be studied prior to the eventual arrival of the Emerald Ash Borer from states to the west.

Role of Tussock Sedge in Creating Hammocks

A factor increasing plant diversity in the Lower Marsh, and to a lesser extent in the Upper Marsh, is the mounding that serves to create islands of elevated ground for species not adapted to periodic inundation.

One theory of how these islands develop is that the mounding growth of tussock sedges provides a place for trees and wildflowers to sprout and gain a foothold. Their root mass then expands the mound.

Turtlehead —one of the wildflower species found growing on these mounds.

Invasive Plants That Pose a Threat

EXOTIC INVASIVE SPECIES

Exotics such as Phragmites, Reed Canary Grass, Japanese Stiltgrass, Garlic Mustard and Lesser Celandine pose threats of varying degree. Isolated stands of Wisteria and Japanese Knotweed could spread if not dealt with in the near term. Prolific natives like duckweed, cattail and box elder are also capable of creating imbalances, and need to be looked at. Efforts to knock out the Phragmites and J. Knotweed have had a big impact, but will require ongoing followup to prevent recolonization.

Phragmites –The giant reed had expanded to cover some 2 acres of the upper marsh, with smaller colonies elsewhere. Most has been killed, but resprouts and recolonization pose a threat unless there's ongoing monitoring and intervention.

Reed Canary Grass – A perennial cool-season grass, that grows about 5 feet high, forms dense stands, blooms and sets seed early in the season. Most numerous in the lower marsh, where it now dominates large areas, growing sometimes in pure stands (photo), sometimes densely beneath native shrubs. Control is difficult.

Lesser Celandine -- A spring ephemeral. Looks similar to marsh marigold, but with smaller leaves and flowers. Spreading all along the canal. Spreads to form dense, exclusionary stands in the floodplain. Crowds out natives. Can be sprayed early in the spring, before other species develop leaves. Disappears in late spring, but bulbuls remain in ground.

Japanese Stiltgrass – An annual grass, introduced from Asia during the World Wars when it was used as packing for porcelain. Nearly ubiquitous in the mid-Atlantic states, it forms dense stands in the understory of Princeton's woods and can survive and spread in mowed lawns at a greatly reduced size. Stiltgrass sprouts late in spring, grows up and over other low vegetation through the summer, and sets seed in September. In the Refuge, there are substantial areas where it is not present, probably due to periodic inundation.

Carpgrass (Arthraxon hispidus) – Very similar in appearance to stiltgrass. Tends to prefer wet, sunny locations. Will compete with anything planted in the wet meadow between the water company buildings and the upper marsh.

Japanese Honeysuckle -- This perennial vine becomes a groundcover in shady areas, and an aggressive climber in sunnier locations. More easily pulled than most other

perennial invasives. An evergreen, it can be sprayed in the winter when deciduous natives are dormant.

Asian Bittersweet --Another highly invasive vine, more widespread than the Wisteria.

Shrub Honeysuckle – Various species of honeysuckle shrubs grow in Princeton. At the Refuge, these are found primarily along the north shore of the upper marsh, in a 25 foot band between the marsh edge and the broad Institute Woods trail.

Privet -- Also found along the north edge of the upper marsh.

Multiflora Rose – Grows densely, particularly along the road between the upper and lower marsh. Partners for Fish and Wildlife sprayed some of it when they treated the Phragmites, but more remains. Can be cut and stump-treated with 20% Rodeo in the dormant season.

Porcelain Berry -- A highly invasive vine along the canal corridor, related to the native wild grape. It has only been spotted in two locations in the Refuge, but could become a major problem if allowed to get established. Remove on sight.

European Frogbit – A small patch was found in September, 2007, at the edge of the marsh, near the observation tower. It floats on the water and could spread quickly across the marsh if not removed immediately. It has already begun to spread out from the shoreline. Some was removed in October, 2007, but a thorough inspection of the area near the tower is needed.

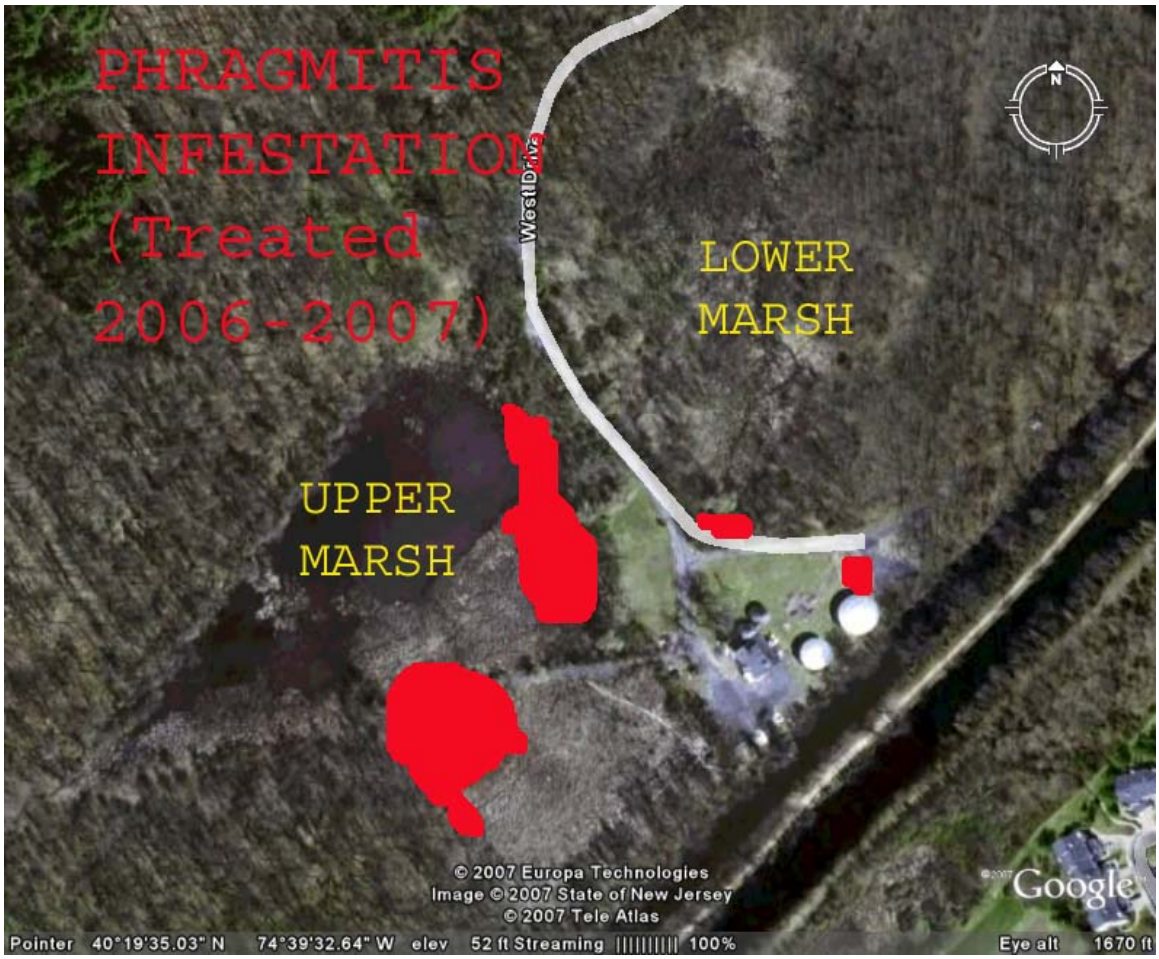
Purple Loosestrife – Scattered plants of purple loosestrife can be found in all sunny areas of the upper and lower marshes. Though not as yet dense enough to be impacting native diversity, this highly invasive species will likely increase in density and eventually pose a serious threat to native species. Intervention now, while the numbers of the species are low enough to deal with by hand, is needed to prevent the invasion from becoming an intractable problem in the future. Removal can be achieved by handpulling and/or glove treatment with dilute Rodeo. The thick cattail stands may harbor additional numbers of purple loosestrife that must also be treated.

Tree of Heaven (Ailanthus) – A small grove of this species is established just south of the lower marsh.
Princess Tree – A mildly invasive exotic. A couple of specimens are mixed with the Ailanthus, south of the lower marsh.
Asian Wisteria --There is one infestation of this very aggressive vine growing in trees along the banks of the Stonybrook, near the pump.

Garlic Mustard – A biennial that releases phytotoxins through its roots.

Japanese Knotweed – One small infestation along the Stonybrook, just west of the pumphouse, was treated in 2006.

PHRAGMITES STATUS REPORT



2006 marked the first stage in the removal of Phragmites from Rogers Refuge. In July, Partners for Fish and Wildlife cut down the reed, leaving a fringe of uncut reed that would later serve to block the herbicide from drifting beyond the boundaries of the Phragmites infestation. FORR volunteers, using hand tools, cut down a patch of Phragmites growing near one of the water company tanks.

