Roxbury Farm Biodiversity:
Conservation and Agroecological Considerations

Farmscape Ecology Program
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INTRODUCTION

This work was undertaken with two main goals: 1) to help provide more detailed information about the interaction between Roxbury's farming activity and habitat for native species and 2) to contribute to Roxbury's understanding of the interaction of how wild plant and animal species may affect agricultural production. We have much more experience addressing the former than the latter, however we recognize the importance of looking at wild species management from both perspectives. We hope that our dabbling in agroecology is a first step that helps us become more versed and useful in this realm. As one of us was recently told, 'Anything worth doing, is worth doing poorly.' So, please bear with us and let us know your comments – they will help us learn.

Most of the fieldwork reported here was done during the summer of 2007. The pond work was conducted during 2006 while some snow tracking, ground checking and bird snooping occurred in early 2008. We focused most of our attention on areas that were or recently had been influenced by active farming. In addition, relating to the focus of an upcoming study, we also spent substantial time exploring floodplain forests. The wooded uplands received relatively little attention and the swamp on the SW corner of the property eluded us for much of the study because we didn't realize that it lay on Roxbury property.

In most cases, our work was primarily descriptive, and we essentially roamed about describing what we could see. While we made several visits to Roxbury during the year, we doubtless missed certain seasonal events – the blooming of certain flowers, the flight of certain insects, the migratory passage of certain birds. Thus our lists are not exhaustive. We do hope they are more or less representative of what you find on the Farm.

This report has two main parts and they overlap somewhat. Specifically, we first present a description, organized by plant and animal group, of the wild species found on the Farm. We try to introduce the flora and fauna and highlight those species of conservation interest. Where appropriate, we also discuss the potential influence of these organisms on farm production, i.e., we touch upon agroecology. We hope that this first part gives you an overview of some of the organisms on your farm.

The second section is map based. That is, we present a habitat map and a habitat-by-habitat discussion of the conservation and management issues relating to each habitat. Obviously, there is some redundancy here – if, in the previous section, we described certain species of conservation interest, then, in this section, we will mention them again in relation to their particular habitats. We hope that this second part is useful in a practical sense and lets you quickly find information regarding a specific portion of your farm.

Finally, at various points in the report, we have highlighted particular studies or monitoring that we believe might help us learn important information. These are an invitation to you. Please let us know which if any of these studies seem interesting and worthwhile.

PART1: DESCRIPTIONS OF THE PLANTS AND ANIMALS

PLANTS

Plant Conservation

There are close to 1300 species of plants growing wild in Columbia County. Two thirds of these are considered native species, meaning that they were here before European settlement. One third of the wild plants originated in Europe or Asia (and very few from South America or the Western US), and they have been either intentionally or unintentionally introduced to our region. Plant conservation efforts are directed exclusively at native species, attempting to "save all the pieces" that were here before European settlement. Usually, plant conservation measures focus on rare species. There are 57 plant species in Columbia County that are listed as endangered or threatened, and a larger number is protected as exploitably vulnerable (= likely to become threatened in the near future) by the State of New York. Approximately 200 more species are considered regionally-rare by Hudsonia. These state-protected and regionally-rare plants, which we will refer to as species of conservation interest, are highlighted in bold in the plant list attached in Appendix 1.

Wild Plants on Farms

A large percentage of the introduced plants are well adapted to our European-style agriculture and therefore thrive well on farms, making up the bulk of plants on pastures and hay meadows (which often have been originally seeded with varieties of European grasses and legumes), competing as weeds with cultivated plants, and gracing the edges (along farm roads, fence rows, and margins between intensively managed and natural habitats). There are few bothersome weeds that are actually native to our region (e.g., Ragweed), but most native plants do not compete well in the fertile and frequently disturbed soil of cultivated fields. Even in pastures and hayfields, the native plants are usually in the minority, both in terms of species numbers and coverage.

Nevertheless, farms in Columbia County can provide plenty of habitat for native plants. So far, we have found approximately 400 native plant species on Columbia County farms. The on-farm habitats that are often rich in native plant species are wet meadows, swamps (wetlands dominated by woody vegetation), ponds/marshes, streams/creeks/ditches and their associated upland corridors of unmanaged or lightly managed vegetation, upland forest and fencerows (if they are remnants of upland forest or have been established for a long time), upland old fields and shrublands. In our studies of Columbia County farms, we have now documented at least 54 species of conservation interest in wetlands, shrubby old fields, and farm woodlots.

Plants of Conservation Interest on Roxbury Farm

We should emphasize that our plant survey from Roxbury Farm is far from complete and that we focused our search for native plants on areas where we expected the most plants of conservation interest. Appendix 1 presents a list of all the plants we documented on Roxbury Farm and the habitats where we saw them, complemented with the plant list published by Hudsonia in 2004 for the Martin Van Buren Historical Site and the South Farm of Roxbury Farm. This merged list contains almost 500 plant species, 213 of which were reported only by Hudsonia (and a few of these might exclusively occur on the Martin Van Buren Site, where we did no work). It is certainly no exaggeration to say that there are at least 500 plant species, 330 of them native, growing wild on Roxbury Farm. At least thirty-five wild plant species on Roxbury Farm are of conservation interest.

In the following, we will introduce the main groups of native vascular plants found on Roxbury Farm, discuss where they are found on the farm, and provide ecological background that helps understand some of these distribution patterns. We categorize the plants into Spring Ephemerals; Native Herbs and Wildflowers; Native Grasses; Sedges, Rushes and Cattails; Native Aquatic Plants; Native Vines and Lianas; Native Shrubs; Native Trees; and Invasive (Introduced) Plants. We consider these in turn below.

Spring ephemerals are a group of herbaceous forest plants that emerge before the leafing-out of the tree canopy and provide early-season pollen (and to a lesser degree, nectar) sources for bees, butterflies and other insects. Strictly speaking, these are a subgroup of the following category, but we highlight them here because of their beauty and specialized ecology. They sometimes complete their entire lifecycle (seed to seed) between April and June (e.g., False

Mermaid Weed). Most spring ephemerals, however, are perennials that sprout from bulbs, tubers, or rhizomes early in spring. Their green parts wilt before the end of summer, sometimes leaving fruits displayed on isolated dry fruiting stalks (e.g., Wild Leek). A dense and diverse flora of spring ephemerals often seems to indicate forests that have not been cleared of their canopy in a long time. Indeed, studies by others have shown that these plants are very slow to recolonize cleared areas.

Many spring ephemerals thrive best in deep, rich, moist soils. At Roxbury Farm, the richest community of spring ephemerals was found in the floodplain forests along Kinderhook Creek. They included the NYS-protected Bloodroot, Red Trillium, and White Baneberry, the regionally-rare Dutchman's Breeches, False Mermaid Weed, and Spring Beauty, as well as Wild Leek ("Ramp"), Trout Lily, Skunk Cabbage, False Solomon's Seal, Early Meadow Rue, amongst others. We did not survey "Southern Swamp" during the spring months. We would expect some of these spring ephemerals to thrive there as well. All other swamps and upland forests at Roxbury Farm did not have a rich spring flora. Skunk Cabbage was the most ubiquitous spring ephemeral, basically present in all the swamps. Trout Lily and False Solomon's Seal grew on the wooded hill on North Farm, Red Trillium in the forest surrounding the "Old Lower Pond". This relative poverty in spring ephemerals is most likely due to the young age of most upland forest and wooded swamp patches on Roxbury Farm. Even the spring ephemerals in the Floodplain Forest certainly do not represent a "pristine" situation.

Deer are famous for their ability to significantly impact spring flower populations by grazing. We monitored a dense patch of more than 200 young Meadow Lily plants, first observed on May 7 and by July 5 found no more than five flowering individuals. (Meadow Lily's are not considered spring ephemerals because they bloom somewhat later, however these flowers occur in the same habitat and we believe the deer probably have a similar impact on spring ephemerals.) There is anecdotal evidence that these lilies are highly sought after by deer in our region. Furthermore, invasive plants (e.g., Garlic Mustard, Dame's Rocket) are present in the floodplain forest, and although they are not dominant, their presence might modify the native ground flora through competition for light and water, as well as alleopathy (negative chemical interactions).

Native herbs and wildflowers can conveniently be grouped, according to their shade tolerance, into *forest* and *meadow* species and, according to their tolerance for "wet feet", into upland vs. wetland species. Within these broad categories are groups of species that show a preference for certain soils (e.g. calcareous indicators). Some native wildflowers, especially those of forests and certain wetlands, are quite intolerant of changes in their habitat and might not re-colonize a secondary forest or a wetland with modified hydrology. Others are early colonizers who take advantage of freshly or repeatedly disturbed sites. Finally, wildflowers can be grouped according to their flowering times. We already discussed the spring ephemerals in forests. Their strategy of early spring emergence and rapid senescence does not seem to be paralleled by any native meadow plants. Yet meadows and forests do share two flower groups that can be categorized by flowering time: the summer and the fall flowers. The summer flowers are a taxonomically very diverse group that provides most of the native wildflowers from May through August. The fall flowers are dominated by plants of the aster family –including Goldenrods- that burst into bloom in early September and provide pollen and nectar through October. Across all these groups, we found approx. 140 native herbs and wildflowers on Roxbury Farm.

For native ***forest*** *herbs and wildflowers*, the floodplain forest was again the most interesting habitat. It was the only place on the farm where we found the NYS-protected Cardinal Flower and the regionally-rare Meadow Lily and Giant Ragweed, joining the spring ephemerals later in the season. We found the regionally-rare Halbert-Leaved Tearthumb in the "Southern Swamp" and expect it to harbor additional native herb and wildflower treasures. The other swamps, while not spectacular, had a decent set of native wildflowers, including the NYS-protected Turtlehead (host plant to caterpillars of the Baltimore Checkerspot butterfly) and the more common Skunk Cabbage, Wild Geranium, Early Meadow-rue, Spotted Joe-Pye Weed, and Purplestem Angelica. We don't have any exciting wildflower finds to report from any of the upland forests.

From our experience throughout Columbia County, native *upland meadow wildflowers* tend to be most diverse on poor soils. That is where they can best compete with the European species that are so well adapted to the rich soils that

farmers strive to create. Most of Roxbury Farm has been in very intensive agricultural management for a very long time, and there are not many areas of poor soils where a diverse community of native wildflowers could thrive. An exception is the area of the abandoned gravel pit where topsoil has been removed and spontaneous re-vegetation of the mineral soil is allowed to take its course without further disturbance. Waste grounds like this are often perceived as eyesores and examples of places where the land has obviously been "hurt". However, these places can serve as habitat to pioneering native species that get overgrown by other species in better soils, and can become floristically quite diverse, because none of the otherwise common species gets to dominate the scene. On the mineral soil near the "Gravel Pond", we found many common native upland and wetland wildflowers, plus the regionally-rare Whorled Milkwort and another uncommon plant (most likely a Frostweed). The other place where native wildflowers can come into their own at Roxbury Farm are the old fields. They currently seem to be dominated by Goldenrods and Asters, but might have a potential to be managed for more wildflower diversity.

The wet meadows, especially on North Farm, had a decent set of common native *wetland flowers*, although we were surprised by the absence of certain typical wet meadow flowers, such as Swamp Milkweed, and did not find any wildflower species of conservation concern in this habitat at Roxbury Farm (but see section on grasses and sedges, below!). We believe, that there is a potential for the restoration of more diverse wet meadows, simply by reducing the mowing frequency to once every three years.

Finally, the edge of the "Upper Pond" also had a decent set of common native wildflowers, it was the only place where we saw a single Swamp Milkweed (regionally not an uncommon wet meadow plant) and we also observed a regionally-rare Great Solomon's Seal between the "Upper Pond" and the driveway.

Native grasses in our region hardly ever form extensive stands on upland meadows comparable to those of the European pasture grasses, and they also rarely become bothersome weeds in the cultivated fields. Little Bluestem, one of the common prairie grasses in the Midwest, can become prominent on dry hillsides in Columbia County, but there was no Little Bluestem at Roxbury Farm, because there is none of its typical habitat. Of the 16 native grass species found on Roxbury Farm, all but two were species associated with wet meadows and swamps or with streamsides (both, floodplain forest and sand/gravel bars). But even in their preferred habitats, these native grasses usually grow in single clumps, one here, one there, and the smaller species are easily overlooked. Prominent during the fall and winter are the 2m tall, big clumps of the tan-colored, dried stems of Big Bluestem and Switchgrass. Prominent during the summer is the dreaded Rice Cutgrass, which forms impenetrable tangles of its flimsy, razor-sharp stems in wet meadows and open swamps. None of the native grasses at Roxbury were considered regionally-rare, although we had personally never seen Big Bluestem in Columbia County before.

Basically all the **sedges, rushes and cattails** in our region are native. There are a surprisingly large number of sedges that grow in upland forest regionally, however, at Roxbury Farm, the prime habitat for the 37 native sedges, rushes, and cattails were the same as those for native grasses: the wet meadows, swamps and the floodplain forest. Hudsonia researchers documented a NYS-threatened sedge (*Carex davisii*) from the floodplain forest, and two regionally-rare sedges (*Carex grayii* and *Carex squarrosa*) from "Southern Swamp" and the forest along "Muddy Brook", respectively. We now know of two locations, on North and South Farm, where another regionally-rare sedge (*Carex trichocarpa*) occurs in moist upland meadows near the forest edge.

"Gravel Pond" is the only pond on Roxbury Farm that had a diverse flora of **native aquatic plants**, but we did not find any rare aquatic plants during our survey.

Native vines and lianas were common in the floodplain forest, including two regionally-rare species, Climbing Hempweed (documented by Hudsonia from the South Farm) and Moonseed, found by us on the North Farm. But 12 more common species of native vines and lianas also occurred around the ponds, in upland forest (e.g., grapes), along fence rows, and even in wet meadows (e.g., Poison Ivy) and pasture (e.g., Virginia Creeper).

