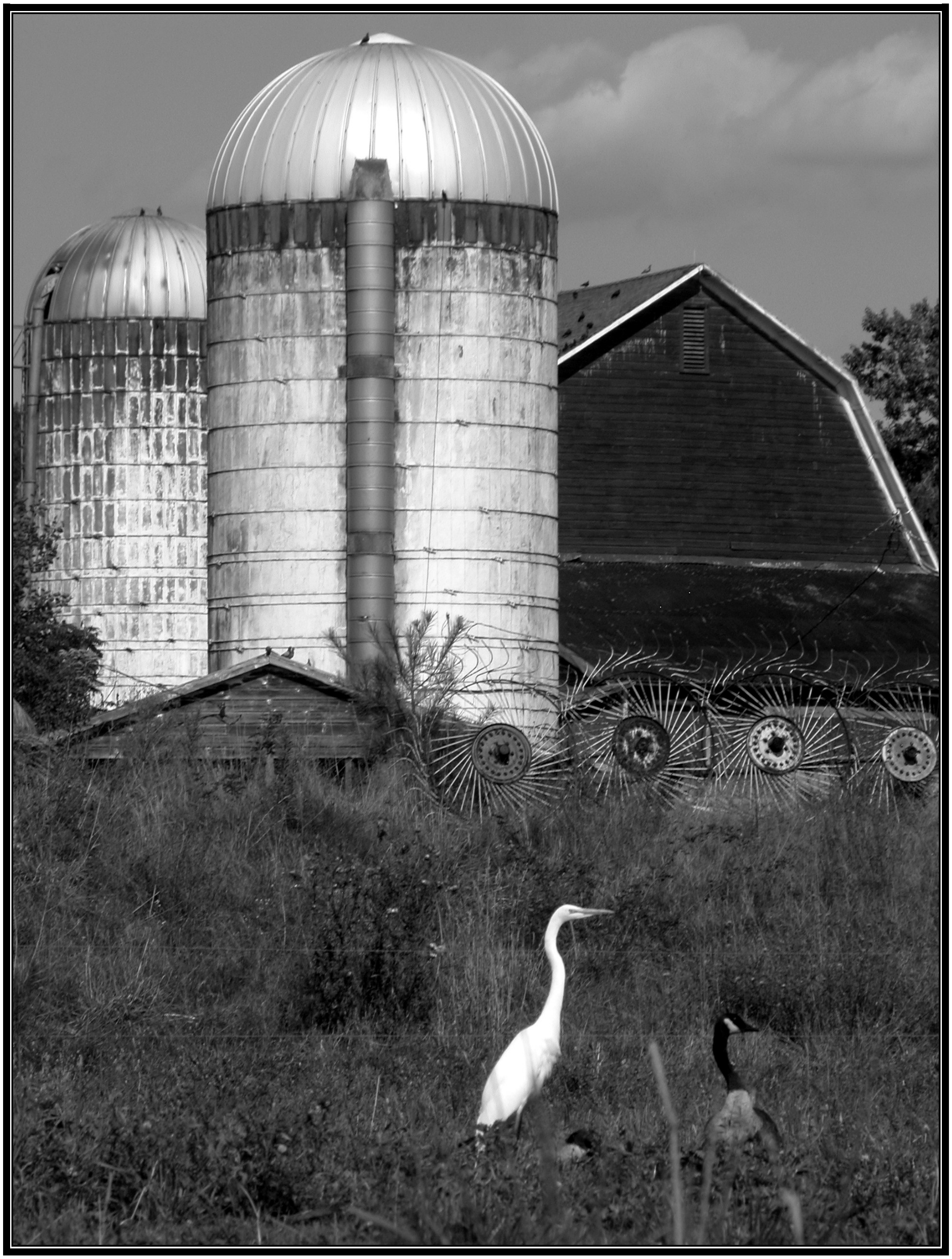
The Flora & Fauna of Some Columbia County Farms:

Their Diversity, History and Management



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SUMMARY

For at least the past 250 years, agriculture has played a major role in determining the landscape of Columbia County. While it continues to do so, agriculture in the County faces a challenging future due to competition from farther away and increased land demand for other uses. While there are important socio-economic reasons to consider the future of local farming, the goal of our work is to evaluate the nature conservation value that current farming plays in our landscape. What are likely to be the conservation repercussions should farms disappear from our landscape?