In September, 2006, Partners for Fish and Wildlife sprayed all the Phragmites in the Refuge with Rodeo (glyphosate). The results were excellent. In spring of 2007, there was very little regrowth of the Phragmites. It did regrow here and there, however, and on August 31, 2007, Partners for Fish and Wildlife conducted a followup spraying. Judging from the look of the Phragmites, this followup spraying was very effective, with minimal drifting of herbicide onto native growth nearby.

Shoots of Phragmites will no doubt emerge here and there in 2008. It will be important to cut these or, preferably, to treat them with Rodeo, either by spot spraying with a backpack sprayer or by using a soaked glove method to prevent the reed from regaining a foothold. FORR and the township will be responsible for doing this followup.

NATIVE INVASIVE SPECIES

Cattails

Though cattails are the premier wetland plant in the public imagination and in most artistic renderings, they are a very aggressive native species that can diminish plant and habitat diversity over time. They provide a useful dense cover for wildlife, but their aggressiveness could threaten the current balance with other useful plant species.

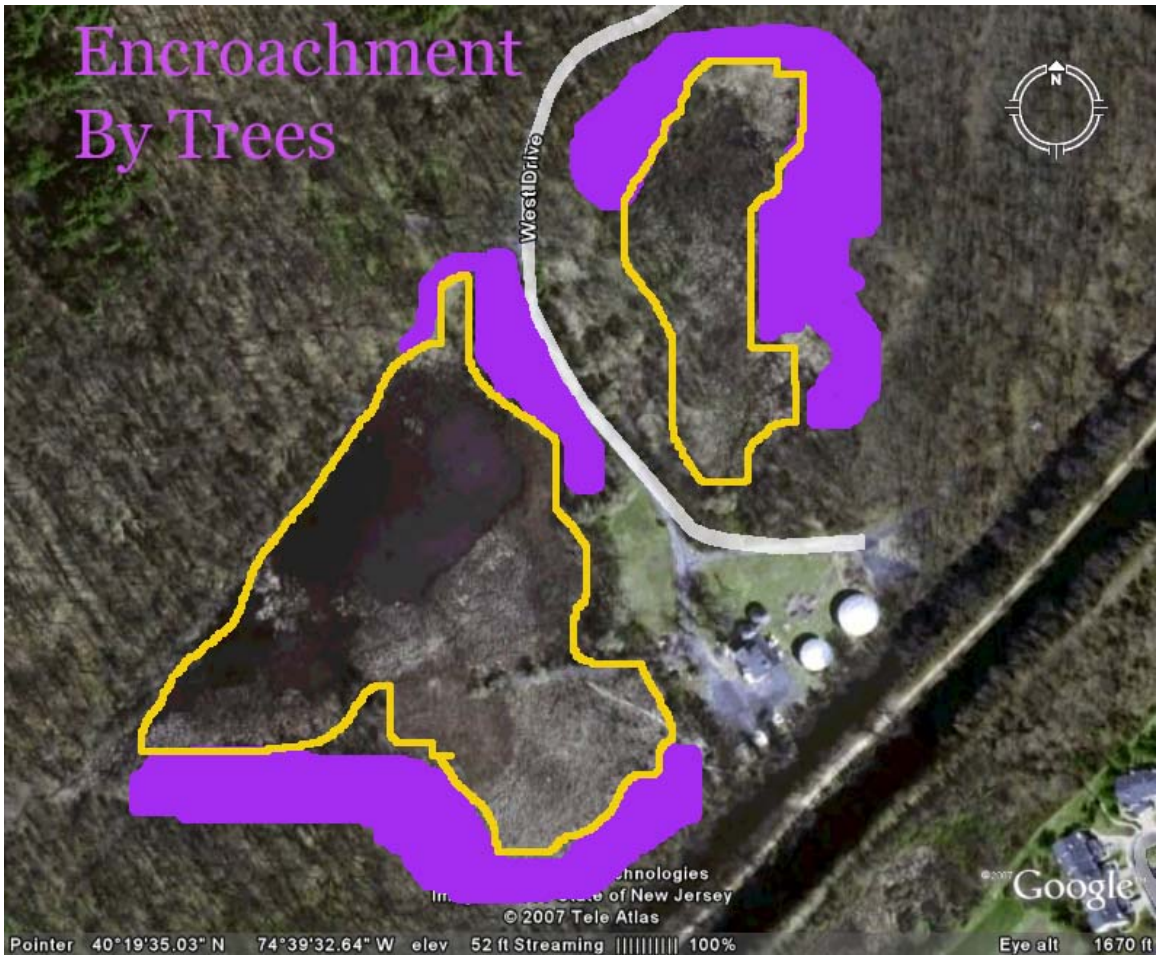
Interestingly, the presence of scattered, stunted ash trees in one section of the refuge apparently shades the cattails sufficiently that they do not form dense, exclusionary stands. This "wetland savanna" habitat is worth observing to see which bird species it serves.

Green Ash and Box Elder

Encroachment by these native but weedy tree species has had the biggest impact on the Refuge. Dense stands of young trees have colonized the perimeter of the marsh, casting deep shade upon a 100 foot wide band of formerly open area. Remnant tussock sedges and buttonbush suggest this perimeter previously supported a rich herbaceous and shrub layer. Dense shade now only allows sparse vegetation and bare ground. The Green Ash and Box Elder are mixed with some scattered Red Maple, American Elm and Pin Oak.

These two photos, taken by Tom Southerland in 1968 and 1988, show the dramatic change in the landscape caused by the growth of box elder and other woody species.

FOREST ENCROACHMENT AND COMPOSITION



Changes to the structure of the plant community may be needed, balancing herbaceous growth, understory and tree canopy. There is considerable opportunity to expand herbaceous growth and shrub understory in the lower marsh, if the problems of encroaching shade and possibly heavy browsing by deer are addressed. Tree girdling and drainage manipulation may provide low-cost solutions.

VEGETATIVE ENCROACHMENT ON UPPER MARSH

The boundary of the upper marsh is well defined on the north and east sides, but to the south and west the grade is very subtle, so that small changes in water level translate into a substantial lateral shift in the extent of inundation. Thus, a makeshift dam on the western outlet caused the water to expand southward, expanding the area of the inundation.

As in the lower marsh, the upper marsh's southern edge has grown up in dense, young trees, with red maple, elm and box elder mixing with a predominance of ash. The dense shade suppresses all but vestigial growth of forbs and shrubs. (See photos, previous page).

VEGETATIVE ENCROACHMENT ON LOWER MARSH

The lower marsh sustains a remarkably rich native plant community, with old, craggy specimens of buttonbush, silky dogwood, swamp rose, nannyberry and meadowsweet. Rising here and there, but never much over 15 or 20 feet, are a few stunted willows, ash and pin oaks that may play a role in this plant community. The shrubs and trees form hillocks, a few feet in width and a foot or so high, giving the ground a humped appearance and providing varied gradations of wetness upon which wildflowers and grasses can find suitable perches to grow. Turtlehead, tall meadowrue and Joe-Pye Weed can be found here, along with bur-reed and tussock sedge. One proposed theory is that these hillocks began as clumps of tussock sedge, from which tree seedlings sprouted, eventually expanding as the tree roots spread.

Surrounding the lower marsh is a mix of young trees, comprised of box elder, green ash, American elm and pin oak. Rising above this mixture in places are a number of specimen trees, primarily oaks. The young trees are encroaching on the open area, pushing up into the canopies of the larger trees, and have begun to shade out old buttonbush, nannyberry and swamp rose growing along the edges (see photo, in which a green ash is extending rightward over a buttonbush).

These thick stands of young trees are also competing for water with the specimen oaks, and cast such a thick shade that herbaceous growth is very thin or non-existent beneath them. Two invasive exotic tree species are established on the high ground on the southeast side of the lower marsh—Ailanthus and Princess Tree.

In addition to the encroachment by trees, two herbaceous invasive exotic species threaten this area. Most serious is the invasion of reed canary grass, which grows thickly at the north and south ends. Scattered plants of purple loosestrife are also well established and are likely to become more numerous if not dealt with.

Cattails—an aggressive native—are present in the lower marsh, but do not appear to pose any threat of domination, most likely due to the drier conditions and the partial shade provided by scattered trees.

TRANSECTS

Some informal transects were done, proceeding from the marsh edge into the young forest that has displaced herbaceous growth along the perimeter. Walking in a straight line, beginning at the edge of the marsh and heading into the dense young trees along the perimeter, dominant plants in the sparse understory were identified at intervals. The goal was to assess current understory plant growth as one moves further into the wooded area, for comparison with future composition if changes are made to the overstory. The grade along the 100+ foot transects is very nearly flat. The photo shows how the dense shade, most likely along with heavy deer browsing, has reduced the shrub/herbaceous layer in these fringe areas. The transects provide a sense of the limited herbaceous growth.