Native shrubs occurred on Roxbury Farm in upland shrubland, swamp, upland forest, floodplain forest, along fence rows, around ponds, and even in wet meadows. Maybe the most ubiquitous of the 27 native shrub species on the Farm

are Staghorn Sumach, Grey-Twig Dogwood, and Black/Raspberries. In open wet areas, willows and Silky Dogwood were also common. The NYS-protected Winterberry occurred in the "Southern Swamp" and Hudsonia documented the regionally-rare Alternate-Leaved Dogwood, probably from the same site. We found a willow specimen at the shore of the "Gravel Pond" that might be the regionally-rare Prairie Willow.

None of the 46 **native tree** species documented from Roxbury Farm are state-listed or regionally-rare. But different habitats on the farm support tree communities of very distinct species composition. In the floodplain forest, the common trees were Sycamore, Silver Maple, Cottonwood, Ash, Boxelder, and Basswood. Red Maple, Green Ash, and American Elm were common in the "Southern Swamp" along with Yellow Birch and Swamp White Oak. Hudsonia also reported Slippery Elm and Black Willow. On higher ground within that swamp we also saw Black Birch, American Beech, and Hemlock. The upland forest around the "Old Lower Pond" was dominated by Cottonwood, the forest around the small "Spring Pond" was dominated by Black Locust, which is not considered native to our region, but also had Black Cherry and Bitternut. The canopy of the forested hill on North Farm was composed of White Pine, Oaks, and Maples. Black Cherry and White Ash were probably the trees most commonly found in fence rows. Butternut was scattered throughout along the margins of the wetter sites.

Interestingly, all our **ferns** are native species, and all but three very common species (Bracken Fern, Hay-scented Fern, and Sensitive Fern) are NYS-protected. Remarkable are the several stands of regionally-rare Ostrich Fern in the floodplain forest and "Southern Swamp" of Roxbury Farm. We suspect that most of the fern species Hudsonia reported, were found in the "Southern Swamp" and adjacent upland forests.

In summary, habitats with a good potential for native plant conservation on Roxbury Farm are the floodplain forests along the Kinderhook, the wet meadows and the swamps. A diverse native flora with some interesting plants also occurs on the upland meadows on mineral soil surrounding the former gravel pit.

Invasive plants are non-native plants that don't stay "close to people" and the intensively managed habitats, but have the potential to spread into the more natural habitats and to compete with native species on their "home turf". They can diminish population sizes and the diversity of native species in invaded habitats. Therefore, native plant conservation often considers the invasive species as competitors of native plants.

Almost 30 invasive species were documented on Roxbury Farm (Appendix 1). However, not all of them are likley to severely impact the native plant communities. In fact, some of the herbaceous plants considered invasives in the New England Invasive Plant Atlas seem to be common components of Columbia County pastures and hay meadows with little tendency in our region to invade more natural habitats (e.g., Gill-over-the-ground, Sheep Sorrel, Canada Thistle). Three exceptions should be emphasized. Garlic Mustard has become a ubiquitous herb in small forest patches and along forest edges and in those already stressed locations seems to have quite an impact on the native forest herbs, including spring ephemerals. It probably is present in all upland and floodplain forest patches at Roxbury Farm, but should be watched especially in the floodplain forest, where a sudden spreading could significantly impact the native ground flora. Japanese Knotweed does particularly well along the shore of creeks and has come to totally dominate certain stretches of stream banks. At Roxbury, it grows currently in isolated colonies along the banks of the Kinderhook Creek. Again, if it spreads significantly, it has the power to shade out native ground flora. Purple Loosestrife does very well in wet meadows and open swamps, particularly in nutrient-enriched situations. It is currently most common in the wet meadows on the North Farm. However, as long as it stays one component of a diverse wet meadow community, it can be tolerated for its value as a nectar and pollen plant for insects.

The two invasive grasses to keep an eye on are Reed Canary Grass, which currently seems to be limited to a meadow patch, which it basically dominates, in the northern floodplain forest, and Common Reed, which currently seems to be occurring in small patches at the edge of swamps. Both of these species have the potential to take over wet meadows and should be watched. There were two invasive aquatic plant species, Eutrophic Water-Nymph and Water-Chestnut, in the "Gravel Pond". The latter has the ability to cover an entire pond's surface within a few years, shading out all submerged aquatic plants. We found only a small patch in 2006 and took the liberty to weed it out. If the diverse

aquatic plant community in "Gravel Pond" is of any interest to you, you will have to keep an eye on the Water-Chestnut, which most likely will continue to grow or be carried into the pond again by waterfowl.

Of the seven invasive shrubs documented from Roxbury Farm, Multiflora Rose, Japanese Barberry and Honeysuckle might be the most common and the most likely to have an impact on plant communities of conservation interest in the floodplain forest and in "Southern Swamp". Their control, however, would require tremendous effort. More rewarding might be an attempt to limit the further spread of Tree-of-Heaven, one of the three invasive tree species known from Roxbury. It first took hold on this continent as a rapid colonizer of vacant urban lots and is now also spreading into the country-side. This species occurs currently as isolated individuals in fence rows and along forest edges and one round of the farm with a chainsaw should be able to keep it in check. Finally, the only invasive vine on Roxbury Farm is Oriental Bittersweet, a high-climbing woody liana which is quite common in both upland forest plots on the North Farm, and –in smaller densities- was also found in fence rows and in the floodplain forest. Unfortunately, these plants can actually "strangle" trees by inhibiting the horizontal expansion of the tree trunks, out-shade the host trees with their foliage and topple or break the branches of host trees by their sheer weight.

Managing for Native Plant Conservation on Roxbury Farm

Currently valuable habitats: We recommend a *laissez-faire* approach on the swamps and the floodplain forest with the possible exception of some invasive plant control. The wet meadows are valuable as they are, but need continued management (mowing probably every three years or light grazing) to stay wet meadows.

Habitats with a potential for improvement: The proposed reduction in mowing frequency of the wet meadows should result in an enrichment of native species within a few years. Keep an eye on potential invasives! If, after a number of years, the expected suit of native wet meadow plants hasn't established itself, one could consider seeding or planting additional species. Similar to the wet meadows, we have the impression that the old fields near the Kinderhook on the North Farm could be enriched with native plants to create more diverse "wildflower meadows". However, we did not survey the vegetation in these fields during the summer and would recommend a detailed documentation of their floristic composition throughout the growing season before thinking of intensive management to increase the diversity of native flowering plants. The upland forests need time and potentially help with control of invasives in order to develop more diverse native understory communities. There don't seem to be many examples of published attempts to restore native herb communities to secondary forests. But it might be worth researching this issue a bit more, potentially by tapping into the experiences of people who cultivate native medicinal plants in NE forests.

Wild Plants and Agricultural Production

One can conceive of several ways in which wild plants interact positively or negatively with agricultural production. Maybe the most obvious is the direct negative interaction between weeds and cultivated plants. We all know that certain wild plants love to grow in cultivated fields, compete with cultivated plants for light, water, and nutrients, and can have an impact on yield. And you know much better than we do how to keep them at bay. However, we were intrigued by suggestions in the literature about the possibility that certain "weeds" under certain conditions might actually facilitate the growth of the cultivated plants. This is thought to happen either by their ability to access nutrients from deeper soil layers and to transfer them into layers of the soil that are accessible to the crop plants, by repelling certain herbivores from the cultivated plants, and/or by creating a favorable microclimate in the field. We would be curious to hear if your observations on any of this.

Another interesting double-edged sword seems to be the wild plants growing along the field margins or fence rows. As you point out, such un-mowed strips of non-cultivated vegetation can provide shelter/wintering habitat for insect pests (Flea Beetle, Cucumber Beetle?). However, they might also provide food and shelter for beneficial insect predators and pollinators. Obviously, it depends very much on the specific crop-pest-predator situation and the surrounding habitats, whether the beneficial or the negative effect of such un-mowed margins/fence rows takes precedence.

Larger areas of non-cultivated habitat interspersed with or adjacent to the cultivated fields may have an important role in providing nectar and/or pollen to pollinators during times of low pollen availability in the cultivated plants. Early in the season, the spring ephemerals in upland forests (e.g., Violets), riparian forests (e.g., Trout Lily), and swamps (e.g., Skunk Cabbage), as well as early flowering shrubs and trees (e.g., Willows) provide pollen and nectar to bees that will

later pollinate the vegetables. Late in the season, the fall-blooming flowers of the aster family (including goldenrods) provide plentiful food for flower-visiting insects along un-mowed field margins, in old fields, and wet meadows.

Ideas for Enhancement of the Beneficial Effects of Wild Plants

In Europe, there has been experimentation with "wildflower strips", which are 3-10m wide beds sown with a mix of native flowers, interspersed within the crop fields. It has been shown that these sown wildflower strips can increase insect diversity and the density of natural enemies for crop pests. Natural enemies are favored by the presence of a structurally complex vegetation, rich in species and structure, with a long flowering period. However, years of research in Switzerland have gone into developing the right species mix, which should ideally be sown from local seeds. Examples of the quantification of the net effect of these wildflower strips on pests and crop yield are still few.

It might be worth doing small experiments with mini wildflower strips composed of a few different native wildflower mixes. One could follow the insect and bird populations of these different plantings and ask which ones seem to be most useful in promoting beneficials as defined by Roxbury's particular pest control needs. If successful, these wildflower strips could not only provide habitat for natural enemies but also pollen for pollinators and habitat for native plants and their associated insects. If certain flower mixes looked potentially useful, then, eventually, cautious 'scaling-up' could be attempted and monitored.

BIRDS

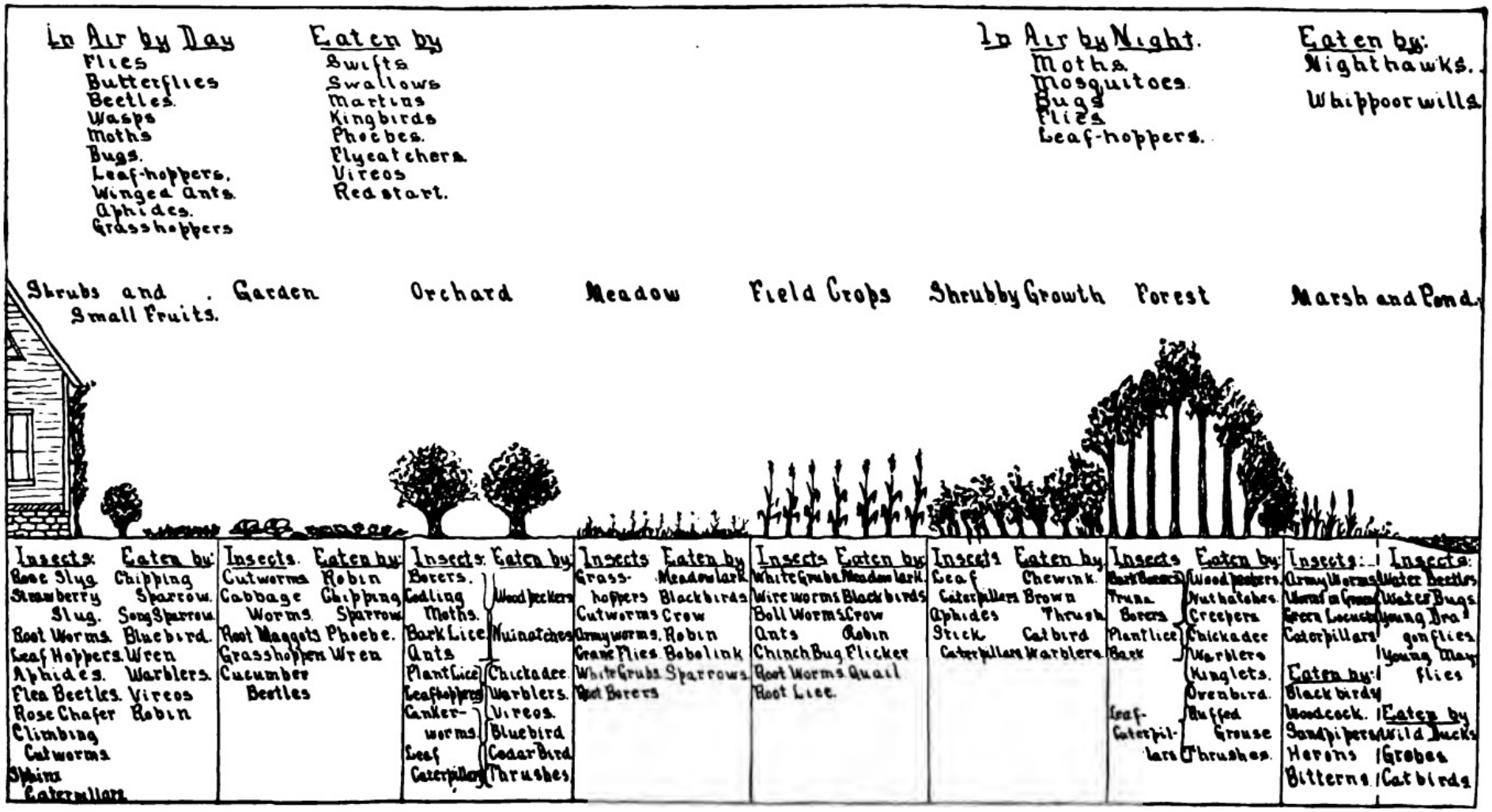
There are at least two perspectives from which to look at the biodiversity of farmland: from a conservation perspective in which farmland is viewed as potential habitat assisting the maintenance of native species; and from an agricultural perspective in which those native species are viewed as potential helpers or potential pests.