To address this question, we have begun to evaluate the value of on-farm habitats to native plants and animals. We conducted farmstead surveys of herbaceous (and, to a certain degree, woody) plants, of birds, of butterflies, and of a variety of aquatic organisms.

Our work to date has concentrated most heavily on our "home farm", Hawthorne Valley Farm. However, in 2005 we also began study of six other Columbia County farms.

Obviously, farms affect the native landscape. Were we not already a largely forested county, the negative impacts of farms on woodland organisms might be of concern. However, given the current scale of agriculture in the County, farms generally add to the native diversity of our county by providing refuge for grassland and shrubland organisms that might otherwise be largely absent. Many of these organisms found their original home in habitats that have diminished substantially at the national scale (e.g., prairies and wetlands). Thus, grasslands and shrublands of farms in our area can contribute to the conservation of species whose natural habitats have dwindled.

We found that Columbia County farms are home to at least 350 species of native plants, of which around 10% are openland plants of conservation concern. We cite at least 150 species of birds found on Columbia County farms; these include 25-30 grassland and shrubland species, many of whom are declining globally. Our farms provide habitat for at least 49 species of butterflies. While there does not seem to be a set of butterflies completely analogous to the grassland and shrubland birds, we present a list of 18 butterfly species to watch if farmlands decline.

Our work with aquatic organisms added nuance to this picture. In most cases, it is difficult to argue that farms provided important habitat for these species. However, our results do suggest that careful farming can be compatible with many species and, in the case of pond amphibians, can actually provide useful habitat provided those ponds are managed appropriately.

In sum, we believe that there are conservation reasons for preserving working farmland in Columbia County. These benefits do not come without potential costs. However, given adequate safeguards and compared to the frequent alternative of large-scale development, we conclude that the conservation value of farmland supplements the already compelling socio-economic reasons for maintaining viable agriculture in our region.

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General Introduction

Looking across our hillsides now, dark blocks of pine stagger into view. From above, these strangely square patches are joined by phantom lines through the forest, visible or not depending upon one's angle. A little exploration on the ground shows these to be the traces of fields past. And a little digging into censi from 19th and early 20th centuries documents what the fieldwork proposes: our landscape was once, perhaps 150 years ago, up to 80% open land. That's nearly as open as present-day Iowa. At that point, there were about four sheep for every man, woman and child in the County. And there were only 20,000 fewer people than at present.[1]

As a result, we are still living midst over-grown hay meadows, sheep pastures and rye fields in a landscape punctuated by yet-active farms and never-fully-cleared woodland recesses. We are, in other words, living in a "**farmscape**". During the ebb and flow of the forests, many organisms less conspicuous than trees rolled in and out with the "tide". Birds, butterflies and plants, stretching eastward along fingers of prairie, found familiar turf in traditionally late-cut hayfields; turkeys, fisher and black bear populations retreated into wooded refugia. No doubt numerous other plants and animals, so inconspicuous we may still not know them, followed their more evident companions.

These biological currents continue to flow. Those turkeys, fisher and black bear – such scarce sightings in my childhood - while still exciting, are certainly more commonplace. The Meadow Larks, whose 'Spring-of-the Year' song graced meadows during the last quarter of the 20th century, are now few and far between. Such comings and goings are not always straightforward and easily predictable. The habitats in our landscape have no dichotomous program of opening or closing. Our settlement patterns fluctuate: ridgelines become not only logistically accessible to houses, but also desirable; ponds become common fashion; internet lets us take our offices into the hills. Our agriculture re-shapes itself: regionally, it contracts; the technology and timing of haying changes; markets for this or that local product shrink (apples for example) while others expand (salad mix); cows are wedded to corn. Logging sees its popularity wax and wane. All these activities scar or tickle the belly of nature.

Finally, were our own activities not complex enough, there are the creatures themselves, whose tastes and needs we often understand but poorly. While some butterfly populations shrink precipitously in the northeast (e.g., the Regal Fritillary), others burst forth (e.g., the Wild Indigo Duskywing, a native species whose caterpillars "wisely" added alfalfa to their diets). Some warblers seem to make do with what shrubbery we deign to offer them (e.g., blue-winged warblers), while other, very-closely related species (e.g., the golden-winged warbler) seem sickened by our current landscape or by the biological company it brings. We introduce new species from elsewhere on our planet, some of which confine themselves to habitats that are also largely imported (e.g., grasslands, roadsides, house lots). Others invade wilder areas, crowding the native plants (e.g., purple loosestrife and garlic mustard). Such ecological interactions are sometimes intricate to the point of unpredictability, and clouded by time. For time is our last unknown – how long does it take a species to react visibly to changes in its surroundings? Are our fisher flowing in because an ecological dam was opened yesterday, or rather because one was opened 30 years ago and may now, in fact, be closing again? Are the exotic earthworms (none was probably present here 500 years ago) changing our forest soils in ways that it may take a tree's generation or two for us to notice?[2]