#1 Begins at lone silver maple behind Well #4

First 30 feet (ending at woods edge): white-flowering smartweed and dead Phrag
Next 30 feet: Mostly ash, a pin oak, dead Phragmites
Next 30 feet: Yellow iris, nettle, clearweed
Next 30 feet: reed canary grass, sensitive fern, clearweed
Beyond: Mostly bare ground

#2 SW side of marsh
First 15 feet: Cattails, buttonbush
Next 15 feet: Viburnum dentatum, stunted maple and ash
Next 25 feet: smartweed, woolgrass, arrowhead
Next 30 feet: sensitive fern, tearthumb, smartweed, yellow iris, larger trees

#3 Near makeshift dam on west side of upper marsh
First 30 feet: tearthumb, white-flowering smartweed
At 30 feet (from cattails at edge of marsh): red maples, smartweed, tearthumb, rice grass, false nettle
At 60 feet away from marsh edge: Clearweed, false nettle, green ash, moneywort, Geum, poison ivy
At 90 feet away: lizards tail, clearweed, hog peanut, spicebush, ash, pin oak, moneywort
At 120 feet: box elder, spicebush, lady's thumb, clearweed, rice grass, big specimens of ash and oak

DEER IMPACT AND MANAGEMENT

The combination of invasive species and heavy browsing pressure by deer has had a **devastating impact on native flora in New Jersey**. Deer show a preference for eating native species, increasing the competitive advantage of exotic invasive species.

The **concentration of deer in Princeton has been dramatically reduced** in recent years, due to aggressive control measures financed by the township. In Mountain Lakes Preserve, for instance, neighbors who once saw herds of 40 deer now see deer more rarely, and only two or three at a time. Most of the reduction is due to the contract Princeton Township has with White Buffalo, a professional service, to remove approximately 100 deer in Princeton every year. Non-professional bow hunters have removed 22 deer from Princeton parks over 4 years, according to an article in the Princeton Packet.

The **impact of deer on Rogers Refuge is affected by management on adjoining land**. According to one of the managers of the Institute Woods, the Institute for Advanced Studies does not allow the township to include the Institute Woods in its deer control program. For the past 20 years, the Institute has instead permitted a group of about ten bow hunters to hunt in the Institute Woods. (Photo shows a perch used for bow hunting near the Refuge.) The hunts are annual, conform to strict game law requirements, and are coordinated by the group's leader. A couple of hunters are permitted to use shotguns for a limited time each year.

Deer undoubtedly have **some impact on vegetation in the Refuge**. I saw deer on about half of my visits to the refuge--typically one sighting of one deer. They are not hesitant to wade out into inundated areas of the upper marsh. Plants showing evidence of deer browse include Jewelweed, Joe-Pye-Weed and Arrowhead.

There is evidence, however, that **shade is a stronger factor than deer** in determining habitat quality. Native vegetation is lush and diverse wherever sun is reaching the ground in the upper and lower marshes. Plant populations in sunny locations appear robust enough that deer browsing does not prevent plants from growing and blooming. For instance, browsed Joe-Pye-Weed makes multiple, smaller flowering heads rather than one large one. Jewelweed (shown in the photo) shows evidence of extensive deer browsing, but remains abundant.

The effect of deer on spicebush is congruent with observations elsewhere in Princeton. Four years ago, sprouts from the shrub's base would be eaten down by deer over the winter. With the reduction in deer browsing pressure, those sprouts are now growing into full-sized trunks.

At least five additional species of native shrubs can be found in the Refuge. If there is one symptom that points to deer as a limiting factor for vegetation, it is the sparseness of young woody growth. Mature trees and shrubs survive current browsing pressure, but deer browse is likely preventing seedlings from growing into mature specimens.

A deer fence in a test area would be instructive, but if the main missing component is a shrub layer, it would also be possible to protect newly planted shrubs individually, giving them enough sunlight to flourish. There are lots of examples of shrubs surviving deer browse currently in the Refuge, so that a small assist rather than a substantial deer exclosure might be sufficient to make a big difference.

Recommendations:

- Work first to reduce shade along edges of marsh
- Protect transplanted shrubs and forbs with individual cages or small exclosures
- Support deer control measures in Institute Woods and other nearby natural areas
- Discuss with Township the possibility of their contractor, White Buffalo, including the Refuge in their annual culling of deer. White Buffalo reportedly did this once in the past, staking out deer in the cattails on the west side.
- Consider setting up small deer exclosures in contrasting habitats to test impact
- Monitor results and, if deer prove a larger problem than currently discernible, consider larger deer exclusion efforts

COSTS OF DEER EXCLOSURES (Two quotes)

Quote #1: Benner's Gardens, in Phoenixville, PA. This company was used by Washington Crossing State Park (NJ side).

1 acre: $2,874.80

3 acres: $4,678.80

(Includes 7.5 foot high heavy plastic fence, nylon cable, posts and all installation equipment. Transport and installation would be done by volunteers.)

Quote #2: (Information from the New Jersey Audubon Society) "As for the fence details, the company would need to have a site visit for the most accurate cost estimate. The company that New Jersey Audubon Society used to construct the Scherman-Hoffman deer fence was Power Fence, located in the Somerville area. Mat Pryor (908-823-0393) is the primary contact. Our fence was actually a little cheaper than I initially thought – we paid $30,000 to fence approximately 15 acres just to provide you with a cost reference. The fence is a metal wire fence with horizontal wire designed to slide down on verticals when trees fall on it. This group came recommended by Duke Farms (they constructed the Duke Farm deer fence)."

Miscellaneous Information

According to Emile DeVito of the NJ Conservation Foundation, a deer density of 5-10/square mile allows forest healing.

It would be helpful to know whether Princeton Township is doing any deer control in the vicinity of the Refuge. It would also be interesting to ask the Institute deer hunting group for observations on changes in deer population in recent years.

Any deer fencing will need to be highly visible to birds in order to prevent accidental injury in the Refuge.

Some animal is eating wild rice in areas of open water. This may help explain why wild rice didn't do very well last year, after the new pump was installed. Possibly muskrat?

ACCESSIBILITY – The Visitor's Experience

Consideration of the visitor's experience must begin at the entryways into the refuge. The Refuge is not well known in Princeton in part because access to it is not well marked. Signage marking the entry by road is aging, and entrypoints from Institute Woods trails are unmarked. For visitors who successfully reach the parking area, the new observation tower provides an obvious destination and an extraordinary vista across the Upper Marsh. But after visitors have experienced the tower, it is not clear where else to go. There are driveways and footpaths, but they are not marked as to whether the public is welcome, or where they lead. There are no good views of the Lower Marsh, or of the Upper Marsh from other angles.

ROAD SIGNS LEADING TO REFUGE

Signage for the Refuge begins at the corner of Alexander Street and West Drive.

Another intersection is farther down West Drive, where the road forks.

A white Private Property sign posted there (on the right in photo) does not clearly refer to the right fork, which leads to the Nassau Swim Club. It can easily be interpreted to mean that the left fork, leading to the Refuge, is also off-limits. Potential visitors have no clear indication that the left fork leads to a refuge open to the public. In addition, the Rogers Refuge sign at that fork tends to get overgrown with vegetation in mid-summer.

Recommendations:

- Consider updating, cleaning and/or re-setting signage at Alexander and West Drive. Tom Southerland recommends at the least changing "Wild Life" to "Wildlife", or replacing altogether with a Charles Rogers Refuge sign.
- Add to the Rogers Wildlife Refuge an arrow pointing left and "Public Welcome".
- Remove vegetation more aggressively to prevent mid-summer overgrowth on Refuge sign.

KIOSK

Box for holding flyers has gaps on sides that allow birds to use the box as a nesting site. Kiosk could use more information about bird and plant life, and especially a map clearly indicating that visitors are welcome to walk past the water company buildings to access trails. Otherwise, many visitors will be confused as to where they can go.

Recommendations:

- Modify flyer box to prevent bird access (add triangular pieces of wood on either side)
- Fix any space in the shingle roof so that water doesn't damage the board.
- Add interpretive information and map to kiosk
- Design and print flyer with map, if none exists

BOARDWALK and PLATFORMS

Creating destinations beyond the initial visit to the main observation tower would greatly enhance the visitor's experience. The map shows locations for platforms providing complementary views of the Upper Marsh, and a loop trail around the east side of the Lower Marsh.

Additional Platforms

As indicated on the map, Platform A would provide a view into the Upper Marsh from a different angle. Platform B would provide a view into a currently hidden part of the Upper Marsh. Both would provide destinations that will encourage visitors to explore the Refuge.

Boardwalk

FORR members have expressed a strong interest in gaining better access, both physical and visual, to the Lower Marsh. A thick tangle of shrubs, mostly invasive, has grown up, obscuring the view from the road, and existing sightlines are eastward into the morning sun. A trail around the back (eastern) side of the Lower Marsh would solve these problems, but would likely require a boardwalk.