In terms of conservation, the key question is, 'Which native species can fulfill all or part of their life histories successfully in farmland and how might the hospitality of that land be enhanced?' From an agricultural perspective, the question is, 'What are the farmer's production goals and how might native species help the farmer achieve those goals?' Obviously, these two questions interact: birds will only be able to control pests, for example, if the habitat encourages their survival, and birds will be more likely to survive if farmers see them as beneficial.

Reflecting this approach, we will tackle two issues. First, we will consider which birds are present (or might likely be present) at Roxbury, which of these are of 'conservation interest', and how such species might be favored. Second, we will look at those same species in terms of their interaction with agriculture and consider how farm management might accentuate the positive.

Farmland Birds & Conservation

Farms are likely to harbor some of the most rapidly declining bird species in North America. These include those species nesting in grasslands or shrublands. Grasslands and shrublands are not uniform habitats. As exemplified in the Figure 1, subtle variations in grassland and shrubland quality can affect which bird species are present.
For example, few area farms, Roxbury included, are without Catbirds, Song Sparrow, and Yellow Warblers. These denizens of brush are often found along forest edges and in hedgerows. The hectic chatter of the Catbird, punctuated by its whining mews is heard much more often than this inconspicuous grey bird is seen. Likewise, Starlings, House Sparrows, Brown-Headed Cowbirds, and Barn Swallows commonly are seen around farms. The first two, which commonly nest on or around buildings, are European imports. The Cowbird is a more westerly bird that made its way east when Europeans opened up great swathes of grassland connecting Midwestern Prairies with the East. The Brown-headed Cowbird is a Cuckoo of sorts, usurping the parental care of other species for the benefit of its own young. The Barn Swallow is a common native building nester. Originally, it probably nested on rocky cliffs and ledges; it is native both to the Americas and to Europe and Africa.



THE RELATIONS OF BIRDS AND INSECTS ON A NEW HAMPSHIRE FARM.

Figure 1. An illustration of the habitat preferences of some farmland birds. From ***Birds in their Relations to Man***, by Weed and Dearborn, 1905.

Other species are adapted to more open land. Our shorebirds, the Killdeer, wend their way across early spring fields. They are one of our most common pasture dwellers. The Savannah Sparrow is also found around open pastures. It is the only grassland sparrow which remains relatively common in the region. We didn't see any at Roxbury, but they were recorded by Hudsonia and by farm workers. They may increase if pasture is expanded. The Vesper Sparrow, told on the wing by white outer tail feathers that are reminiscent of a Juncos', is a rare open ground nester. It reportedly favors cultivated crop fields, although the frequent cultivation may limit nesting success in such areas. We've only seen this species once in the county – in a vegetable garden at Miller's Crossing.

The Red-Winged Blackbird, common at Roxbury, is considered a grassland bird, although its willingness to nest in a variety of conditions, e.g., wet meadows, drier fields, and pond edges, and its tolerance of small habitat patches, makes it relatively common (although its continental populations are also declining). Its wide taste in nesting habitat was apparent at Roxbury, where it was found in the wet fields on the NW corner of the property and along some damp ditches.

Bobolinks are birds of wide-open, mature hayfields. They appear to shun recently planted fields and are found more commonly in diverse, late cut (but not shrubby) hayfields. None were seen at Roxbury, but we know them from several regional farms. We were surprised to find at least one Eastern Meadowlark at Roxbury (it was seen near the mobile home behind the farmhouse). Eastern Meadowlarks have been declining rapidly. They are rarer in our region than Bobolinks, perhaps because they need more area than this species. Meadowlarks are just as sensitive to early cutting as Bobolinks. The tiny Kestrel is a cavity nester that forages over fields for large insects (e.g., grasshoppers) and small vertebrates.

Finally, a smattering of birds forage in fields but nest along the edge. At Roxbury, these included Kingbirds, Robins, Phoebes, and Common Yellow-Throat. Other birds nest at a greater distance from the fields but are regular visitors such as the American Crow and the Flicker.

Our surveys were done during a couple of breeding-season visits, and we surely missed some species. There are at least three groups of species which we did not survey for. These included shore birds which occasionally (especially during migration) favor muddy field edges; owls (we're trying to plan some surveys but aren't there yet), and wintering arctic migrants.

Managing for birds of conservation interest.

From a conservation perspective, the grassland birds, such as the Bobolink and Eastern Meadowlark, are of most interest. These are the species which are apparently decreasing most rapidly at a continental level. Both species need large extents of late-cut, diverse grassland. In the 19th century, when hayfields were widely distributed in the Northeast and cut once starting in July, our area presented ideal habitat. Few farms are able to maintain such habitat today. It may seem strange to discuss grassland preservation in a landscape that did not, historically, contain much grassland. However, as the Great Prairies have dwindles, eastern grasslands have assumed greater importance.

At least with Meadowlarks, our own observations suggest that there may be value in keeping relatively small areas in long, diverse grass within bigger fields. We have found Meadowlarks around grasslands that may have been broadly unsuitable but where pockets of suitable habitat existed. At Roxbury, the best we can recommend is that some relatively long-grass, late cut patches be maintained on the North Farm where such management is practical. Unfortunately, as a ground nesters, Bobolinks and Eastern Meadowlark are particularly susceptible to predation, including that by house cats (specially designed collars have been successfully used to reduce such predation in free-ranging cats). It is unlikely that Meadowlark, Bobolinks or other grassland birds will make use of Roxbury hayfields unless they are cut after the beginning of July. Some farmers have attempted to cut around grassland bird nests, however research by others has suggested that the resulting habitat 'islands' focus predation pressure on these nests.

The Kestrel, a bird found around grasslands, is doing relatively well at the large scale, but has been declining regionally. Nest sites are often considered to be limited, and these birds reportedly readily use properly-constructed nest

boxes (see, for example, http://www.dnr.state.md.us/wildlife/wakestrelboxplan.html). The number of Kestrels at Roxbury might be relatively easily increased using such boxes.

Farmland Birds & Agricultural Objectives.

Birds can be farm pests and farm helpers. Granivorous birds can help control weeds, while others may consume insect or even vertebrate pests. At the same time, certain species may directly damage crops. Bird damage is relatively easy to document and quantify, but beneficial effects are more difficult to assess. How, for example, do we know if bird predation prevented a pest outbreak if that outbreak never becomes apparent? Likewise, how can we evaluate the degree to which winter seed eating by sparrows reduces spring weed populations?

Prior to the widespread use of herbicides and pesticides, substantial effort was expended in understanding the interaction of birds and agriculture. Ontario, Massachusetts, New Hampshire, Pennsylvania, New York, Illinois, and Wisconsin, along with the U.S. national government, produced accounts of "useful" birds. These works compiled data on bird diets and anecdotal evidence of bird influence on insect pests. Today, a web search for "economic ornithology" brings up almost entirely pre-WWII materials. What recent work there is has focused on experimental approaches to measuring avian effects. Such experiments have been done in various ways but the most common approach has been to compare pest densities and, sometimes, pest damage, on crops with and without bird exclusion nets. Less frequently, researchers have augmented local bird populations by manipulating habitat.

The early, anecdotal accounts of birds affecting pests (as summarized in Forbush's book on the "Useful Birds" of Massachusetts) describe both how the arrival of birds sometimes appeared to thwart insect outbreaks and how, conversely, the lack of birds appeared to stimulate such outbreaks. Anecdotes are just that – stories that may or may not indicate effect. However, given the subsequent experimental support for such effects, some of these stories seem worth sharing.

Numerous historical accounts describe how the dreaded arrival of an insect plague upon a crop was, almost miraculously, dispersed by the arrival of birds. Perhaps the most legendary account describes how the crops of early Mormon settlers were saved from the depredations of katydids (so-called "Mormon Crickets") by the surprise arrival of a flock of sea gulls. Likewise, Forbush recounts examples of Warblers, Robins and Cedar Waxwings controlling tent caterpillars in the US and of European birds mitigating outbreaks of forest insects. These accounts leave room for various interpretations, and it is likely that, at least in some cases, much of the apparent effect of the birds was actually caused by some other coincident influence such as food depletion, disease, or climate.

Accounts of the reverse situation (i.e., the absence of birds leading to pest outbreaks) read like morality tales. Take, for example, the Prussian King who destroyed sparrows in order to preserve his precious cherries, only to have the liberated pests destroy his fruits more thoroughly. Or, the Belgian park goers who found sparrows a messy nuisance, had them exterminated, and then watched Gypsy Moths strip the leaves from their park trees. Kalm, a Swede who travelled through the Northeast in the mid 18th century, commented on the plight of colonists after a frequently-sought bounty on Crows and Blackbirds apparently liberated crop pests and caused widespread crop failure.

Early documentation of avian agricultural importance probably helped convince governments to pass important bird conservation laws, the most potent of which outlawed the hunting of song birds. Prior to that time, song birds were often shot and sold in town markets.

There is strong, recent experimental evidence that birds can indeed reduce insect pest populations. While such a result may seem obvious, population regulation is an elusive topic of study. The key question is not, 'Do birds eat insects?', but rather, 'Do birds eat enough insects to reduce insect pest populations in economically-meaningful way?' Researchers covered some crop plants so as to exclude birds (but not the insect pests), while leaving other plants open to bird visits. They then compared pest populations, and sometimes plant damage, on the covered and uncovered plants. In many, although not all, instances birds caused measurable declines in insect populations. Somewhat less frequently, observable declines in plant damage also occurred. Among the invertebrates whose populations appear to be at least

occasionally regulated by bird populations are corn borer, tussock and coddling moths, grasshoppers, other caterpillars, and spiders.

Efforts to enhance bird populations around crops (e.g., by intercropping with sunflowers or erecting nest boxes) has also been shown to enhance bird foraging and deplete pest populations. Similarly, observational work suggests that proximity of natural bird roosts can be an important determinant of bird effects.

All of our song birds feed insects to their young and thus are eager insectivores, at least during the nestling period. Of course, birds feed upon detrimental and beneficial insects, but, given that insect pests likely outnumber predators and at least some of the important predators (e.g., lady bugs) have a level of chemical protection, it is generally assumed that the beneficial effects of insectivorous birds outweigh their negative ones. An ample opus of diet information from the early economic ornithology work can be consulted for individual bird species, if one wants to gauge the likelihood that a particular bird species will control a given pest.

Managing for beneficial birds.

Any remotely reasonable suggestions (and, at this stage, that's likely to be the best we can do) will need to be farm-dependent. The assumptions behind the below suggestions are based mainly on our phone conversation, namely that Flea Beetles, Leaf Hoppers, European Corn Borer, and Cucumber Beetles are your biggest insect problems, while bird damage only appears substantial on nearly-mature sweet corn. Bird predation has not been reported as an effective control of any of these pests with the possible exception of bird predation on corn borers in feed corn. Nonetheless, Leaf Hoppers and Cucumber Beetles are reportedly consumed by some of our common insectivorous birds.

It would be interesting to experiment with nest boxes as a means of cucumber beetle and potentially leaf hopper control. Most of the birds likely to occupy nest boxes are insectivorous, and all feed their nestlings insects. It might even be possible to augment the density of such pest species near boxes and so increase the pest's vulnerability. Attractants could be placed near boxes, and the boxes themselves could be placed in or near the crop fields of interest. It would be relatively simple to test the effectiveness of such measures by sweep netting for pests in crops near or far from such nest boxes while recording nest box occupation visually.

When feeding in or around low crops, most birds appreciate some degree of nearby shelter, even if they don't use it for nesting. This protects them from aerial predation. While expanding hedgerows might be unadvisable due to the refuge they supply to overwintering insect pests, one might consider 'mobile hedgerows', i.e. brush piles placed near crops during the growing season which are then removed after the last harvest. One might even consider spreading leaf mulch beneath as a trap crop of sorts for over-wintering pests. The mulch could be ploughed in or removed once the 'hedgerow' was moved in the autumn. These 'mobile hedgerows' should enhance the presence of birds in large fields; their use could be easily monitored visually, and insect populations in fall-collected mulch could be sampled using a Berlese Funnel.

Finally, some farmers have had success attracting predatory birds to crops by interplanting with super-palatable attractant plants. For example, sunflowers have been used to attract insectivorous birds to vegetable plots where they then spent time foraging for insects amongst the crop plants. The number of birds in the crops and the number and length of in-crop foraging bouts increased substantially (2 to 6 fold) in fields with sunflowers. It would be interesting to repeat this Florida work in the Northeast.

AMPHIBIANS (i.e. frogs and salamanders).

To our knowledge, amphibians do not play a large part in agroecology. Hence most of this section relates to their conservation. However, amphibians are thought to be bio-indicators of environmental quality, which time, in turn, can relate to production issues. The high susceptibility of amphibians to environmental contaminants may be due to their semi-permeable skin coupled with complex metamorphosis during their life cycle. The widely-publicized worldwide

decline in frogs may be due to a variety of increased environmental stresses ranging from habitat loss to climate change to chemical contamination.
Our amphibian work was focused on the four ponds present on the South Farm. Hudsonia investigated the wetland in the extreme SW corner of the property during their work. There are probably also stream amphibians present in the Kinderhook Creek, we plan to assess those during the summer of 2008.

Relative to the other ponds we studied in the County, Roxbury ponds had relatively few amphibian species. In particular, vernal pool amphibians (Wood Frogs or Spotted Salamanders) were not recorded from any of the ponds, and Spring Peepers and Tree Frogs were surprisingly uncommon. Green Frogs and Bull Frogs were the most prevalent species. Hudsonia reported a greater variety of amphibians in their report on fieldwork from 2003 and 2004. In part, this is because they included the swamp at the very SW corner of the property and the wetland on Park property, areas we did not survey. Their surveys suggest that Vernal Pool amphibians and Spring Peeper were present. We may have simply missed some species despite three nighttime visits to listen for adults and a daytime search of pond margins for amphibian eggs. In any case, our results are relative – we don't claim Spring Peepers did not occur at Roxbury, only that they were fewer or less active than those on the other farms we surveyed in a similar fashion during a similar time period.