In sum, the landscape that we see around us is the confusing, ever-changing product of natural ecological forces and the human hand, sometimes working together, sometimes working in opposition (and often doing both simultaneously). We can't unravel this complex tapestry for you in any detail.

What we will try to do is take one local land use, agriculture, and explore its present and, to a certain extent, historical imprint on our surroundings. For now, we will largely confine our observations to Hawthorne Valley Farm. When available and appropriate, we will include knowledge gathered elsewhere by ourselves and others. When we are done, we hope that you will not only better understand what you see around you daily, but also have a rough idea of where those surroundings have come from historically and at least an inkling of where they might be headed.

Part 1: A Brief Intro to Ecology in Relation to our Work.

What is Ecology?

"Ecology" was a term that arose in the second half of the 19th century as scientists realized that there was actually a scientific discipline that could be defined as studying what organisms do in terms of their own economics, essentially in terms of how they make a living. Prior to that, while hunters, farmers, loggers, naturalists and others had certainly observed where animals were found or where certain plants grew, those observations were largely informal. Reading through the zoological and botanical volumes of *The Natural History of New York* (published around 1850), one finds mainly a taxonomic description of our state's organisms. Works published a mere 50 years later (e.g., Eaton's *Birds of New York*) contain a wealth of information on migrations, diet, nesting preferences, distributions according to ecological regions, etc. One quickly finds the information being applied to human needs and actions, both in terms of how those biological activities were affecting human enterprises and how humans were impacting other organisms. In the 1970s, if not earlier, "ecology" took on political connotations, referring not only to biological intricacies but also to cultural movements aimed at reducing negative human impacts on our environment.

So, what do we mean by "ecology" in the context of Farmscape Ecology? All of the above. Some of our key questions are the following: What habitats do farms provide to native plants and animals? How do the life styles of those organisms interact with our land use? How do we provide for the needs of both humans and other creatures in this shared space? In this section, we will provide an introduction to some of the fundaments of ecology that are relevant to our work. In the next section, we will describe our farmscape in a regional and historical setting.

Ecology can be thought of at two scales: the scale of the individuals (what plants do groundhogs eat? where do they sleep? what predators do they fear?) and the scale of populations or species (what is a species' range? is it increasing, declining, stable? do fluctuations in the population of one species seem to be related to those of another?). Of course, there is a connection between the two scales. For example, if many groundhogs are being eaten by coyotes, then one might expect that as the population of coyotes increases, that of groundhogs will decline. Ecological relationships are rarely simple and so scaling up from observations of individuals to the implications for a species as a whole is tenuous at best. Individualized studies need to be supplemented by attempts to follow the health of populations. Passenger Pigeons used to periodically swarm into our woods, dispersing nuts, piling droppings on the forest floor, even wreaking havoc on the trees of our forests. Almost until the very end, they seemed so numerous that the thought of their extinction seemed ludicrous. However, had scientists been monitoring their populations more broadly, it likely would have been apparent earlier that such swarms were declining in size and frequency. Conversely, to understand the fluctuations that we are observing in a population, it is often necessary to look at the ecology of individuals. For example, the disappearance of Allegheny Woodrats from the Northeast had been a mystery until the fate of individual rats was followed, and it was discovered that a Raccoon-borne disease might be at the heart of the problem.[1]

A Quick Field Ecology Primer: Landscape Patterns

Most of our own work has started at the scale of the population – we count Bobolinks, census butterflies, estimate little bluestem occurrence. In part, that is because such studies are relatively easy to do; however, they also help us see which species might be most common or important in the farmscape. It would be silly for us to spend time studying the eating preferences of, say, the big brown bat, if these bats foraged over farms only once in a blue moon (research from elsewhere suggests that they may actually be frequent visitors).