To minimize the length of boardwalk required, it would be possible to utilize the high ground that appears to be left over from two deadend roadways that jut into the Lower Marsh from the river side and from West Drive. The remaining span is approximately 400 feet long. This route stays to the east of the shrubs and stunted trees in the Lower Marsh, leaving them undisturbed in favor of a route that goes through a colony of invasive Reed Canary Grass, which could be treated as part of the installation.

A similar boardwalk installed by the township across the lower end of Coventry Farm cost $80/foot, not including the installation cost. That would put the cost of a boardwalk through the lower marsh in the range of $30,000. Funding could be a combination of township, water company, and foundation sources, augmented by fundraising.

Possibilities for Trail and Boardwalk Funding:

- The Office of Natural Lands Management in the NJ DEP offers trails funding from the National Recreational Trails Program. Deadlines are in mid-December, and grants can be up to $25,000 for trail construction and signage.
- The Concordia Foundation is a local foundation supporting trail development in Mountain Lakes
- Princeton Township funded and directed the installation of the boardwalk connecting Mountain Lakes Preserve to the Great Road.

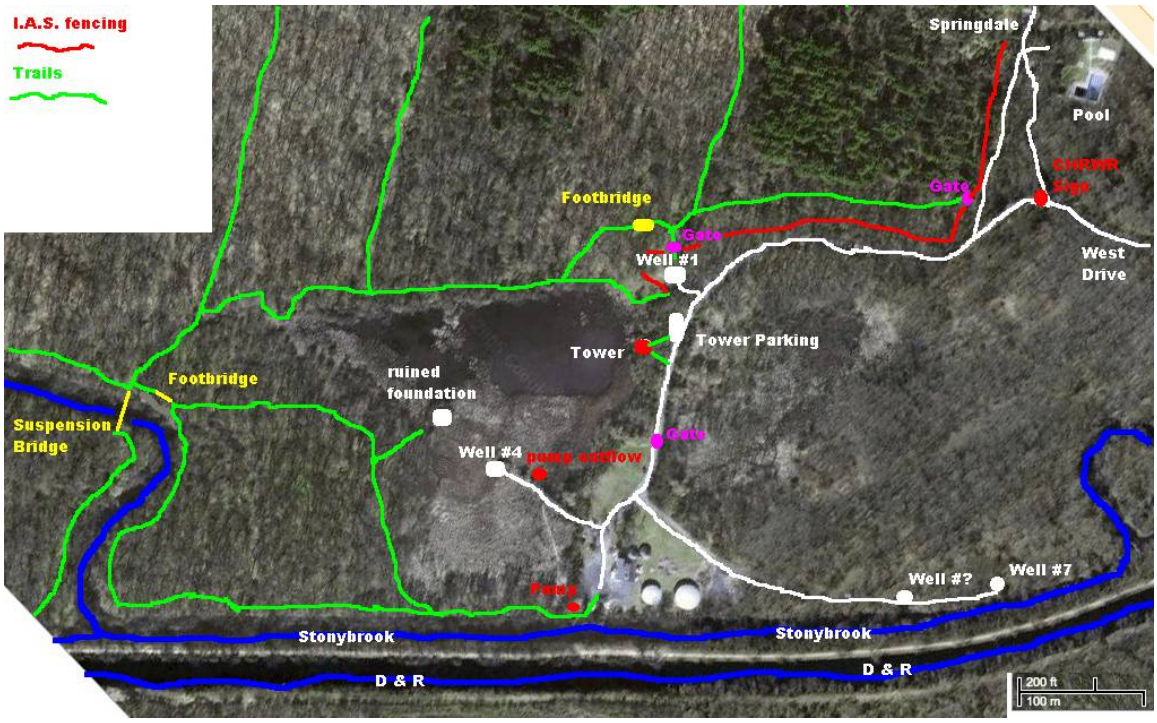
INTERPRETIVE SIGNAGE IN REFUGE

Signage can be located at vistas, such as on the observation tower and at any other platform(s) to be constructed. The New Jersey Audubon Society has offered to help with wording and contracting out for construction of signs. The township may also be a resource.

Tree Identification signs can be purchased at http://www.vosssigns.com/Tree.htm. 4"X6" plastic signs, which include some text about each tree species, are about $4 each. Similar signs were used in Community Park North, and appear to be unaffected by weather or vandalism after more than a decade.

CONNECTIONS WITH ADJOINING PRESERVED LANDS

Improved access between the Refuge and the Institute Woods would make visits to the Refuge easier and more frequent.



Map by Jim Williams

Two trails connect the Refuge to the Institute Woods to the north and west, but they frequently become overgrown in the summer, and are not well-marked.

The short trail leading past Well #1, north to the Institute Woods, has become a conduit for stormwater runoff ever since a creek from the Institute Woods changed course, veering away from the upper marsh. Suggestions for rerouting the runoff are given in the Hydrology section, above.

Access to another trail, leading westward along the Stonybrook past the pumphouse to the swinging bridge, is unclear and made unsafe by limbs hanging from a tree overgrown with invasive Wisteria.

Recommendations:

- Clear invasive shrubs, and common native shrub species if need be, growing within reach of the trails, so that mid-summer growth will not continually cause obstruction. Cut at ground level to reduce regrowth.
- Post laminated signs at either end of trails, telling where they lead. A laminated sign at the gate leading to the water company buildings, explaining that the public is welcome to walk past the buildings to access trails, would help clarify where visitors can go.
- Reorient creek at Well #1 to send its waters west or east to avoid the trail and well #1 driveway. Quick action is needed to avoid further erosion of the trail by runoff.
- Sever all Wisteria vines and treat stumps with glyphosate.

BORDERING PROPERTIES—INTEGRATING MANAGEMENT

(ROGERS REFUGE AS PART OF A LARGER HABITAT)

Ideally, management of the Rogers Refuge would be integrated with management of surrounding properties, including the Institute Woods, Princeton Battlefield, D&R Canal State Park and Turning Basin Township Park. Management of one affects the others, and would preferably be complementary. The current consortium—FORR, township and water company, working together on Refuge—could in the future be expanded to include the Institute for Advanced Studies, a Friends of the Institute Woods (yet to be created), Princeton University and the Princeton Battlefield.

PROPOSED MANAGEMENT TIMELINE

Jan-March 2008

The dormant season is an excellent time to work in the Refuge. Sightlines are clear, and risks associated with deer ticks are minimized. Even though plants are dormant, stump treatments of invasive shrubs with herbicide can still be done.

Drainage:

1. Repair pump
2. Block western exit ditch of Upper Marsh with sandbags
3. Divert flow of feeder creek west or east of Well #1. (Try first with handtools. If backhoe needed, then coordinate with ditch clearing.)
4. Clean out impediments in ditches leading to and from two culverts between upper and lower marsh
5. Install depth gauges—one for each marsh (These can be handmade or possibly purchased.)

Invasives Control

1. Cut invasive shrubs to ground, particularly on north and east sides of the Upper Marsh. Treat stumps with glyphosate, if available.
2. Consider treatment of reed canary grass's winter growth
3. Mark and girdle young trees that have encroached on the marsh
4. Cut Wisteria vines at base. Treat with glyphosate, if available.

Planting of Native Species

1. Harvest locally and plant live stakes of native shrubs; protect from deer
2. Plant wildflower seedlings and/or plant seeds in open areas; mark and protect from deer. (See Flora section for more details.)

Observation Platforms

1. Determine location for any additional observation platforms
2. Clear required area (permits required?)

Trails

1. Mark route for trail around east side of lower marsh
2. Clear vista into lower marsh from high ground on east side by girdling and/or removing young trees.

Spring/Summer, 2008

Drainage

- Monitor water flow and depths, and dam integrity

Invasives Control

- Continue cutting invasive shrubs
- Monitor and remove/treat any regrowth of Phragmites
- Treat Reed Canary Grass either with herbicide, covering with black plastic or mowing, before it sets seed
- Remove, cut or treat Purple Loosestrife
- Monitor spread of Cattails

Planting of Native Species

- Continue planting wildflowers and shrubs as they become available
- Monitor cages protecting seedlings from deer

Observation Platforms

- Pursue financing and means of installation

Trails

- Continue work to clear and make useful a route around the east side of the Lower Marsh. Have birders use and assess the trail route during spring migration in April/May
- Pursue financing and means of installing a boardwalk

Fall, 2008

- Assess progress, next steps

ONGOING MANAGEMENT

No matter what changes are instituted, there will need to be follow-up. Control of invasive species and monitoring of drainage routes will need to be ongoing.

APPENDIX 1 – Plant Inventory

The data for this inventory was collected by Stephen Hiltner and compiled on www.bhwp.org, the website for Bowman Hill Wildflower Preserve.