Green Frogs and Bull Frogs are amongst the most aquatic of our frogs, they spend almost the entire year in or around water bodies. Vernal pool amphibians, Spring Peepers and Tree Frogs, on the other hand, spend much of the non-breeding season in upland forest. Thus, one reason for the relative poverty of Roxbury Farm amphibians may be the lack of suitable adjacent forest. The strongest predicator of amphibian populations in our pond study was what we termed "non-agricultural development", in other words, houses and other buildings plus roads, parking lots and the like. The higher such development, the fewer the amphibians. The close proximity of houses and other structures to the Roxbury ponds may thus have had an effect. We are unsure what the direct cause of this relationship is, but it may reflect contamination or domesticated predators such as house cats. As we shall also see for dragonflies, the presence of fish reduced amphibian abundance, especially when there was little vegetation emerging along the banks. Kelly O'Hearn mentioned frequently seeing Blue Herons foraging at that pond. Certainly, bird predation would also be facilitated by the lack of such shelter. Another possibility is that residues of agro-chemicals such as DDT, Atrazine and Chlorodane, which were reportedly used on the property as late as 1999, are still in the system and continue to affect amphibian populations.

"Vernal Pool Amphibians" are an interesting group worthy of a bit more comment. Strictly speaking, "vernal pools" are seasonal pools, i.e., ones which dry up at the height of summer and then fill with water during autumn, winter and summer. Because of their temporary nature, these pools have no fish and few amphibian predators (such as Bull Frogs and Newts which are year-around pool residents). However, permanent pools that have no fish and/or have ample shoreline vegetation for shelter can sometimes also harbor "vernal pool" amphibians. We found such amphibians in nearly half of the 93 *permanent* ponds we surveyed around the County. Because the adults of these amphibians may only spend one week per year at ponds, they occurred most often at ponds with ample adjacent woodland habitat. Wood Frogs, for example, are known to move up to 3800' from the ponds where they breed. The relative absence of vernal pool amphibians from Roxbury ponds was probably due, in part, to the presence of fish in one or two ponds, plus the relative lack of nearby undisturbed forest patches.

Active wetland restoration or vernal pool creation would likely provide habitats that would eventually attract a wider diversity of amphibians. We would be glad to explore those possibilities with you, however, they are somewhat major undertakings. At this point, the easiest management approach might be *laissez-faire*, allowing the ponds to gather silt and shoreline vegetation naturally. Allowing a wooded strips to grow up between the gravel pit pond and the neighboring woods might assist the dispersal of some species. The relatively high levels of sediment contamination that we found in the ponds prompts concern for water quality and, if you were really curious about the factors affecting amphibian survival, then we would recommend more intensive water testing which included hydrocarbons and common, persistent herbicides and pesticides. If you were planning to irrigate from these ponds, we certain suggest such tests if you haven't already done them.

REPTILES AND MAMMALS

We did not specifically survey for reptiles or mammals, although we plan to do some of this during our up-coming stream corridor work. The Snapping Turtles and Painted Turtles reported by Hudsonia are relatively common on farms. Snapping Turtles like to nest in ploughed fields, and they should be watched for during the nesting season (peaking the first three weeks of June). If animals are observed nesting, then, if feasible, the nest can be flagged to avoid accidental damage prior to hatching. Although be forewarned, most turtle nests are destroyed by predators prior to hatching.

We did find a Wood Turtle shell on the northern farm at Roxbury, in a field not far from the Kinderhook. These are somewhat rare turtles who live along our larger streams. In New York State, they are a species of Special Concern. It is thus exciting to find evidence of their presence at Roxbury. We hope to get a better idea of their abundance during our up-coming stream corridor study. Wounding by agricultural machinery is thought to be a major cause of their current decline. Researchers in Quebec found that 6 of 30 adult Wood Turtles that they followed over a two-year period were killed by farm activity. Given that this species does not even reach sexual maturity for 14-18 years and then only lays 4-12 eggs, the death of just one or two mature adults per year can destroy a population. Based on the Quebec study, we strongly recommend that, if practical, the heights of rotary mowers be set to at least 4" for cutting done within 300m of the Kinderhook before the end of August. Cutting at this height can help avoid wounding Wood Turtles (and reduce wear on mower blades). The Quebec researchers endorsed a 300m buffer (cleared periodically in late autumn) along creeks to help protect Wood Turtle populations, however they recognized the practical difficulties of this suggestion.

Incidental to our above observations was the sighting of Mink and Otter tracks in the floodplain forest along the Kinderhook. While not rare, these are nice species to find and are components of a functioning stream ecosystem. We also began the study of stream fish which we hope to continue during the coming year. Because those results are not directly related to the upland habitats and because we hope to expand on that fish work during the next year, we will not describe our initial findings here.

Table 1. Butterflies observed at Roxbury Farm. Butterflies on our Farmland Butterfly Watch list are indicated in bold..

Roxbury Farm Butterflies

American Lady
American Snout*
Baltimore Checkerspot
Black Swallowtail
Bronze Copper
Cabbage White
Checkered Skipper*
Clouded Sulphur
Common Ringlet
Eastern Comma
Eastern-tailed Blue
Great Spangled Fritillary
Least Skipper
Meadow Fritillary
Monarch
Orange Sulphur
Pearl Crescent
Peck's Skipper
Red Admiral
Silver-spotted Skipper
Spicebush Swallowtail
Tiger Swallowtail
Viceroy

* - observed by Hudsonia

MAINLY INSECTS

As with birds, we can approach invertebrates (i.e., insects and the like) from two perspectives: conservation and agricultural production. Below, we discuss the invertebrates encountered at Roxbury Farm from these two perspectives. Given how little we know about the Farm's insects, our comments are very preliminary, and one of our main focuses is highlighting what might be worth exploring in more depth.

The Conservation of Insects

Sadly, the insect species most in need of conservation in the County are probably unknown. The species which we list here are relatively large and conspicuous; the fate of their more inconspicuous relatives goes unsung.

Butterflies: There have been well-documented declines in certain regional butterfly species. The Regal Fritillary, Grizzled Skipper and Tawny Crescent, for example have disappeared almost entirely from the East Coast. The reasons for these declines are often poorly known, suggesting that there is much we do not understand about butterfly life histories. Many of the conservation issues facing regional butterflies are due to habitat change. Openland species likely expanded dramatically as agriculture spread throughout the Northeast in the 18th and 19th century. The subsequent reduction and/or industrialization of those lands likely contributed to the decline of the Regal Fritillary

mentioned above. Likewise, certain wetland or ridgeline species are threatened by alteration to those habitats.

Habitat specificity amongst butterflies is often at least partially due to the specialized diet of caterpillars. While adult butterflies may nectar at a variety of flowers, the caterpillars are often much more particular and have evolved complex biochemical and even behavioral mechanisms for surmounting and exploiting plant defenses.

Based on our own observations and a review of the literature, we have a created a Farmland Butterfly Watchlist. These are species which are often or potentially found on farms and yet which appear to be declining at least in certain areas. They do not include butterflies that are rare, but which favor habitats rarely found on farms in our area (e.g., dry rocky woods or spruce bogs). Five species from that list were found at Roxbury (see species in bold in Table 1).

Roxbury could potentially harbor at least two ecological groups of butterflies: wetland/riparian species and grassland/edge species. Typical of the first group is the Bronze Copper, which we found along the ditch that cuts N/S through the large fields on the South Farm. Roxbury is the third Columbia County farm where we have found this species, and yet most regional guides describe it as a species which has experienced major declines. Confined to scattered wetlands (it is much less prevalent than its food plant – various species of Dock or *Rumex*), this species may exemplify a butterfly which is threatened by current trends to drain or fill wetlands and which finds a refuge on ecologically-managed farms. "Tidying up the landscape" definitely would not help this species. Baltimore Checkerspot, also found at Roxbury, is not nearly as rare as Bronze Copper and may be experiencing a demographic Renaissance given that the caterpillars are now beginning to include English Plantain in their diets. However, it is generally considered a wetland butterfly, and is apparently declining in certain regions (e.g., New Jersey).

The Black Swallowtail and Meadow Fritillary are field and edge species respectively. Caterpillars of the former feed on members of the carrot family, including Queen Anne's Lace and cultivated crops such as parsley, Dill, Fennel and Celery. While its decline has not been dramatic or extensive, it may be threatened by habitat loss and pesticides and so is worth watching. The Meadow Fritillary is likewise not a particularly rare species at the moment, however it favors meadows and woodland violets, a combination not always maintained in our landscape. It has been observed to decline markedly where development pressures are high. The American Snout, recorded by Hudsonia during their work, is relatively uncommon locally, probably because the range of its food plant, Hackberry, is largely limited to southern and western portions of the County. Neither Hudsonia nor we found Hackberry at Roxberry, and this may have simply been a wide-ranging adult. However, if Hackberry were to be found, it would likely be along the stream corridor, and the possibility that this butterfly is inhabiting that corridor is an additional reason for its preservation.

Relative to the roughly 90 ponds which we studied around Columbia County, Roxbury ponds and their surroundings were relatively poor in butterflies, ranking in the lower third of all ponds in terms of butterfly diversity. In part, this is probably due to the absence of extensive "wet meadow" habitat around these ponds. On other farms, such habitat was associated with increased butterfly diversity. We also found that there was a negative correlation between overall butterfly diversity and pond sediment contamination levels. Researchers in Europe believe that this may reflect an indirect effect in which soil contamination reduces plant health and hence suitability for butterflies. In any case, the sediments of Roxbury ponds were relatively high in heavy metals and other indicators of human contamination (ranking in the bottom 20-30% of all ponds; lead and phosphorus were particularly high), and the butterfly results may reflect the biological consequences. The lead contamination at least may result in part from the past use of lead arsenate as a fungicide on the orchards that were previously nearby. If it hasn't already been done, it might be useful to run some heavy metal tests of soils in the adjacent fields.

Table 2. Dragonflies and Damselflies of Roxbury Farm.
Species in bold are relatively specialized.

DAMSELFLIES

American Rubyspot*
Eastern Forktail
Ebony Jewelwing
Familiar Bluet
Fragile Forktail
Orange Bluet
Sedge Sprite
Skimming Bluet

DRAGONFLIES

Beaver/common Baskettail
Blue Dasher
Common Green Darner
Common Whitetail
Dot-tailed Whiteface
Eastern Amberwing
Eastern Pondhawk
Halloween Pennant
Red Meadowhawk
Shadow Darner
Widow Skimmer

*- Hudsonia observation

Dragonflies: Because their larvae are aquatic, Damselflies and Dragonflies (together called "Odonates") are associated with wetlands and streams. Ponds, lakes and marshes tend to have a different set of odonates than streams and rivers. At Roxbury, most of the information which we have collected so far refers to insects caught around ponds; stream corridor work this coming summer will surely add species to the list. Species indicated in bold on our dragonfly list are ones which we considered to be specialists of a sort, they tended to rarer overall (occurring at less than 10% of the ponds we studied).

Roxbury ponds were below average in dragonfly diversity, located in the lower 50% of all ponds (see Table 2 for list of species found). The strongest predictor of odonate diversity which we found in our study of Columbia County ponds was adjacent pastureland: ponds near pasture tended to have higher diversity. The probable reason for this relationship is the fact that dragonflies and damselflies appear to like a variety of structure around their ponds – they need in-water vegetation so that their larvae can crawl out of the water, and the adults need higher spots for perching. For example, British management recommendations for pond margins describe edges very similar to those found at ponds in lightly grazed pastures. Despite not being grazed, Roxbury margins were relatively diverse except along the more wooded shoreline, and the reason for the relatively low species diversity is not immediately clear. As with amphibians, the presence of fish in ponds also was associated with reduced dragonfly and damselfly diversity in our study. Fish can prey upon the young odonates; at least one of Roxbury's ponds has fish. Our dragonfly surveys were a one-time-only affair, and so some results may simply reflect poor dragonfly flying conditions on the day of the survey.

Tiger Beetles: These are a group of beetles closely related to the Ground Beetles (Carabidae). They are fiercesome predators, stalking open areas for prey. They are often restricted to stream edges. We have not yet conducted any in-depth surveys for these species, however, even during incidental inspections, we found the banks of the Kinderhook at Roxbury to have ample Tiger Beetle populations. Only two species, the Six-Spotted and Hairy-Necked Tiger Beetles have so far been identified, but their abundance suggests we should keep our eyes open for additional, potentially rarer, species.

Insects & Agriculture

Obviously, you know much more than we do about the insect species which have major impacts on your crops. Here, we can only report the few data that we do have, discuss ecological context a little bit, and propose techniques for exploring some of the issues that seem unclear, at least to us.

Aside from the butterfly and dragonfly surveys mentioned above, we also sampled Native Bees and field invertebrates ("invertabrates" are the animals without backbones; aside from insects these include such organisms as snails and spiders). We also took ant and spider samples for more in-depth analyses but are still working through the identification issues with these animals.