The work of other biologists has highlighted several patterns that we should be aware of at the scale of populations. Some of the most important patterns relate to the distributions of populations and habitats. For example, is an animal population that lives on a single habitat island as likely to survive as a population of the same size that is spread over several habitat islands of equal total? There is no easy answer because the outcome probably depends upon characteristics such as how "permeable" the boundaries are around each island, the reproductive traits of the species, and the occurrence and scale of disasters. If our 'islands' are true oceanic islands, then the permeability of the boundaries will depend largely upon the distance between the islands and the animals' abilities to swim or fly (or the seeds' ability to float). If our islands are woodlots in a sea of unforested habitat, then their permeability will likely depend upon whether that intervening habitat is abandoned fields, the backyards of umpteen houses, a six-line highway or a golf course. Whether the animal flies or walks and how leery it is of humans will also be important. As we will see later, farms may be fairly permeable for most wildlife, at least when compared to more intensive human developments.[2]

The scale and frequency of disasters also enter the consideration because of the "Don't put all your eggs in one basket!" adage. If our imaginary oceanic islands are also volcanic, erupting with an island-sterilizing ferocity every 500 years or so, then any species confined to just one island will, eventually, be obliterated. On the other hand, a species which is spread over several islands and has the dispersal ability to recolonize devastated islands has a much better prognosis. If we are talking instead about "islands" of grassland in a "sea" of non-grassland, then key questions include the size of those islands, the ability of our study organisms to disperse among fields, and the frequency with which, for example, the fields get plowed. As we will explore, the fate of different grassland birds depends upon how much land they need for nesting, how picky they are in their choice of nesting areas, and how the timing of haying meshes or doesn't mesh with their reproductive cycles.

Additionally, just the absolute size of a population affects its chances for survival. The smaller a population, the more likely that some fluke of nature might wipe it out entirely. The Heath Hen, a grouse-like bird, once roamed the East Coast of North America. Hunting and habitat loss slowly cornered them in Martha's Vineyard. Despite widespread recognition of their plight, a series of disasters – fire, severe winter weather, predation, and disease – struck this last outpost and the bird was pummeled into extinction by about 1932. Likewise, some of the last, best patches of old growth forest in southern New England were heavily damaged by the hurricane of 1938. Furthermore, amongst social creatures, population size itself might be a key factor in reproductive behavior. Returning to the Passenger Pigeon, it is suspected that once wild populations got below a certain level, their communal mating behavior was disrupted, their *en masse* approach to predator protection thwarted, and, essentially, the few stragglers stood around and watched themselves go extinct. A similar situation could be envisioned for some vernal pool amphibians (like the Woodfrog) which congregate seasonally in short-lived reproductive orgies. The calls from these pools can be intense and may help stimulate reproduction. If populations were to drop, there might well be a point at which frogs scattered through the woods didn't hear their brethren, and fewer were drawn to breed.[3]

Finally, while it may have more significance for us as observers than for a given species, we should be aware of lag times. Humans could stop reproducing today, and while our fate as a species would thereby be sealed, there would be ample human populations for decades into the future. As we study a species, we must be conscious of such ecological lag time. It may be trivially short for quick-living species but confusingly long for animals that live several years (don't think just elephants – bats can live for nearly 20 years, sturgeon for more than 100). The demographics of trees, with life spans that can be measured in centuries, can be even more deceptive. This effect is so important for trees that no study of forest dynamics is anywhere near complete without a tally of seedlings and saplings in the understory. Walking into a pine forest in our area, for example, you are more likely to find young oak or maple springing forth near the ground rather young pines; pines grow best in openings and once they themselves close those openings, another suite of tree species takes hold.

None of these patterns is strictly prescriptive. In and of themselves, they will not tell you what is going to happen. However, they are real patterns that are worth bearing in mind as one plans ecological studies and tries to interpret their results.

A Quick Field Ecology Primer: The Ecology of Individuals

At the scale of the individual, generalities are a bit harder to come by. However, organisms do need food, water, appropriate shelter, an ability to resist extant disease and predation, and adequate conditions for reproduction. These are all necessities that farmers must satisfy for their crops and livestock; in their own way, wild organisms are no less demanding. Let's briefly consider each of these needs in turn.

Food is a broad term that includes "inputs" with many different functions. Food is often a source of energy. In this sense, sunlight is food for plants. What constitutes an energy source for a given plant or animal depends not only on the composition of the food, but also on the digestive abilities of the consumer. Obviously, a cow will fair better on hay than we will. Food consumption is determined not only by what a food can provide, but also by what an organism needs. For example, some organisms (e.g. insects and "cold-blooded" animals) are better able to survive periods of food scarcity because they don't have the constant "overhead charges" associated with keeping their bodies warm.