Site Information:
BHWP List #: 32661
State: NJ
Zip code: 08540
Restoration: Yes (date: 2006)

Additional Information:
Site Name: Rogers Refuge Princeton 07
Surveyors: Stephen Hiltner
Survey Date: 2007
GPS Coordinations: N W
Description : Man-assisted marsh within floodplain of Stony Brook, below Institute Woods in Princeton, NJ

Site Summary : This list contains 100 plants, of which 80% are native to NJ

Plant Stewardship Index 28.37
Total Mean C 3.17
Native Mean C 3.92
Floristic Quality Index 35.11

Bowman's Hill Wildflower Preserve is extremely grateful to the following persons for contributing their time and expertise so generously in assigning the Coefficients of Conservatism, producing the checklist of species in the database, and other expert assistance. Pennsylvania: Janet Ebert, Jack Holt and Anne Rhoads New Jersey: Karl Anderson, Emile De Vito, Ted Gordon, Tom Halliwell, Linda Kelly, Mary Leck, Bill Olson, Bill Rawlyk and Kathleen Stralcosch Walz And of course for the invaluable guidance and experienced advice of Jr. Gerould Wilhelm and Leslie Jones Sauer.

Key to Index Header

PA CC	Pennsylvania Piedmont Coefficient of Conservatism
NJ CC	New Jersey Coefficient of Conservatism
N	Native
I	Introduced
na	Not on state list

Under consideration, or may not be enough specimen data

Wetland Indicator Definitions (Rhoads and Block)

ORL	Obligate Wetland Species 99%
FACW	Facultative Wetland Species 67-99%
FAC	Facultative Species 34-66%
FACU	Facultative Upload Species 1-33%
UPL	Obligate Upland Species 1%

Rank	NJ Rank
SX	Extirpated
Si	Critically imperiled
S2	Imperiled
S3	Vulnerable
SH	Historic

.1 Elements documented from a single location

Assignment Of Coefficients

0 to 3 Plants with a high range of ecological tolerances/ found in a variety of plant communities

4 to 6 Plants with an intermediate range of ecological tolerances/ associated with a specific plant community

7 to 8 Plants with a poor range of ecological tolerances/ associated with advanced successional state

9 to 10 Plants with a high degree of fidelity to a narrow range of habitats

Methodology

1) Compile a plant list of the species within the assessment area.

2) Assign the Coefficient of Conservatism (CC) to each plant documented on the plant list.

3) Calculate the Native Mean Coefficient value by totaling the CC's and divide the sum by the number of native plant species within the assessed area.

4) OR Calculate the Total Mean Coefficient value by totaling the CC's and divide by the sum of the total number of plants (native and introduced) wilhin the assessed area.

5) Multiply the Native Mean Coefficient OR the Total Mean Coefficient by the square root of the total of the number of native plant species

FQI = Native Mean C x Sqrt N
FQI = Flortstic Quality Index
PSI = Total Mean C x Sqrt N
PSI = Plant Stewardship Index
N = Number of native species
I = Number of introduced species

Native Mean C = Sum of Coefficients / N
Total Mean C = Sum of Coefficients / N ÷ I

Genus	Epithet	Common Name	NJ lJst	NJ CC	NJ Rank	Wetlands	Planted	Comments
Abutilon	theophrastii	Butter-print	I	0		UPL		Cuttivated fields, roadsides and waste ground.
Acer	negundo	Box-elder	N	2		FAC+		Low, moist areas, stream banks, and floodplains.
Acer	rubrum var. rubrum	Red maple	N	3		FAC		Dry to moist woods, swamps and bogs. NJ: throughout
Acer	saccharum var. saccharum	Sugar maple	N	5		FACU		Moist woods, wooded slopes, ravines and alluvial areas.
Alisma	subcordatum	Broad-leaved water- plantain	N	3		OBL		Marshes, stream and pond margins and muddy shores.NJ: tidal flats, ditches.
Alliaria	petiolata	Garlic-mustard	I	0		FACU-		Disturbed woods, flood plains and waste ground.
Alnus	serrulata	Smooth alder	N	4		OBL		Low, wet woods and swamps.
Ambrosia	artemisiifolia	Common ragweed	N	0		FACU		Fields, meadows, cultivated areas, roadsides and waste ground.
Ampelopsis	brevipedunculata	Porcelain-berry	I	0		N		Cultivated and occasionally spreading to rubbish dumps, roadside thickets and railroad banks.
Amphicarpaea	bracteata	Hog peanut	N	4		FAC		Moist Woods and alluvium.
Aronia	arbutifolia	Red chokeberry	N	5		FACW		Swamps, bogs and moist woods.
Artemisia	vulgaris	Common mugwort	I	0		N		Gardens, lawns, roadsides, thickets, waste ground and rubbish dumps.
Asclepias	incamata ssp. incarnata	Swamp milkweed	N	5		OBL		Swamps, fioodplains and wet meadows.
Asclepias	syriaca	Common milkweed	N	*I*		FACU-		Fields, roadsides and waste ground.
Boehmeria	cylindrica	False Nettle	N	5				
Boehmeria	cylindrica var. cylindrica	False nettle	na			FACW+		Moist, shady ground of wet woods and stream margins.
Carex	crirrita var. crinita	Short hair sedge; fringed sedge	N	5		OBL		Moist to wet woods, thickets, marshes, ditches and stream banks.
Carpinus	caroliniana	Hombeam: ironwood	N	7		FAC		Rich, moist woods and stream edges.NJ: Floodplains.
Carya	ovata	Shagbark hickory	N	7		FACU		Low, moist woods and slopes, in rich soil.

Celastrus	orbiculatus	Oriental bittersweet	I	0		UPL		Disturbed woods, fields, fencerows and edges.
Cephalanthus	occideritalis	Buttonbush	N	6		OBL		Low wet ground, swamps, bogs and lake edges.
Chelone	glabra	Turtlehead	N	7		OBL		Stream banks, wet woods and swamps.
Cicuta	bulbifera	Water-hemlock	N	8		OBL		Marshes, swampy meadows, swales and openings in wet, bottomland woods.
Cicuta	maculata var. maculata	Beaver-poison! water hemlock	N	5		OBL		Swamps, marshes, wet meadows, stream banks and ditches.
Cinna	arundinacea	Wood reedgrass	N	4		FACW		Swamps and wet woods.
Circaea	lutetiana sap. canadensis	Enchanter's-nightshade	N	6		FACU		Rocky, upland woods, damp woods and floodplains.
Cornus	amomum ssp. amomum	Kinnikinik; silky dogwood	N	5		FACW		Moist woods, meadows, old fields and swamps.
Crataegus	crus-galli	Cockspur hawthorn	N	2		FACU		Woods, meadows, roadsides and thickets.
Cyperus	esculentus	Yellow nutsedge, chufa flatsedge	N	0		FACW		Moist ground of fields, flatsedge meadows, lawns and gardens.

Genus	Epithet	Common Name	NJ List	NJCC	NJ Rank	Wetlands	Planted	Comments
Decodon	verticillatus	Water-willow	N	3		OBL		Lakes, swamps and bog margins in shallow water.
Dichanthelium	clandestinum	Deertongue Grass	N	3				
Elaeagnus	umbellata	Autumn-olive	I	0		N		Planted by the Game Commission and extensively naturalized in old fields and abandoned pastures.
Elymus	virginicus	Virginia wild-rye	N	3		FACW-		Moist woods, meadows and river banks.
Epifagus	virginiana.	Beechdrops	N	10		N		Beech woods, parasitic on the roots of Fagus grandifolia.
Epilobiurn	coloratum	Purple-leaved willow-herb	N	2		FACW+		Marshes, stream or pond banks and floodplains.
Euonymus	alatus	Winged euonymous	I	0		N		Cultivated and occasionally naturalized in disturbed woods, stream banks, fencerows and edges.
Fupatorium	dubium	Joe-pye-weedl eastern joe- pye weed	N	5		FACW		Swamps, bogs, calcareous marshes and swales.
Eupatorium	perfoliatum	Boneset	N	3		FACW+		Floodplains, swamps, bogs, stream banks and wet meadows.
Eupatonum	rugosum	White-snakeroot	N	3		N		Woods, meadows and roadsides.

Fagus	grandifolia	American beech	N	8		FACU		A dominant tree of mature forests on moist, rich soils.
Fraxinus	pennsylvanica	Red ash/ Green Ash	N	4		FACW		Alluvial woods, stream banks and moist fields.
Helenium	autumnale	Common sneezeweed	N	5		FACW+		Swamps, moist river banks, alluvial thickets and wet fields.
Hibiscus	moscheutos	Rose-mallow	N	5		OBL		Swamps, marshes and ditches, in shallow water.
Impatiens	capensis	Jewelweed; spotted touch- me-not	N	2		FACW		Moist meadows, swamps and stream banks.
Iris	pseudacorus	Water flag	I	0		OBL		Marshes, shallow wateror wet shores.
Juglans	nigra	Black walnut	N	2		FACU		Open woods and meadows in moist, rich, alluvial soils.
Juncu	effusus	Common rush	N	1				
Ligustrum	vulgare	Common privet	I	0		FACU		Cultivated and frequently escaped to roadside banks, woods edges and waste ground.
Lindera	benzoin	Spicebush	N	5		FACW-		A common component of moist, rich woods.
Liquidambar	styraciflua	Sweetgum	N	1		FAC		Low, wet, coastal plain woods.
Liriodendron	tulipifera	Tuliptree	N	5		FACU		A common forest tree of rich woods.
Lonicera	japonica var. japonica	Japanese honeysuckle	I	0		FAC-		Disturbed woods, fields, thickets, banks and roadsides.
Lysimachia	ciliata	Fringed loosestrife	N	2		FACW		Low, moist ground of fields, stream banks and swamp edges.
Lythrum	salicaria	Purple loosestrife	I	0		FACW+		Swamps, wet meadows and shores.
Microstegium	vimineum	Stiltgrass	I	0		FAC		Moist ground of open woods, thickets, paths, clearings, fields and gardens.
Mikania	scandens	Climbing hempweed	N	3		FACW+		Swamps and moist thickets.
Nuphar	variegata	Bullhead Lily	N	4				
Onoclea	sensibilis	Sensitive fern	N	2		FACW		Marshes, swamps, moist open woods and wet meadows, in subacidic soils.