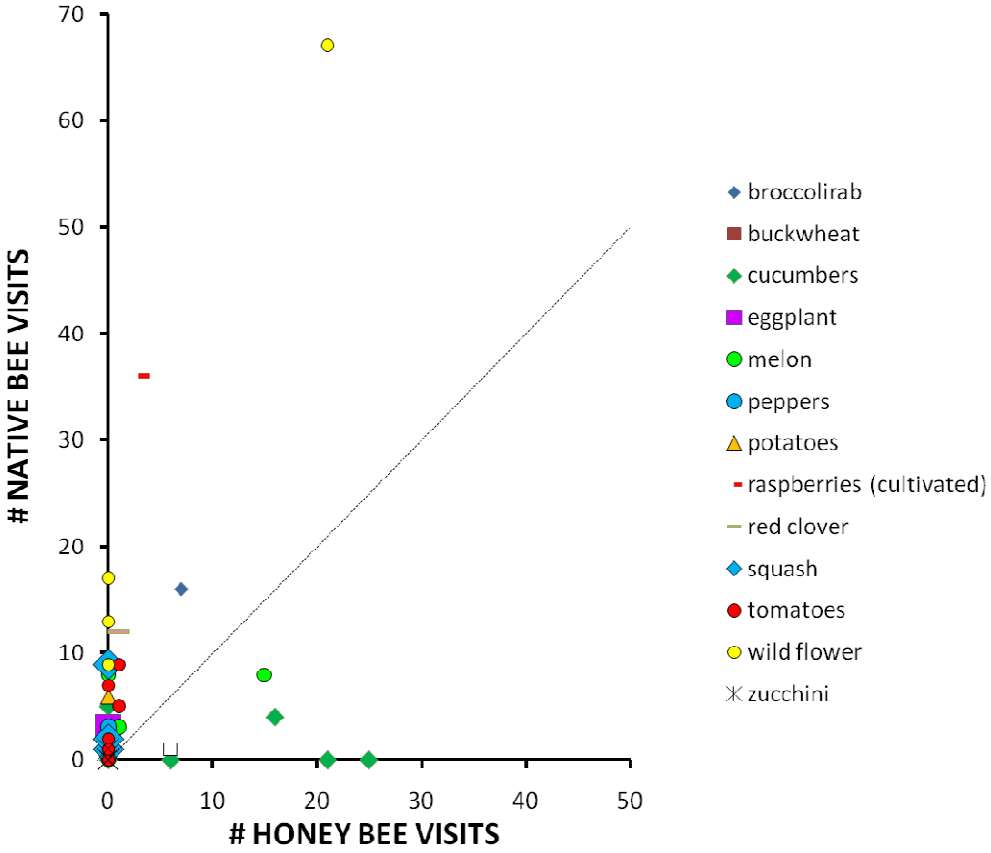


Figure 2. An illustration of the numbers of Honey Bees and native bees observed during 10-minute periods at various crops. In most cases, more native bees than Honey Bees were observed at flowers.

Native Bees: Native bees, while making little or no honey, are able pollinators. Work elsewhere in New Jersey and California has shown that, at least in some cases, they can completely substitute for the European Honey Bees in this task. Our own observations also support the importance of native bees (Figure 2). Recent Honey Bee declines in some regions have raised concern about pollination services. In addition, the pollination techniques of Native Bees sometimes make them much more efficient pollinators. For example, Bumble Bees "buzz pollinate" (a technique in which the bees vibrate their bodies and wings while visiting a flower), and this makes them exceptional tomato pollinators. While tomatoes do not strictly need insect pollinators, research by others has shown that insect pollination can significantly increases fruit set (by up to 500%) and fruit size (by roughly 50%) at least in certain cherry and heirloom tomato varieties. Likewise, it's estimated that 250 native Blue Orchard Bees can pollinate a one-acre orchard, a job that would require at least 15,000 Honey Bees. Finally, it appears that both food and nesting habitats can limit native bee populations, and so appropriate farmland management can help increase those populations. The goal of our work has been to identify the important pollinators amongst the native bees and suggest ways for augmenting their populations.

Native bees include not only the relatively well-known Bumble Bees and Green Sweat Bees, but also a variety of less conspicuous species. There are an estimated 400-450 species of native bees in New York State. While some are generalists and pollinate a variety of flowers, others, such as the Squash Bee (*Peponapis*), are limited to cucurbits.

Table 3. Bees recorded during 10-minute observation periods along crops.

		Average Number of Bees per Observation Period		
Farm	**# of Obs. Periods**	**Honey Bees**	**Native Bees**	**Combined**
Full Belly	5	2.2	12.0	14.2
Hawthorne Valley	7	6.6	4.4	11.0
Little Seed	10	1.6	3.6	5.2
Markristo	4	0.3	4.4	4.7
Miller's Crossing	3	2.0	0.0	2.0
Roxbury	9	4.9	11.8	16.7
Thompson-Finch	2	0.0	5.0	5.0

Martin Holdrege carried much of our work with native bees. He used three different techniques: observations of crops, trapping with bee bowls, and netting off the flower. Each of these techniques supplies a different type of information. For example, direct observation lets us evaluate the number of flower visits being made by native bees vs. by Honey Bees. The bowls provided a standardized relative index of bee abundance and diversity over a 24-hour period, although they were a biased absolute measure because some species (e.g., Honey Bees and Bumble Bees) were rarely caught in the bowls. Finally, netting let

us follow up on our direct observations with the capture of individuals for identification – unfortunately, it is nearly impossible for us to identify most native bee species on the wing; the netting results gave us detailed taxonomic information regarding specifically which bees were found on the flowers of which crops.

While we have quantified few data from other farms, the initial impression was that the bee community was relatively diverse at Roxbury. In total, Martin captured and identified 11 genera and 17 species at Roxbury, while he tallied only 7 genera and 12 species at Hawthorne Valley.

Abundance patterns were less clear. Our visual observations let us compare the number of Honey Bees vs. native bees observed during 10 minute observation periods. Based on *observation* data, Roxbury had the highest total average number of bees of any kind, and the second highest number both of Honey Bees and of native bees (see Table 3). The abundance of bees captured *in bowls* did not follow this pattern (Table 4), and Roxbury was middle-of-the-pack in terms of average number of bees captured per bowl.

Table 4. Number of Bees (Honey Bees and Native Bees) capture in bee bowls placed along crops for approximately 24 hrs.

Farm	# of Bowls Used	# of Bees Caught in Bowls	Bees Caught per Bowl
Roxbury	60	32	0.5
Miller's Crossing	30	21	0.7
Hawthorne Valley	90	56	0.6
Full Belly	15	0	0.0
Markristo	37	6	0.2
Little Seed	45	44	1.0

While these numbers are rough and strict comparisons across farms are difficult because of varying crops and weather, the results suggest that Roxbury had, relatively speaking, a fairly diverse and perhaps abundant bee community last year. We are not yet at a stage where we can explain the variation among farms, and more data are needed. However, Roxbury's practice of maintaining at least some pollen and nectar sources through the growing season can only help. Also, we noted native bees (or possibly wasps) ground nesting in the open soil around the gravel pit pond and elsewhere. Nesting sites are thought to limit some species, and the open ground around the pit may provide important nesting habitat. We hope to do more detailed observations on this during the upcoming field season.

Table 5. The number of invertebrates caught during sweep netting in a hayfield and pasture at Roxbury Farm compared with results from other farms in the County.

		Average Number of Organisms/100 Sweeps				Roxbury Abundance Relative to Other Farms	
		Other Farms		Roxbury			
		Hay (6 farms)	Pasture (7 farms)	Hay	Pasture	Hay	Pasture
Araneae	Spiders	4.9	3.5	0.5	2	-	-
Orthoptera	Grasshoppers	1.1	0.6	2.5	3.5	+	+
	Crickets	0.1	1.1	0	0	-	-
Hemiptera	Assasin Bugs	3.6	1.4	1.5	0	-	-
	Aphids	0.7	2.1	0	0	-	-
	Leafhoppers	11.0	8.6	13	6	+	-
	Other Bugs	19.2	27.0	39.5	6.5	+	-
Coleoptera	Japanese Rose Beetles	1.5	2.5	0.5	0	-	-
	Lady Beetles	2.6	3.6	3	0.5	+	-
	Lady Bug Larvae	3.3	2.1	2.5	0	-	-
	Other Beetles	2.3	4.8	1.5	1.5	-	-
Lepidoptera	Caterpillars	4.3	2.9	2.5	2.5	-	-
Diptera	Flies	10.4	25.6	1.5	5	-	-
Hymenoptera	Wasps	1.4	1.1	1.5	0.5	+	-
	Honey Bees	0.4	1.6	6	0	+	-
	Bumble Bees	0.2	0.6	0.5	0	+	-
	Ants	1.3	2.6	1	0	-	-

Other Invertebrates: Our information on invertebrates other than bees is even more scarce. As part of our work on on-farm grasslands, we surveyed a pasture (SW of the farmhouse) and hayfield (on high land along the north-central margin of the farm). At each location we did a pair of 100-sweep net samplings and inspected a pair of 2ft x 2ft squares on the ground. Organisms were identified to broad taxonomic groups. Tallies of the most common organisms are presented in the Tables 5

and 6. These are ***very*** sketchy numbers, and refer only to the conditions on two Roxbury fields on the one particular day when they were visited, compared to similarly scanty data from other farms.
In terms of the insects caught in the vegetation with a sweep net, the hayfield tended to be diverse relative to the other hayfields studied, while the pasture was relatively depauperate (of course, some of the more abundant organisms were grasshoppers and leafhoppers which you might wish to avoid!). Perhaps the most apparent difference was the relative lack of spiders and perhaps ants on both Roxbury hayfield and pasture. The relative abundance of flies on other farms was, in all likelihood, due to the fact that most other farms had a greater number of cattle and/or spread manure on their fields resulting in more dung flies.

Table 6. The number of invertebrates found during ground searches in a Roxbury Farm hayfield and pasture compared with results from other farms in the County.

		Average Number of Organisms on Ground Surface in 2ft x 2ft area				Roxbury Abundance Relative to Other Farms	
		Other Farms		Roxbury			
		Hay (5 farms)	Pasture (7 farms)	Hay	Pasture	Hay	Pasture
Annelida	Earthworm Castings	11.6	16.4	0.5	1.5	-	-
Mollusca	Snail	0	0.0	0.5	3.5	+	+
Diplopoda	Millipedes	1.3	1.9	0	8	-	+
Araneae	Spiders	1	1.4	0	2	-	+
Hemiptera	True Bugs	1	0.3	0	0	-	-
Coleoptera	Weevils	0	0.1	6	0.5	+	+
	Other Beetles	0.5	0.4	0	0.5	-	+
Hymenoptera	Ants	2.5	2.7	4	2	+	-
	Ant Nests	1.3	3.0	5.5	1	+	-

A dearth of spiders and ants was not so evident in our ground plots as in our sweep nets. Snails seemed consistently more common at Roxbury while earthworms (as reflected by castings) were distinctly rarer. However, earthworms tended to be vary patchy, with three farms having huge numbers of castings (e.g., 11-54 castings per quadrate) while others, Roxbury included, had very few.

These results are patchy and very limited. However, it would be interesting to initiate parallel in-crop studies on a set of regional farms. In these studies, crops would be visited during a series of similar times and assessed for the abundance of invertebrates. Additional techniques (e.g., Malaise, Berlese funnel and/or pit traps) might also be used. These data could provide one with much better inter-crop and inter-farm information and might help farmers better understand how the invertebrate populations of their farms compare to other regional farms experiencing similar weather conditions. This would allow for a more pin-pointed approach to pest control and the encouragement of beneficials plus more detailed inter-farm sharing of information.

Our knowledge of the organic pest management, IPM, agroecology, and ecoagriculture literature is slight. You are probably well aware of information on trap crops, beetle-banks, and other strategies. However, most authors emphasize the individuality of farms and this is supported by our own experiences. This “individuality” means that biological generalities can carry one only so far, and that knowing, for example, the distribution of insect populations in time and space on each farm can be crucial. From this information, more specific tentative invertebrate management plans can be derived, realizing that there will always be an aspect of trial and error. Synthetic herbicides and pesticides are based largely on a ‘one-size fits all’ approach, whereas organic approaches, while certainly benefiting from the sharing of ideas, need to also have an individualized understanding of the given farm. We believe that an inter-farm, cross-crop and cross season study, as outlined in the previous paragraph, might be very useful.

PART 2: THE HABITAT MAP

The habitat map is presented in two sections (Roxbury Farm North, Figure 3 and Roxbury Farm South, Figure 4); the south section overlaps to a large extent with the area mapped by Hudsonia for the Martin Van Buren site and Roxbury Farm in 2004. Our habitat map distinguishes habitat types very similar to those Hudsonia presented in their 2004 report. However, because of the emphasis on the interactions between agricultural production and native biodiversity in this report, we distinguish in our habitat map and in our discussions between the following types of upland meadows: cultivated fields (vegetable field/cover crop), hay meadow, pasture, old field, and upland meadow on mineral soil. We mapped fence rows, and we also added the category of floodplain forest (represented mostly on the North Farm) to reflect the big difference in tree composition and understory vegetation between the seasonally flooded forests along the Kinderhook and the other upland forests on Roxbury Farm. Other habitats found on Roxbury Farm were wet meadow, upland shrub, hardwood and shrub swamp, upland forest, and streams (including sand- and gravel bars and beaches). The areas around the buildings were mapped as developed/cultural and are not considered significant habitat for native plants and animals. (Although if there were flower gardens or patches of old field in these areas, they could conceivably play a role in the larger ecology of the Farm.)

HABITAT TYPES

Cultivated Fields/Cover Crops

Location: This is by far the largest habitat on the South Farm, covering approximately 64% of the area (a total of approx. 83 acres in four large patches). On the North Farm, it covers only approximately 10% of the area (less than 16 acres in three consecutive patches north of the buildings).

Nature Conservation Value: This habitat usually has little value for the conservation of native plants. The wild plants growing in the vegetable fields were composed of common agricultural weeds that thrive in nutrient-rich, frequently disturbed soil, such as Common Chickweed, Amaranth, Lamb's Quarters, Velvetleaf, Common Purslane, and Galinsoga. The beds sown into cover crop were usually densely vegetated by the seeded Red Clover, Buckwheat, or grains, allowed less space than the vegetables for the agricultural weeds to thrive.

Certain native animals do utilize cultivated fields and the agricultural treatment of these areas can 'leak' back into wilder sections of the Farm. A few of our native "grassland" birds will attempt to nest in cultivated areas, these include Killdeer and Vesper Sparrows; the latter is relatively rare and was not seen at Roxbury. However, it was noted in the vegetable fields of another farm in the County. Some turtles will attempt to nest in the loose soil of ploughed fields. It is not uncommon to find a Snapping Turtle lumbering across ploughed land in summer.