Genus	Epithet	Common Name	NJ List	NJCC	NJ Rank	Wetlands	Planted	Comments
Parthenocissus	quinquefolia	Virginia-creeper	N	1		FACU		Woods, fields and edges.

Peltandra	virginica	Arrow-arum	N	3		OBL		Swamps, stream or lake edges and tidal marshes.
Phalaris	arundinacea	Reed canary-grass	I	0		FACW		Marshes, alluvial meadows, shores and ditches.
Phragmites	australia	Common reed	I	0		FACW		Marshes, ditches and moist disturbed ground.
Phytolacca	americana	Pokeweed	N	0		FACU+		Forest openings, waste ground and gardens.
Pilea	pumila -	Clearweed	N	3		FACW		Cool, moist, shady areas.
Platanus	occidentalis	Sycamore	N	4		FACW-		Stream banks, low woods, floodplains and alluvial soils.
Polygonurn	arifolium	Halberd-leaftearthumb	N	6		OBL		Wet woods, baggy thickets, swamps, wet meadows and ditches.
Polygonum	cuspidatum	Japanese knotweed	I	0		FACIJ-		Stream banks, roadsides, railroad banks and waste areas.
Polygonum	persicaria	Lady's-thumb	I	I)		FACW		Wooded slopes, moist thickets, edges of swamps, roadsides and waste ground.
Polygonum	sagittatum	Tearthumbl Arrow-leaved tearthurnb	N	5		OBL		Low moist ground, vernal ponds, bogs, swamps or marshes.
Polygonum	scandens var. scandens	Climbing false-buckwheat	N	3		FAC		Moist woods, thickets, roadsides and waste ground.
Polygonum	virginianum	Jumpseed	N	4		FAC		Moist open woods, floodplains and roadside&
Pontederia	cordata	Pickerel-weed	N	7		OBL		Swampy edges of lakes and streams, also tidal shores.
Prunus	serolina	Wild black cherry	N	1		FACU		Woods and fencerows.
Quercus	alba	White oak	N	4		FACU		A dominant forest tree on dry to moist sites.
Quercus	palustns	Pin oak	N	3		FACW		Low, moist or seasonally wet woods or swamps.
Robinia	pseudoacacia	Black locust	N	0		FACU-		Open woods, floodplains, thickets and fencerows.
Rosa .	rnultiflora	Multiflora rose	I	0		FACU		Disturbed woods, pastures, old fields, roadsides and thickets.
Rosa	palustils var palustrus	Swamp rose	N	6		ORL		Swamps and marshes.
Rubus	allegheniensis	Common blackberryl Allegheny Blackberry	N	3		FACU-		Old fields, open woods and clearings.
Sarnbucus	canaderisis	American elder	N	2		FACW		Woods, fields, stream banks and moist roadsides.

Sassafras	albidum	Sassafras	N	2		FACU-		Old fields, hedgerows and woods edges.
Saururus	cernuus	Lizard's-tail	N	8		OBL		Swamps and shallow water along the edges of streams.
Scirpus	cyperinus	Wool-grass	N	2		FACW+		Marshes, moist meadows, swamps, shores and ditches.
Sicyos	angulatus	Bur cucumber	N	3		FACU		Moist open soil, stream banks, roadsides or waste ground.
Sparganium	eurycarpum	Bur-reed! Giant Bur-reed	N	7		OBL		Bogs, swamps, lake margins, ditches and swampy meadows.
Spiraea	alba var latifolia	Meadow-sweet	N	2		N		Swamps, marshes and rocky or baggy shores NJ: Old fields.
Staphylea	trifolia	Sladdernut	N	8		FAG		Moist, rocky woods and stream banks.
Symplocarpus	foetidus	Skunk cabbage	N	5		OBL		Moist woods, swamps and bogs.

Genus	**Epithet**	**Common Name**	**NJ List**	**NJCC**	**NJ Rank**	**Wetlands**	**Planted**	**Comments**
Thalicirum	pubescens	Tall meadow-rue	N	*5*		FACW+		Wet meadows, low open woods and swamps.
Toxicodendron	radicans	Poison-Ivy	N	1		FAC		Open woods, roadside thickets, fencerows and edges.
Tridens	flavus	Purpletop	N	I		FACU		Meadows, old fields and roadsides.
Typha	latifolia	Common cat-tail/ Broad- leaved Cat-tail	N	**3**		**OBL**		**Swamps,** marshes, **wet shores and ditches.**
Urtica	dioica	Stinging Nettle	**I**	**0**				
Urtica	dioica sap. gracilis	Great nettle	N	**3**		FACU		FlOodplains and thickets, in moist soil.
Vernonia	noveboracensis	New York ironweed	N	*4*		FACW+		Stream banks and wet fields, pastures or meadows.
Viburnum	dentatum	Southern arrow-wood	N	**5**		FAC		Swamps and wet woods.
Viburnum	lentago	Nannyberry	N	*7*		FAC		Woods, swamps and roadsides.
Viburnum	prunifolium	Black-haw	N	**5**		FACU		Woods, old fields, thickets and roadsides.
Wisteria	sinensis	Chinese wisteria	I	**0**		N		Disturbed woodlands, abandoned nurseries and gardens.

Zizania	aquatica var. aqualica	Wild-rice	N	8		OBL		Tidal and non-tidal marshes.

PLANT STEWARDSHIP INDEX Bowman's Hill Wildflower Preserve P.O. Box 685, New Hope PA 18938 215-862-2924 www.bhtp.org

APPENDIX 2 – Birds of the C. H. Rogers Wildlife Refuge

Based on the 1977 list by R. Blicharz
updated by L. Larson and T. Southerland

1 Canada Goose Branta canadensis
2 Wood Duck Aix sponsa
3 Gadwall Anas strepera
4 American Wigeon Anas americana
5 American Black Duck Anas rubripes
6 Mallard Anas platyrhynchos
7 Blue-winged Teal Anas discors
8 Northern Pintail Anas acuta
9 Green-winged Teal Anas crecca
10 Ring-necked Duck Aythya collaris
11 Hooded Merganser Lophodytes cucullatus
12 Common Merganser Mergus merganser
13 Ring-necked Pheasant Phasianus colchicus
14 Wild Turkey Meleagris gallopavo
15 Northern Bobwhite Colinus virginianus
16 Common Loon Gavia immer
17 Pied-billed Grebe Podilymbus podiceps
18 Double-crested Cormorant Phalacrocorax auritus
19 American Bittern Botaurus lentiginosus
20 Least Bittern Ixobrychus exilis
21 Great Blue Heron Ardea herodias
22 Great Egret Ardea alba
23 Snowy Egret Egretta thula
24 Little Blue Heron Egretta caerulea
25 Green Heron Butorides virescens
26 Black-crowned Night-Heron Nycticorax nycticorax
27 Yellow-crowned Night-Heron Nyctanassa violacea
28 Glossy Ibis Plegadis falcinellus
29 Black Vulture Coragyps atratus
30 Turkey Vulture Cathartes aura
31 Osprey Pandion haliaetus
32 Bald Eagle Haliaeetus leucocephalus
33 Northern Harrier Circus cyaneus
34 Sharp-shinned Hawk Accipiter striatus
35 Cooper's Hawk Accipiter cooperii
36 Red-shouldered Hawk Buteo lineatus
37 Broad-winged Hawk Buteo platypterus
38 Red-tailed Hawk Buteo jamaicensis
39 Rough-legged Hawk Buteo lagopus
40 American Kestrel Falco sparverius

41 Merlin Falco columbarius
42 Peregrine Falcon Falco peregrinus
43 King Rail Rallus elegans
44 Virginia Rail Rallus limicola
45 Sora Porzana carolina
46 Common Moorhen Gallinula chloropus
47 American Coot Fulica americana
48 Killdeer Charadrius vociferus
49 Greater Yellowlegs Tringa melanoleuca
50 Lesser Yellowlegs Tringa flavipes
51 Solitary Sandpiper Tringa solitaria
52 Spotted Sandpiper Actitis macularius
53 Least Sandpiper Calidris minutilla
54 Wilson's Snipe Gallinago delicata
55 American Woodcock Scolopax minor
56 Laughing Gull Larus atricilla
57 Ring-billed Gull Larus delawarensis
58 Herring Gull Larus argentatus
59 Great Black-backed Gull Larus marinus
60 Rock Pigeon Columba livia
61 Mourning Dove Zenaida macroura
62 Black-billed Cuckoo Coccyzus erythropthalmus
63 Yellow-billed Cuckoo Coccyzus americanus
64 Barn Owl Tyto alba
65 Eastern Screech-Owl Megascops asio
66 Great Horned Owl Bubo virginianus
67 Barred Owl Strix varia
68 Long-eared Owl Asio otus
69 Northern Saw-whet Owl Aegolius acadicus
70 Common Nighthawk Chordeiles minor
71 Whip-poor-will Caprimulgus vociferus
72 Chimney Swift Chaetura pelagica
73 Ruby-throated Hummingbird Archilochus colubris
74 Belted Kingfisher Ceryle alcyon
75 Red-headed Woodpecker Melanerpes erythrocephalus
76 Red-bellied Woodpecker Melanerpes carolinus
77 Yellow-bellied Sapsucker Sphyrapicus varius
78 Downy Woodpecker Picoides pubescens
79 Hairy Woodpecker Picoides villosus
80 Northern Flicker Colaptes auratus
81 Pileated Woodpecker Dryocopus pileatus
82 Olive-sided Flycatcher Contopus cooperi
83 Eastern Wood-Pewee Contopus virens
84 Yellow-bellied Flycatcher Empidonax flaviventris
85 Acadian Flycatcher Empidonax virescens
86 Alder Flycatcher Empidonax alnorum

87 Willow Flycatcher Empidonax traillii
88 Least Flycatcher Empidonax minimus
89 Eastern Phoebe Sayornis phoebe
90 Great Crested Flycatcher Myiarchus crinitus
91 Eastern Kingbird Tyrannus tyrannus
92 White-eyed Vireo Vireo griseus
93 Yellow-throated Vireo Vireo flavifrons
94 Blue-headed Vireo Vireo solitarius
95 Warbling Vireo Vireo gilvus
96 Philadelphia Vireo Vireo philadelphicus
97 Red-eyed Vireo Vireo olivaceus
98 Blue Jay Cyanocitta cristata
99 American Crow Corvus brachyrhynchos
100 Fish Crow Corvus ossifragus
101 Purple Martin Progne subis
102 Tree Swallow Tachycineta bicolor
103 Northern Rough-winged Swallow Stelgidopteryx serripennis
104 Bank Swallow Riparia riparia
105 Cliff Swallow Petrochelidon pyrrhonota
106 Barn Swallow Hirundo rustica
107 Carolina Chickadee Poecile carolinensis
108 Black-capped Chickadee Poecile atricapillus
109 Tufted Titmouse Baeolophus bicolor
110 Red-breasted Nuthatch Sitta canadensis
111 White-breasted Nuthatch Sitta carolinensis
112 Brown Creeper Certhia americana
113 Carolina Wren Thryothorus ludovicianus
114 House Wren Troglodytes aedon
115 Winter Wren Troglodytes troglodytes
116 Marsh Wren Cistothorus palustris
117 Golden-crowned Kinglet Regulus satrapa
118 Ruby-crowned Kinglet Regulus calendula
119 Blue-gray Gnatcatcher Polioptila caerulea
120 Eastern Bluebird Sialia sialis
121 Veery Catharus fuscescens
122 Gray-cheeked Thrush Catharus minimus
123 Bicknell's Thrush Catharus bicknelli
124 Swainson's Thrush Catharus ustulatus
125 Hermit Thrush Catharus guttatus
126 Wood Thrush Hylocichla mustelina
127 American Robin Turdus migratorius
128 Gray Catbird Dumetella carolinensis
129 Northern Mockingbird Mimus polyglottos
130 Brown Thrasher Toxostoma rufum
131 European Starling Sturnus vulgaris
132 Cedar Waxwing Bombycilla cedrorum

133 Blue-winged Warbler Vermivora pinus
134 Golden-winged Warbler Vermivora chrysoptera
135 Tennessee Warbler Vermivora peregrina
136 Orange-crowned Warbler Vermivora celata
137 Nashville Warbler Vermivora ruficapilla
138 Northern Parula Parula americana
139 Yellow Warbler Dendroica petechia
140 Chestnut-sided Warbler Dendroica pensylvanica
141 Magnolia Warbler Dendroica magnolia
142 Cape May Warbler Dendroica tigrina
143 Black-throated Blue Warbler Dendroica caerulescens
144 Yellow-rumped Warbler Dendroica coronata
145 Black-throated Gray Warbler Dendroica nigrescens
146 Black-throated Green Warbler Dendroica virens
147 Townsend's Warbler Dendroica townsendi
148 Blackburnian Warbler Dendroica fusca
149 Yellow-throated Warbler Dendroica dominica
150 Pine Warbler Dendroica pinus
151 Prairie Warbler Dendroica discolor
152 Palm Warbler Dendroica palmarum
153 Bay-breasted Warbler Dendroica castanea
154 Blackpoll Warbler Dendroica striata
155 Cerulean Warbler Dendroica cerulea
156 Black-and-white Warbler Mniotilta varia
157 American Redstart Setophaga ruticilla
158 Prothonotary Warbler Protonotaria citrea
159 Worm-eating Warbler Helmitheros vermivorum
160 Ovenbird Seiurus aurocapilla
161 Northern Waterthrush Seiurus noveboracensis
162 Louisiana Waterthrush Seiurus motacilla
163 Kentucky Warbler Oporornis formosus
164 Connecticut Warbler Oporornis agilis
165 Mourning Warbler Oporornis philadelphia
166 Common Yellowthroat Geothlypis trichas
167 Hooded Warbler Wilsonia citrina
168 Wilson's Warbler Wilsonia pusilla
169 Canada Warbler Wilsonia canadensis
170 Yellow-breasted Chat Icteria virens
171 Summer Tanager Piranga rubra
172 Scarlet Tanager Piranga olivacea
173 Eastern Towhee Pipilo erythrophthalmus
174 American Tree Sparrow Spizella arborea
175 Chipping Sparrow Spizella passerina
176 Field Sparrow Spizella pusilla
177 Savannah Sparrow Passerculus sandwichensis
178 Fox Sparrow Passerella iliaca

179 Song Sparrow Melospiza melodia
180 Lincoln's Sparrow Melospiza lincolnii
181 Swamp Sparrow Melospiza georgiana
182 White-throated Sparrow Zonotrichia albicollis
183 White-crowned Sparrow Zonotrichia leucophrys
184 Dark-eyed Junco Junco hyemalis
185 Snow Bunting Plectrophenax nivalis
186 Northern Cardinal Cardinalis cardinalis
187 Rose-breasted Grosbeak Pheucticus ludovicianus
188 Blue Grosbeak Guiraca caerulea
189 Indigo Bunting Passerina cyanea
190 Bobolink Dolichonyx oryzivorus
191 Red-winged Blackbird Agelaius phoeniceus
192 Eastern Meadowlark Sturnella magna
193 Yellow-headed Blackbird Xanthocephalus xanthocephalus
194 Rusty Blackbird Euphagus carolinus
195 Common Grackle Quiscalus quiscula
196 Brown-headed Cowbird Molothrus ater
197 Orchard Oriole Icterus spurius
198 Baltimore Oriole Icterus galbula
199 Pine Grosbeak Pinicola enucleator
200 Purple Finch Carpodacus purpureus
201 House Finch Carpodacus mexicanus
202 Red Crossbill Loxia curvirostra
203 Common Redpoll Carduelis flammea
204 Pine Siskin Carduelis pinus
205 American Goldfinch Carduelis tristis
206 Evening Grosbeak Coccothraustes vespertinus
207 House Sparrow Passer domesticus

APPENDIX 3 -- Charles H. Rogers Wildlife Refuge Birds, Then and Now

(Some random takes by Tom Southerland)