Interactions with Agricultural Production: This is obviously the habitat where most intensive agricultural production happens. If weeds are a problem, there are no plant conservation concerns if the weeds get controlled using organic methods.

Many wild animals feed in cultivated areas, either as pests or as beneficials feasting on pests. How cultivated areas are treated can therefore have a major influence on the populations of native species in the surrounding 'wilds'. Pesticides and herbicides are perhaps the most common example of a crop treatment that can have profound effects on wild species; this is probably not an issue at Roxbury although overflow effects from adjacent conventional land may occur and the effects from past pesticide application might still be reflected in the invertebrate community. From an agro-ecological perspective, please see PART 1 for some thoughts on how crops might be manipulated in order to enhance the agricultural benefits of native insect species.

Suggested Management: In general, work of others has suggested that crop diversification provides resources to a greater range of native species including some beneficials such as native bees. Some have found that beetle banks, wildflower strips, floral interplantings and the like have increased on-farm biodiversity in ways that help production. We would hardly recommend such measures without having a much more detailed knowledge of the distribution and dynamics of important pests and beneficial. Please see our discussion of insects in the previous section.

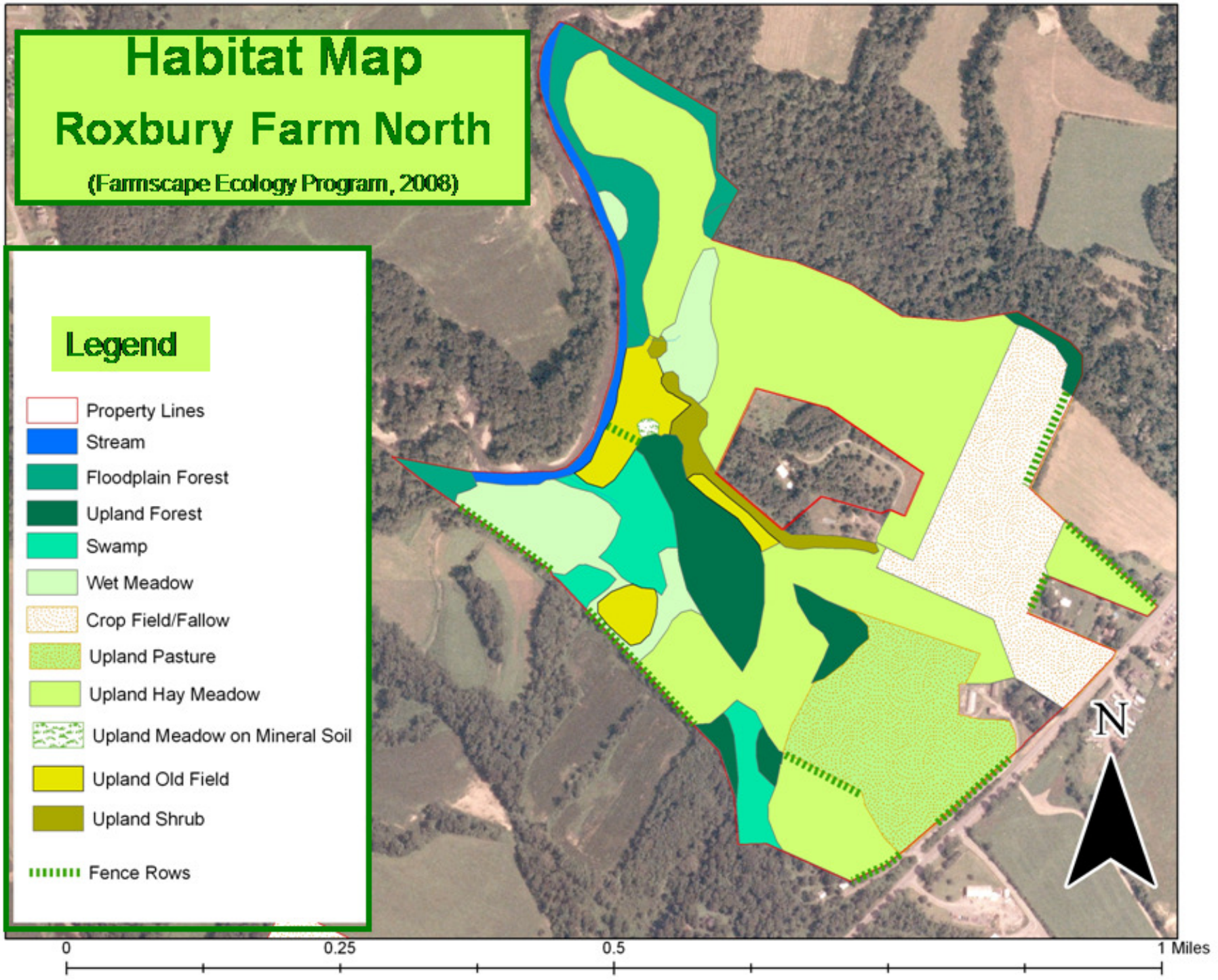


Figure 3. A Habitat Map of the North Farm. Please see text for descriptions of habitats.

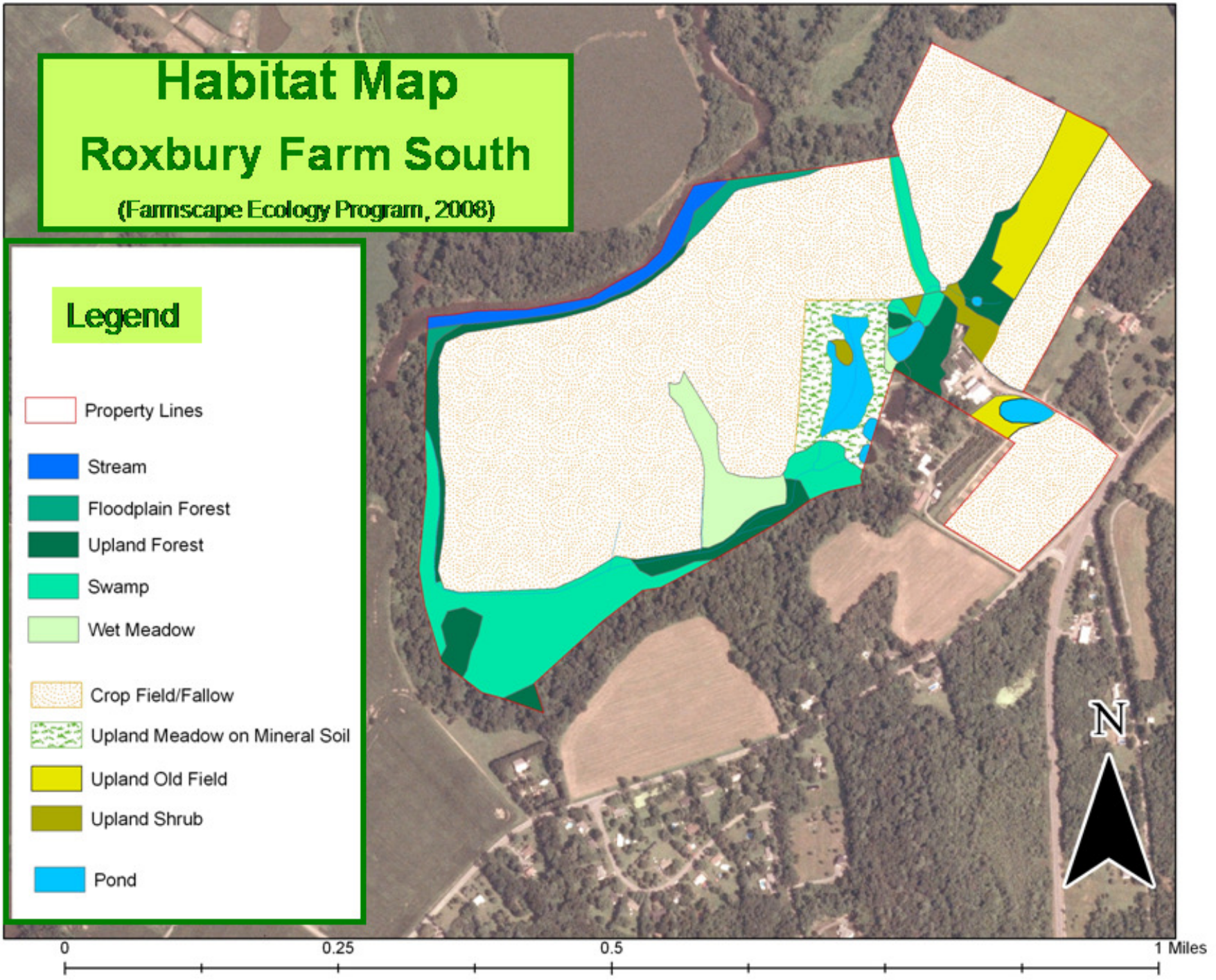


Figure 4. A Habitat Map of the South Farm. Please see text for descriptions of habitats.

Upland Hay Meadows
Location: There are two large (32 acres and 14 acres) and two small (4.5 and 2 acres) upland hay meadows on the North Farm, together covering approximately 1/3 of the area.

Nature Conservation Value: This habitat has little value for the conservation of native plants. Although the hay meadows varied in their plant composition, reflecting differences in soil conditions and management (past use, time and frequency of cutting), they were all composed primarily of introduced meadow grasses, legumes, and a set of other common meadow plants, both introduced and native. The one exception might be the meadow in the north-west corner of North Farm, which occasionally gets flooded, but did not have enough wetland indicator species to call it a wet meadow. The northwestern tip of that meadow was still part of the floodplain forest on the 1948 aerial photo. On the margin of that meadow, we found a regionally-rare sedge species (*Carex trichocarpa*).

While most hayfields have relatively few native plant species, they can still provide important habitat for native wildlife including birds and insects. We noted Eastern Meadowlark on the North Farm; and the Hudsonia report lists Bobolinks (but does not report breeding). Savannah Sparrows were also reported by Hudsonia, they suggested that breeding was occurring. We did not observe this species. Several other birds such as Wood Cock and Kestrels may use hay fields at various times. For birds which nest in hayfields, early (prior to July) hay cutting is a major threat.

No particularly rare butterflies were noted in Roxbury hayfields, although five of our Farmland Watch List were seen in or near hayfields. Two of these species, Black Swallowtail and Meadow Fritillary, are most likely to be found flying in hayfields although only the former might actually lay eggs there.

A Wood Turtle shell was found along the edge of the hayfield in the NW corner of the Farm; this is a New York State species of Special Concern and is declining throughout its range.

Interactions with Agricultural Production:
Hayfields can provide refugia for agricultural pests and beneficials. However, until we have a better understanding of who these species are and of their distribution and dynamics on the Farm, we cannot provide concrete information for tying hayfield management into farm-wide agroecological management.

Suggested Management: Although various techniques have been suggested for making modern haymaking more compatible with grassland bird conservation, we believe that only late mowing (after July 4th if possible) is likely to be effective. Because birds do return to the same or nearby fields each year, and because hayfields evolve over time depending on their cutting regime, we recommend that if only limited late cutting is done, then the same field be late-cut each year rather than considering a rotation of late-cut fields. Eastern Meadowlark and Bobolink nesting is not compatible with the early grazing of pastures, although grazing after a late hay cut does not seem to affect populations. See PART 1 for a bit more on grassland birds.

In the fields along the Western edge of the North Farm, we believe that Wood Turtle conservation should be taken into account. We found the shell of one such turtle along the edge of one of the northernmost hay meadow. There is good evidence that the populations of this rare species can be destroyed by modern haying methods, although they do benefit from the open habitat that farming can create. Based on studies done in Quebec, we recommend that, for hay cutting near the Kinderhook, mower blades be set no lower than 4". Please see the longer discussion in our PART 1 section on reptiles.

Upland Pasture
Location: There is currently one 14 acre patch of fenced pasture west of the buildings on North Farm.

Nature Conservation Value: This habitat has little value for the conservation of native plants.

Roxbury pastures are not currently extensive and we did not observe any wildlife of conservation interest in these fields. They may be foraging areas for many of the same species seen around other parts of the Farm. In our work on other farms around the County, we found that pastures could be home to at least a pair of grassland birds: Savannah and Field Sparrows. We saw neither of these during our work, but the Hudsonia report listed them as sighted. If present, we doubt that they were common during the summer of 2007.

Interactions with Agricultural Production:
Grazing regime determines the vegetation. Generally, intensive rotational grazing should maintain plant diversity, because the animals are forced to eat indiscriminantly and then the plants are given adequate time to regenerate before they are grazed again. Ideally, the pasture will not degrade through an increase in unpalatable and undesired species. Extensive grazing, on the other hand, allows the animals to select their preferred species, biting them off repeatedly before they have regenerated sufficiently, while avoiding the undesired species. Through this selection against the preferred and for the undesired species the pasture will degrade over time. Maintaining a certain plant diversity in a pasture is considered beneficial for the health and weight gain of the animals. A diverse plant community can dynamically respond to variations in climate, ensuring adequate quality of feed. Plant species differ also in their quality, reflected by differences in ratios of nutriens (e.g., carbohydrate/protein ratio), amounts of micro-nutrients, and presence of secondary plant compounds. A diverse pasture allows the grazing animal to pick and choose the plants it might need to maintain or restore balance in its digestive system. Some researchers even speak of the possibility of self-medication in domestic animals, e.g. the increased consumption of tannin-rich plants to counteract intestinal parasites.

As with hayfields, pastures might serve as refugia of some sort for agricultural pests and beneficial, however we don't yet know enough to describe these patterns.

Suggested Management: The grassland birds cited above appear to be able to survive around rotationally or lightly grazed pasture, but seemed to be absent from the most heavily grazed pastures we observed. If Roxbury plans to expand grazing, we would (for a variety of probably obvious reasons) recommend rotational grazing.

Upland Old Field
Location: The South Farm has currently a 4 acre patch of upland old field located on a slope between the two northern cultivated fields. The North Farm has four upland old fields ranging in size between approx. ½ acre to 2 acres. Two of them border Kinderhook Creek, one lies south of the wooded hill and the smallest one borders the wooded hill in a narrow strip along its north side.

Nature Conservation Value: These old fields are dominated by common native plant species, such as goldenrods and asters, but also support common introduced meadow plants such as Queen Ann's Lace, and in the wetter spots, the invasive Purple Loosestrife and Reed Canary Grass.

For wildlife, these fields tend to provide many of the benefits that one seeks in more heavily utilized grasslands but without the risk of agricultural interruption. The abundance of wildflowers can provide important nectaring sites for bees and butterflies, especially late in the season. These patches probably also provide egg-laying sites for some of our grassland butterflies. They are likely prime habitat for other insects as well. For example, we often see Praying Mantis egg cases in old fields. The old field patches at Roxbury may have been too small to support the nesting of many birds. If shrubs were to begin invading these areas, certain shrubby grassland species, such as Brown Thrashers and Field Sparrows might be expected to nest there, but others would disappear.

Interactions with Agricultural Production: Upland old fields are probably not a great repository for crop field weeds, because plants tend to be perennials that don't do well in regularly disturbed soil.

These would likely be focal habitats for any study of the on-farm distribution and dynamics of insect pests and beneficial. Given their diversity of structure and vegetation, coupled with the ample primary productivity coming from the lack of a tree canopy, these can be rich areas for insects. Late-season wild flowers may be important pollen and

nectar sources for bees. Some of this value may be lost as old fields succeed into shrubland and then forest. If these areas were found to play a valuable road in farm agroecology, then rotational cutting might be required.

Suggested Management: If this habitat type were deemed important enough overall, then it could be maintained by brush-hogging every three years in order to arrest the natural succession. If the old fields were left to themselves, over time they would turn into shrub lands and eventually upland forest, which are both of value for different sets of animals. The most management intensive and possibly most beneficial in terms of native plant conservation, might be the option to attempt their enrichment with additional native species. However, as already mentioned in the plant section, we do not recommend any expensive measures without a more detailed baseline study of their current floristic composition. In any case, we believe these areas should be maintained until their role in the overall agroecology of the farm landscape is better understood.

Upland Meadow on Mineral Soil

Location: A 4-acre patch of upland meadow has developed around the gravel pit on the South Farm and a very small patch (<.5 acres) of a similar meadow on mineral soil is found on the North Farm just west of the wooded hill. We are unclear about the history of the latter patch, but it looks as if the area has been denuded of top soil, maybe in the process of building or improving the farm roads.

Nature Conservation Value: Although these upland meadows on mineral soil give the impression that the land has been hurt and is trying to heal (which in fact is true), they are interesting botanical habitats for that very reason. The topsoil has been removed, many of the common plants of hayfields and pastures have a hard time growing in these sterile conditions and that leaves space for rarer plants, mosses, and lichens, which would not be able to compete successfully with the more common plants at sites with more favorable conditions. On the mineral soil near the "Gravel Pond", we found the regionally-rare Whorled Milkwort and another uncommon plant (most likely a Frostweed).

The relatively open ground and light management of these areas make them suitable for ground-nesting insects (such as some of our native bees). We also observed a turtle nest in this habitat. Other researchers in the Northeast have emphasized the importance of bare-ground areas for turtle nesting (for a lovely account of the life history of many of our turtles, see "Year of the Turtle"). The asters, goldenrods, Joe-Pye-Weed and other native wildflowers that grow in abundance around the gravel pit might be important for insects. As with old fields, the resident insects of this habitat should be explored in detail.

Interactions with Agricultural Production: There is currently no direct use of these sites for agricultural production. The patch on the South Farm is adjacent to cultivated fields but the nature of its vegetation makes it an unlikely source for troublesome field weeds. The patch on the North Farm is so distant from the cultivated fields, that a direct impact of any of the species utilizing this patch on the agricultural production is hard to imagine. Without collecting more detailed information on the insect populations, we can't know what role, if any, this habitat plays in agroecology.

Suggested Management: If possible, we recommend a "laissez-fair" approach to the management of these patches because of their unique flora and the potential habitats they provide for insects and some wildlife.

Upland Shrubland

Location: There is a marked lack of this habitat type on both parts of Roxbury Farm. On the South Farm, a small upland shrubland has developed "from scratch" on the peninsula of the gravel pond and a somewhat larger shrubland is currently found south of the farm road leading down to the fields. On the North Farm, a narrow shrubland strip (of approx. 2 acres) borders the farm road south of the "enclave". Narrow strips of shrubland also occur along fence rows, but this habitat feature is described separately below.

Nature Conservation Value: In our current agricultural landscape, shrublands tend to develop on marginal soils (thin topsoil, rocky, excessively drained, nutrient-poor). For the same reason mentioned in the section on upland meadows on mineral soil, interesting native plants are sometimes found in shrublands. The common meadow plants don't

compete well on the shallow soils and give certain rarer plants (native and introduced) a chance to get a foothold. However, we did not find any plants of conservation interest in the shrublands on Roxbury Farm.

Due to the limited extent of this habitat, we have no direct information on its value as wildlife habitat. Shrubland habitat in general provides food and nesting resources for many birds. Rabbits often seek "thickets" for both food and shelter. One of the only regional mammals being considered for Endangered Species status is actually a rabbit – the New England Cottontail. It has been almost entirely supplanted in our region by the Eastern Cottontail. However, the small patch size and temporary nature of these shrublands (wetland-associated shrublands tend to be more long-lasting) make them unlikely habitat for New England Cottontails.

Interactions with Agricultural Production:
While they surely play a role in the Farm's ecology, this habitat may be too limited to have any major effects on either native species conservation or agroecology.

Suggested Management: At this point, in part due to its small extent, we have no particular management recommendations.

Fence Rows
Location: We define a fence row as a narrow strip of woody vegetation separating two upland meadows (such as crop fields, hay meadows, or pastures) marking a former or extant fence line, stone wall or drainage ditch. The woody vegetation may consist mostly of shrubs, with only an occasional tree interspersed, or it might be a continuous row of trees, accompanied by shrubby vegetation. Few fence rows are left on the South Farm compared to 60 years ago, when the first aerial photos were taken. The situation was more dynamic on the North Farm. While several fence rows visible on the 1948 aerial photos have disappeared, new fencerows have grown between formerly undivided fields. Most of the extant fence rows on the North Farm are located along the farm perimeter, but one fence row extends along the southern edge of the sheep pasture, separating it from a hay meadow, and a very rudimentary fence row, probably marking an old drainage ditch, leads west from the forested hill to Kinderhook Creek, separating two old fields. Two linear swamps (along the active drainage ditch on the North Farm and the N-S-ditch on the South Farm) may also function like fence rows.

Nature Conservation Value: There is much talk in the literature about the importance of hedgerows in the agricultural landscape. We have come to believe that their role as forest remnants is probably more important in England and in the more intensively farmed regions of this continent than in our currently quite well-forested Columbia County. In fact, fence rows are a double-edged sword for conservation: they divide meadows and might reduce the effective size of open land beyond the thresholds tolerated by sensitive grassland breeding birds. On the other hand, they can provide habitat to native plants, provide nesting and perching sites for insect-eating birds, and berries for migrating songbirds, and may also be utilized as traveling corridors by forest-interior mammals hesitant to venture out into open fields. The latter benefit is generally no different from that provided by forest edges.

Interactions with Agricultural Production: Fence rows tend to harbor less of the bothersome field weeds, if they have been long established or are remnants of the original forest vegetation. Recently planted windbreaks in Canada had less interesting native plants and more weeds.

The most important ecological role for fence rows is probably as extensions of protective cover into agricultural habitats. Insects, birds and small mammals may find temporary or long-term shelter in hedgerows. From this shelter, they can range out into the surrounding cropland. When these animals are pests, the hedgerow is a headache for the farmer; when the animals are pest predators, the hedgerow may be welcomed by the grower.

Suggested Management: Based on our observations and conversations with you, it seems that the birds who would use hedgerows would often be beneficial (except near corn; see discussion in PART 1); the same may not be true of insects or mammals. We believe it would be interesting (although perhaps not practical) to experiment with temporary hedgerows which would provide shelter for birds during the growing season but could then be moved prior to the next

season so that the underlying ground could be turned, thereby destroying the pest populations that had come to over-winter.

Upland Forest

Location: The largest upland forest (6.5 acres) with a canopy of Oaks, White Pine and Maples is found on a hill at the center of North Farm. Just east of this hill is a smaller forest (1.5 acres) with a low canopy dominated by Scotch or Red Pine and Staghorn Sumach, which covers a slope and is currently fenced in as pig pasture, and just south of that, small upland forest patches borders a small swamp. Only small patches (the largest is approximately 3.5 acres, the smallest less than .5 acres) of this habitat type are found on South Farm. Upland hardwood forest surrounds the ponds on either side of the farm road leading down to the fields, occurs on some "islands" within the "Southern Swamp", and along the western and north-western perimeter of South Farm.

Nature Conservation Value: In our somewhat cursory look at the upland forests on Roxbury Farm, the only interesting botanical find was Red Trillium in the forest around the "Old Lower Pond". Most of the upland forest patches at Roxbury Farm are small, isolated from other forests, and were largely non-existent in 1948. These factors may explain their poor understory plant community and their high density of invasive woody plants, such as Oriental Bittersweet and Honeysuckle, Japanese Barberry. In spite of the fact that these forests are clearly no pristine woodlands, they add structural diversity to the farm landscape and are likely much appreciated by fauna. In contrast, the upland forest along "Muddy Creek" along the western perimeter of South Farm and in the "Southern Swamp" never seems to have been completely cleared and has a potential to harbor interesting ground flora. Hudsonia reports a regionally-rare sedge (*Carex squarrosa*) from the forest near "Muddy Creek", which we did not field check at all.

Small, isolated patches of upland forest are unlikely, in our largely forested landscape, to harbor unique wildlife. Such patches may, of course, be occasionally used by larger carnivores of some conservation interest (e.g., Bobcat and possibly Fisher). The fact that Wood Thrush and Scarlet Tananger were recorded from adjacent forestland by both us and Husdonia suggests these forests provide at least some habitat for forest birds. It seems unlikely that rare forest birds regularly breed in Roxbury upland forests given its relatively recent origin and small patch size. The Canada Warbler mentioned in the Hudsonia report is unlikely to indicate a regular breeding population.

Interactions with Agricultural Production: Forest patches may provide habitat for birds that forage for insects over agricultural habitats. Flickers (which tend to nest in trees along edges) and Tree Swallows, for example, nest in trees but forage for insects on or above openland at least part of the year.

Forestland may be a mixed bag in terms of mammals: foxes and weasels, who would likely prey upon rodent pests, probably appreciate forest retreats. On the other hand, if one is considering to begin lamb production, then the potential for coyote predation might be worth considering. However, given the large home range of coyotes, the management of forests on Roxbury farm property is probably largely irrelevant. Likewise deer, who might forage on Roxbury crops, can easily enter from off-property.

Suggested Management: Invasive plants are quite prominent in some of the forest patches and one might try to do something to avoid their further increase. Oriental Bittersweet, in particular, can expand to the point at which it damages trees. The quality of forest patches as native plant habitat might be improved by the planting of forest herbs, although this intensive work.

Both the Flicker and Tree Swallow mentioned above are examples of cavity nesters. This doesn't mean that individual trees should not be cut for firewood or timber, but these species demonstrate the value of leaving standing deadwood. Extensive logging or removal of timber would reduce nest site availability for these and other cavity nesting birds.

Floodplain Forest

Location: The biggest patch of floodplain forest (6.5 acres) is on the North Farm, covering about half the length of the shoreline of Kinderhook Creek with an approx. 50 m wide band and then looping around the northern edge of the

northernmost hay meadow. Roxbury Farm has two additional, smaller patches of floodplain forest, which are contiguous with more of the same habitat type beyond the boundary line.

Nature Conservation Value: For native plant and wildlife conservation, this is probably one of the most valuable habitats on Roxbury Farm. Several tree species, such as Sycamore, Silver Maple, and Boxelder are unique to this habitat. Floodplain forest had the highest number of plant species of conservation interest of all habitats on the Farm and a number of rare or uncommon species were found exclusively in this habitat. They include Dutchman's Breeches, Bloodroot, Meadow Lily, Spring Beauty, False Mermaid Weed, Virginia Waterleaf, Wild Leek, Wild Onion, Cardinal Flower, Giant Ragweed, Toothed Woodfern, and Moonseed. Noteworthy are also the extensive stands of the regionally-rare Ostrich Fern. We hope that our upcoming research on stream corridors will help us better understand what the presence of these species tells in terms of the quality of this habitat, but our gut-feeling is that these species are indicators of relatively intact floodplain forests. Otherwise, the vegetation in the floodplain forest at Roxbury Farm is composed of a diverse mix of common native (including trout lily, yellow and spotted jewelweed) and introduced plant species. Although invasive species, such as garlic mustard and field garlic, are part of this community, the native plants seem to be holding their ground throughout most of the alluvial forest. An exception is the northernmost part of the alluvial forest, where notorious invasive species of floodplain forests, such as Japanese knotweed, multiflora rose, and privet, are quite common.

A suite of insects, such as tiger beetles and certain dragonflies, depend upon the integrity of this habitat. Likewise, animals such as Mink and Otter probably use such regions as part of the larger wanderings. While no area birds appear to be restricted to floodplain forest, reports from New Hampshire suggest that certain forest-dwelling species such as Warbling Vireo, Brown Creeper, and Rose-Breasted Grosbeak are most common in this habitat.