1. Charles Rogers once told me that Red-shouldered Hawks were more common than Red-tailed Hawks in the Princeton area and I recall several times seeing one perched in a tree in the lower marsh although my computer record of birds in the 60s only shows one entry and that was 10 May 1964 when the area was called "the pumping station." But the computer entry was taken from a bird calendar.
2. The fallout of warblers, vireos and other migrating passerines in the refuge was most impressive in the 60s into the late 70s. Just taking the above date, we saw in the morning the following birds at the pumping station: Blackburnian, Blue-winged, Tennessee, Chestnut-sided, Wilson's, Myrtle, Magnolia, Yellow, Black and White, Canada, Parula, Bay-breasted, Black-throated Blue warblers (13 warblers in all) plus Ovenbird, A. Redstart, "Maryland" Yellow-throat and Blackpoll. Also seen amongst others were Scarlet Tanager, Black-billed cuckoo, Yellow-throated Vireo and Gray-cheeked Thrush. And on 11 May 1968 at the pumping station we had 17 warblers.
3. Three days earlier on 7 May 1964 before starting work at the University we saw ten warblers that included a Nashville Warbler. (Note that in the 60s and 70s if we were in town in late April through mid-May during the work week, we would often bird just in the Refuge in the morning and leave the area about 8:30 a.m. and often) Even as late as 17 or 18 May 1978, we stopped at the Refuge in mid-morning en route to North Carolina's Outer Banks with a non-birder Jim Merritt who was at the University to go on a pelagic trip. Jim, a writer, a lover of nature and a well-known trout fisherman was going along with us to do a story on the pelagic trip. The warbler fallout at the Refuge was simply unbelievable. So unbelievable that it was extremely difficult to leave the small area located almost 50 yards down the dirt road from the Charles H. Rogers sign. (Since 2002 or 2003 it is lucky if we see six warbler species in May so we now rarely go out in the morning. And even we include the Institute Woods seeing over ten different warblers requires much effort.)
4. Charles H. Rogers once told me that the Orchard Oriole was the more common bird in the Refuge between it and the Baltimore Oriole. But that had changed before we arrived in Princeton in Oct. 1962 when the Orchard Oriole became a rarity. Now we are seeing Orchard Orioles in May on a regular basis although still outnumbered by the Baltimore.
5. The Checklist of Birds compiled by R. J. Blicharz probably has number of errors. For example, it shows the Black-capped Chickadee as common in the winter, spring and fall. Granted, the north-south dividing line between it and the Carolina Chickadee was perhaps then located in the greater Princeton area, I doubt if the Black-capped was ever common here in the Refuge (perhaps uncommon). It certainly is not now as the dividing line has moved further north (yet there are still hybrids in Princeton).

6. The Ring-necked Pheasant use to be seen or heard in the Refuge almost throughout the year up into the 70s but no more. In fact, the pheasant is getting difficult to see throughout New Jersey -- the reason: development and the fact that the state no longer seems to be reintroducing them from pheasant farms. Now the Wild Turkey receives most of the state's game bird attention. The state, however, still reintroduces Bobwhites whose numbers are also way down in many areas. And it should no longer appear on our Refuge checklist.
7. Migrant shorebird species in the spring have improved in the refuge but this is partly reflected on water levels being down during the periods when the pump was not working. For example, the checklist doesn't show either of the yellowlegs.
8. Now the variety of breeding birds is also down. Take the *Empidonax* flycatchers. The Least Flycatcher is now seen only in migration but it use to be a dependable breeder just off the path to the pump house out into the marsh. After it stopped breeding, the Willow Flycatcher became a dependable breeder in the lower marsh but it, too, stopped breeding (probably 1997). Breeding warbler numbers are down, particularly the American Redstart and Yellow Warbler. Eastern Towhees were once common breeders around the Refuge and at least two were within the boundaries but no more.
9. Perhaps the old checklist is correct showing Ring-billed Gulls as breeders, but if so, it had to be many, many years ago.

APPENDIX 4 -- CONFIRMED BREEDERS IN 1995

From Laurie Larson, a list of the birds that were "confirmed" breeders (by the standards of the Breeding Bird Atlas) in 1995 in the Institute Woods and Rogers Refuge: (53 total)

Green-backed Heron
Canada Goose
Wood Duck
Mallard
Killdeer
Rock Dove
Mourning Dove
Great Horned Owl
Belted Kingfisher
Red-bellied Woodpecker
Downy Woodpecker
N. Flicker
Pileated Woodpecker
E. Wood-Pewee
Willow Flycatcher
E. Phoebe
E. Kingbird
Tree Swallow
Barn Swallow
Blue Jay
Am. Crow
Carolina Chickadee
Tufted Titmouse
White-breasted Nuthatch
Carolina Wren
House Wren
Blue-gray Gnatcatcher
Wood Thrush
Am. Robin
Gray Catbird
N. Mockingbird
Cedar Waxwing
Eur. Starling
Yellow-throated Vireo
Warbling Vireo
Blue-winged Warbler
Yellow Warbler
Am. Redstart
Ovenbird
Com. Yellowthroat

Scarlet Tanager
N. Cardinal
Rose-breasted Grosbeak
Chipping Sparrow
Song Sparrow
Swamp Sparrow
Red-winged Blackbird
Com. Grackle
Brown-headed Cowbird
Orchard Oriole
N. Oriole
House Finch
House Sparrow

In addition, these species were categorized as "probably breeding:" (15 total)

Yellow-billed Cuckoo
Chimney Swift
Ruby-throated Hummingbird
Hairy Woodpecker
Acadian Flycatcher
Great Crested Flycatcher
Veery
White-eyed Vireo
Red-eyed Vireo
Black-and-White Warbler
Worm-eating Warbler
Kentucky Warbler
Indigo Bunting
Rufous-sided Towhee
Am. Goldfinch

Two more species, Red-tailed Hawk and Ring-necked Pheasant, were present during the dates considered likely for nesting; but I never found a nest or any evidence of breeding for them.

APPENDIX 5 – REFUGE BOUNDARIES

A representation of the boundries that are shown on the Tax Map Dec. 1, 1994.

APPENDIX 6 – ADDITIONAL HISTORICAL INFORMATION

(From communications with Tom Southerland)

The Rogers Refuge is centered around a man-made marsh at the end of West Drive off Alexander St. in Princeton Township. The pump was originally installed by the Princeton Water Co. (predecessor of Elizabethtown Water) to recharge the aquifer, before 1960, but an impervious layer prevented percolation and the area became swampy.

The first steps towards gaining protection for the marsh were taken when Tom Southerland, after talking to Charles Rogers, reported to the Princeton Open Space Commission that fill from the Graduate School housing on West Drive was being dumped into the marsh along the road near where the observation tower now stands. Before filling began, the marsh had come literally to the edge of the road. The Commission agreed that an effort needed to be made to stop the dumping, and that the area should be protected. Tom Southerland, James Sayen and Tom Cooke, then a lawyer active in environmental concerns, met with then Borough Mayor Henry Patterson, who was also the owner of the Elizabethtown Water Company. Patterson agreed to the proposal of protection, and afterwards Tom Cooke drew up a Conservation Easement Agreement between the Township and the water company, to be renewed every ten years.

Thus, in 1968 the Princeton Wildlife Refuge was established. At the death of C.H. Rogers in 1977, Ed Bloor (Ray Blicharz's predecessor as the Region Editor for NJ Nature Notes/Records of NJ Birds) suggested the renaming of the refuge in his honor. Tom Southerland made a presentation to the Township and the idea was immediately accepted.

The Friends of the Charles H Rogers was formed at this time. The Princeton Junction scout troop made the first observation tower and provided Tree Swallow boxes. The township installed a Martin house contributed by the Southerlands.

Tom Poole and former resident, Tom Gopsill, were active from the very beginning in continuing the establishment, and along with Tom Southerland took turns as wildlife chairman, with Tom Poole having the longest tenure in the position. They worked with Tom Cook and Jim Sayen and the Open Space committee of the Township.

Ray Blicharz, Mary Doscher, and Janet Aylward helped draft the bird list.

APPENDIX 7 – *Spiraea alba*

A shrub encountered in the lower marsh may or may not be very rare. According to David Snyder of the NJ Natural Heritage Program, there are two varieties of the native shrub, Spiraea alba. The stems on the flowers, and also the axis of the flower head of the very rare Spiraea alba var. alba is conspicuously hairy. Its leaves tend to be narrower and more finely toothed than the more common Spiraea alba var. latifolia. Var. alba is a more northern species; var. latifolia is more southern. Where their two ranges meet, identifying characteristics may be less clear, bringing into question whether the two varieties are distinct. The best time to identify is early on in the blooming period, before the hairs get beat up. Dried samples taken during the dormant season are also useful for identification.

Below is the ranking for Spiraea alba var. alba, though it is more likely, based on geographical location, that the Refuge specimens are var. latifolia.

Global rank: G5T5 (G5 Demonstrably secure globally; although it may be quite rare in parts of its range, especia-lly at the periphery.

Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example, Stachys palustris var. homotricha is ranked "G5T? SH" meaning the full species is globally secure but the global rarity of the var. homotricha has not been determined; in New Jersey the variety is ranked historic.)

State rank: S1 Critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.

Other status: HL (Indicates taxa or ecological communities protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area.

NJ Natural Heritage Program (609) 984-1339

APPENDIX 8 – COMMUNITY RESOURCES

Princeton Environmental Commission
Institute for Advanced Study
Friends of Princeton Open Space
Stony Brook - Millstone Watershed Assoc.
D&R Greenway
Washington Crossing Audubon Society (Chapter NAS)
New Jersey Audubon Society
Princeton University, D. Wilcove and others
Boy and Girl Scouts
Local newspapers
New Jersey American Water