Interactions with Agricultural Production: Floodplain forests can help buffer the interaction of stream and farm. By intercepting materials draining from the farm, they can help maintain stream water quality. By buffering the momentum of floods, they can help reduce erosion that might infringe on cropland.

Floodplain forests often have a flush of spring flowers. These can be important early-season energy sources for pollinators. Awakening Bumble Bee queens reportedly benefit from the early flush of Trout Lilies that commonly occur in these areas. With their hodgepodge of standing dead wood, they can also provide home for cavity nesting birds. The degree to which these habitats are a repository for insects that subsequently enter agricultural habitats is unknown to us at this time.

Suggested Management: There are relatively few intact patches of floodplain forest in Columbia County, and we believe management should focus on maintaining those stretches that do exist. While active floodplain forest management may not be practical or even necessary, certain actions could help maintain these areas and might reduce certain problems on agricultural lands as well. Namely, keeping deer populations low would benefit both the native floodplain forest herbs and crops, and controlling invasives in these forests could reduce certain weed problems on farmland (e.g., Multiflora Rose invasion).

Hardwood & Shrub Swamp

Location: A large hardwood swamp (approx. 8 acres) is the "South Swamp" along the southern edge of South Farm. A smaller swamp extends along the N-S ditch and along the shore of one of the ponds on South Farm. The North Farm has a 4.5 acre shrub swamp south-west of the wooded hill and a smaller hardwood swamp flanked by upland forest southwest of the sheep pasture.

Nature Conservation Value: Swamps are wetland areas where the natural succession of the vegetation has progressed further than in wet meadows. Woody plants dominate this habitat type and less sunlight reaches the ground, resulting in typically less dense and diverse herbaceous flora than in nearby wet meadows. Unfortunately, we only realized after the 2007 field season, that the swamp along the southern boundary of South Farm actually belongs partly to Roxbury Farm. This "South Swamp", as Hudsonia called it in their 2004 report, is certainly the most interesting swamp on Roxbury Farm, because it has been a swamp forest for a long time (it is visible in the 1948 aerial photos) and might

never have been completely cleared or drained (although it is dissected by active and abandoned man-made ditches). Hudsonia researchers found two plants of conservation interest, Gray's Sedge and Winterberry, in the "South Swamp". A winter visit to that swamp revealed a structurally diverse forest with a potential to house additional, yet undiscovered, botanical treasures. The swamp along the N-S ditch on South Farm has also been in place since before 1948, but we did not find any plants of conservation interest, unless the Highbush Cranberry we saw in the winter, turns out to be the native variety and not an escaped cultivar, which we assume as more likely. The swamps on North Farm had completely been cleared in 1948, and had a considerable component of invasive shrubs (Multiflora Rose, Privet, and Honeysuckle). The only plant of conservation interest we found there was Turtlehead. Otherwise, the herbaceous vegetation included relatively common native wetland species, such as Skunk Cabbage, Wild Geranium, Early Meadow-rue, Spotted Joe-Pye Weed, and Purplestem Angelica.

Unfortunately, we didn't realize that the "South Swamp" was on farm property early enough to conduct wildlife studies there during the 2007 field season. Judging by the Hudsonia report and the general regional role of swamps, this area probably harbors some less common species, including, perhaps rare dragonflies and potentially even salamanders.

Interactions with Agricultural Production: Skunk Cabbage, which is common in the swamps of Roxbury Farm, is an early pollen provider for bees. As with other wooded habitats around the Farm, swamps probably provide habitat for species that occasionally make forays onto agricultural land, however, we have no reason to single out this habitat as unusual in that regard.

Suggested Management: From an ecological perspective, the swamps are best left alone. Wetlands in our area are suffering a constant drain (no pun intended) as they are converted to dug ponds or drained for other uses. While inconspicuous and hard to appreciate, these habitats can be important in the overall ecology of the landscape.

Wet Meadow

Location: There are two larger (3 and 6.5 acres) and two smaller (~ .5 acres) wet meadows on the North Farm and one larger (3 acres) wet meadow on South Farm. Narrow strips of wet meadow are also found along the shoreline of some of the ponds on Roxbury Farm, but we discuss those in the section on ponds.

Nature Conservation Value: The wet meadows are habitat for a large set of native wetland plants, mostly grasses and sedges, which don't occur anywhere else on the farm. For example, the wet meadow in the southwest corner of North Farm had clumps of Big Bluestem and Switchgrass. Some of the sedges are hosts to rare wetland butterflies.
The two wet meadows we studied in some detail (one on South Farm and the one in the former cornfield in the northern part of North Farm) were islands of comparatively high plant diversity within the landscape dominated by intensively managed crop fields and upland hay meadows, because they supported a number of native wetland plants that do not grow in well-drained fields, as well as common meadow plants. Although we did not find any threatened, vulnerable or regionally-rare plants (as determined by Hudsonia's 2001 list) in the wet meadows, there were several native plants that we found exclusively in wet meadows and not in other habitats on Roxbury farm, including Allegheny Monkey-Flower, Ditch Stonecrop, Bristly Crowfoot (which is considered regionally-rare in the 2004 Hudsonia report), Arrow-leaved Tearthumb, Rice Cutgrass, a variety of rush and sedge species, as well as several smartweed species. Wet meadows, which are mowed every 2-3 years, can also develop a rich and diverse set of flowers (including Joe-Pye-Weed, Bonset, asters, goldenrods) which provide pollen and nectar for insects in late summer and fall. The wet meadows on North Farm had quite a bit of the invasive Purple Loosestrife, which is an excellent pollen and nectar plant for bees and many other insects.

During a winter visit to the wet meadow along the Kinderhook in the south-west corner of North Farm, we found some big clumps of two native grasses, Big Bluestem and Switchgrass, that we have not documented from another farm in Columbia County, yet. This might be an indication that this particular meadow might warrant a mid summer plant survey, as it is not as wet as the other wet meadows and might be home to additional interesting native plants.

We found Bronze Coppers, a regionally-rare butterfly, in one Roxbury wet meadow. Baltimore Checkerspot, a somewhat more common wetland species, was also encountered. Several other regionally-rare butterflies depend on

food plants of wet meadows and might have been overlooked in our cursory survey at Roxbury Farm. In our study of ponds, we found that adjacent wet meadow was an important positive influence on plant and insect diversity. Historically, much of this habitat probably derived from old beaver meadows, and a suite of regional insects are adapted to it. Amongst the vertebrates, the Leopard Frog seems to be largely restricted to such habitats in our area, although none were heard or seen at Roxbury. Given that beaver

A few birds, such as Red-Winged Blackbirds, may nest in wet meadows if the vegetation is allowed to grow up. Likewise, as in old fields, a variety of insects may occur here, including Preying Mantis. In the southern portion of the County, the federally-endangered Bog Turtle sometimes occurs in wet meadows, but this turtle is unknown in the northern part of the County and occurs in a different form of wet meadow. However, in wet meadows at Hawthorne Valley, we have found Spotted Turtle and Ribbon Snake, both of which are regionally-rare animals.

Interactions with Agricultural Production: Historically, periodically-flooded wet meadows apparently played an important role in colonial agricultural. Prior to extensive green manuring or crop rotation, the hay of wet meadows was one of the few naturally-replenished sources of farm nutrients. Indeed, some towns were laid out such that each farmer received a portion of wet meadow, even if it were not adjacent to the home farm.

Wet meadows are rich places for insects, and it might be interesting to evaluate in more detail their role as shelter and food source for insect pests and beneficials. As with any source of wildflowers, they can provide important food sources for pollinators, especially outside of peak flowering times.

Suggested Management: The wet meadows on RoxburyFarm are probably still recovering from intensive agricultural use in the past. Although they currently don't seem to have many plants of conservation interest, they support a unique flora which adds to the overall plant diversity of Roxbury Farm. We would strongly recommend not draining additional areas. In the long term, you may even consider increasing wet meadow area by not maintaining drainage systems draining surrounding areas. Wet meadows need active management for their maintenance! They need to be mowed or grazed often enough to avoid succession into woody swamp. A rule-of-thumb might be mowing in a 3-year cycle. We expect that such a mowing schedule will lead to an increase in the number and density of native wet meadow plants. Down the road, seeding or planting of additional species might be considered, if needed. You should watch for for invasive plants such as Common Reed, Reed Canary Grass, and Purple Loosestrife, who also might benefit from less frequent mowing.

Where streamside erosion may be an issue, wet meadows can be left to succeed back into floodplain forest, an important ecological habitat in its own right and one that might help stabilize the ground. Unfortunately, given our current bonanza of invasive plants, such a natural succession is often 'tripped up' by the arrival of invasives such as Multiflora Rose, Japanese Barberry, Honeysuckle and Japanese Knotweed. Management to specifically discourage invasives but encourage native woody plants might be ecologically appropriate but time consuming. However, if one scouted the fields in the fall of each year with a set of clippers, then most woody invasives could probably be kept under control.

Streams

Location: Kinderhook Creek forms the western border of North Farm and part of the western border of South Farm. A small stream drains the swamp south of the wooded hill on the North Farm into the Kinderhook and two small streams drain South Farm into the Kinderhook. One flows in the N-S ditch and the one drains the ponds and flows along the southern and western perimeter, where it has been called "Muddy Creek".

The nature conservation values and agricultural interactions of streams are likely complex. Understanding these interactions will be part of our work during the up-coming field season, and we will wait until we know before adding details about this habitat.

Suggested Management: At this point, it seems safe to recommend, as we have done above, the protection of the existing floodplain forests. Furthermore, the streams will benefit from a continuation of agricultural practices that avoid surface runoff and nutrient leaching.

Ponds

Location: The four ponds are all clustered in a small area around the farm buildings on South Farm. All are likely man-made, the "Upper Pond" seems to be fed by a trickle of water coming out of a small swamp on the MVB site. The smallest pond ("Small Pond") in the forest north of the farm road is fed by a seep and then drains into the "Old Lower Pond", which drains into the "Gravel Pond", which drains into "South Swamp".

Nature Conservation Value: "Gravel Pond" had clear water, the richest aquatic plant community, interesting plants on the mineral soils surrounding the pond and turtle nests on the shore, but it was also the only pond where we documented the invasive Water Chestnut. "Upper Pond" had a dense duckweed carpet, probably indicative of some nutrient enrichment. We also found one individual of the regionally-rare Great Solomon's Seal at its shore and it was the only place on the farm where we saw the otherwise not uncommon Swamp Milkweed. The other two ponds were unremarkable in terms of plant diversity.

Ponds obviously provide a unique habitat for certain organisms of the Farm. Aside from being home to aquatic organisms, they provide convenient 'watering holes' for terrestrial animals. In terms of biodiversity, ponds in and of themselves harbor few unique species. Indeed, permanent but small ponds were probably not important components of our landscape prior to European settlement. Ponds naturally begin to fill in relatively quickly, thus they are naturally less common than shallower wetlands. Most of the rare aquatic organisms found around small waterbodies in our area are actually adapted to vernal pools, wet meadows or swamps. That said, ponds can sometimes replicate certain conditions of these shallower waters and, when they do so, species of conservation interest may appear. Please see our discussion of Vernal Pool Amphibians.

Interactions with Agricultural Production: Most of the ponds dug in the County prior to the last two decades (when landscaping ponds came into fashion) were for agricultural purposes: watering holes for animals, irrigation ponds for crops. You can judge the potential importance of Roxbury ponds in that regard. Given the relatively high pond sediment contamination levels, we would suggest water testing for hydrocarbons, heavy metals, and agro-chemicals at least in the ponds regularly used for irrigation. Hopefully, those tests will confirm that the contaminants are safely trapped in the sediments and the water itself is fine for irrigation.

Suggested Management: Because the ponds are at least somewhat valuable for local amphibians and other animals, we would not recommend the destruction of the existing ponds. Where possible, we encourage reforestation around existing ponds. While this seems impractical at the upper pond near the farm office, letting the margins of the lower ponds reforest at least in part (see discussion of Upland Meadow on Mineral Soil above), might improve habitat for some of the amphibians using the ponds. It might also buffer the ponds from agricultural run-off. We discourage stocking with fish because of the impact fish predators can have on other organisms.

SUMMARY OF MANAGEMENT IDEAS

At various points in this document, we have made certain management suggestions. We realize that some are not practical, some are probably wrong, but some may be useful. We finish this document by briefly listing some of those management ideas; more detail can be found in the preceding text.

- Explore the landscape distribution and seasonal dynamics of invertebrate pests and predators on the Farm, highlighting those areas that are most important for determining the balance between these two groups.
- Protect floodplain forest and swamps for their nature conservation value.
- Consider control of invasive plants (esp. Japanese Knotweed) in floodplain forest and woodlots (esp. Oriental Bittersweet).
- Maintain and restore wet meadows for their nature conservation value. Start their restoration by reducing mowing frequency to once every three years. That might go a long way in turning them into richer wet meadows.
- Research into possibilities for enrichment of upland old fields to create diverse native wildflower meadows that might help both native plant conservation and beneficial insects.
- Research into the establishment of wildflower strips within the vegetable fields.
- Protect standing deadwood in woodlots.
- Research into possibilities for restoring diverse forest herb communities in secondary forests of woodlots.
- Maintain fencerows. Consider control of invasive plants (esp. Tree of Heaven and Oriental Bittersweet) in fencerows.
- Research/experiment with “mobile hedgerows”
- Maintain ponds, test water from pond used for irrigation for certain chemicals, and let pond margins re-vegetate.
- When mowing hayfields within 1000’ of the Kinderhook, set mower blades at 4” or higher to avoid injuring Wood turtles.
- Observe Meadowlarks, try to determine where they are nesting, and take steps to maintain that habitat.
- Experiment with nest boxes for Kestrels and other open land birds; some of these are declining bird species and some may help reduce insect pests.