Food also supplies nutrients – the building blocks which make up an organism's body. Energy may plaster together the bricks, but the bricks themselves are still needed. Carbon and nitrogen (for proteins) are common components of the bricks. Plants get their carbon from the air; nitrogen-fixing plants can also fill their nitrogen needs in this way. Because carbon is nearly ubiquitous in foods, most animals which have fulfilled their energy needs have likewise fulfilled their carbon demands. Nitrogen is not so widespread, and potential protein deficiency is a reality for many animals, especially growing ones. Even hummingbirds feed insects to their young as a way of supplying their chicks' protein needs.

Organisms need a variety of nutrients and minerals aside from those that go into the bricks. Sodium, for example, is crucial in water regulation, and phosphorus is a component of most within-body energy delivery systems. More obscure elements and compounds can be required for other functions. In all cases, their relevance in shaping the ecology of an organism depends upon the organism's need for that substance relative to its availability. Animals will search out salt-licks or consume sodium-rich aquatic plants because their demands for sodium are not easily satisfied. Likewise, soil nutrient availability (most commonly, phosphorus, potassium, and nitrogen) can markedly influence plant growth.[4]

Food can also provide a variety of other ingredients that are important to an organism's existence. For example, certain insects, and perhaps even some vertebrates, consume distasteful (to us, at least!) foods and integrate ill-tasting ingredients into self-defence mechanisms. The Monarch butterfly and the milkweed are perhaps the most widely cited example of such a partnership. Food can also provide animals with coloration – the pink of Flamingos (admittedly rare on our farmscape), comes from the tiny shrimp they consume.[5]

Organisms also need water, although their levels of need vary radically. In our area, water is rarely limiting for most native species. It is probably more relevant in an agricultural context where we ask plants to grow quickly in exposed areas or demand high milk production from our cows. Nevertheless, we must realize that when we open up areas to direct sunlight or dry out wetlands, we exclude those organisms accustomed to relatively moist conditions. Most frogs, for example, lose much water to evaporation and so require regular access to wet areas. Some animals don't need to drink water in order to fulfill their needs. Herbivores can often attain the water they need by extracting it from the green plants that they consume. In addition, as our dripping exhaust pipes indicate, a certain amount of water is also generated as a by-product of metabolism, and at times an animal can produce enough water to meet its needs..

"Shelter" is a broad term. Most intuitive perhaps is shelter as protection from the elements. Deer seek protection from the wind, grouse dive into snow banks to shield themselves from the cold night sky. Plants too are more or less accustomed to shelter from the wind. Shelter from predation is also important. One of the main reasons some forest animals hesitate to use fields may be their increased exposure to predators such as hawks and owls. Plants also may need shelter. Most gardeners can quickly tell you which of their fields is more or less sheltered from frost or destructive winds.

The activities of reproduction – finding a partner, mating, raising young – often require a suite of conditions, not the least of which is the presence of the partner. Near Hawthorne Valley, a forlorn American Chestnut annually casts infertile seeds to the ground because, its population decimated by disease, it finds no conspecific with whom to exchange its pollen. Early in the year, a spat of Raccoon roadkills often marks the beginning of this species' mating season, as males wander widely in search of mates. The farther Raccoons or any other animals have to travel to find a "honey" the greater their chance of being killed in the act. Certain animals, like vernal pool amphibians, need special habitats for mating, while many plants need insect intermediaries (i.e., pollinators) for their dating games. For most organisms, the survival of young is a crucial stage and is the period when most mortality occurs. Young are often weak, defenseless and yet demanding. The germination of plant seeds is a critical step in plant life, and most seeds don't even make it that far. Young animals likewise often need very specific habitats, whether or not the parents stay around to protect them. Bird nesting sites and caterpillar food plants are two instances of specific, often limiting, reproductively-related habitat requirements.

As even this brief discourse has illustrated, one can rarely dissect out everything that "adequate habitat" means to an organism. Often there is interaction. For example, an underfed animal may be more demanding of shelter, less able to search extensively for a mate, and less resistant to disease or predation. Because of this complexity, our ecological studies focus only on this level of detail when the broader studies provide cause for it. For example, were we to note the decline of a certain butterfly species, we might logically focus a study on the nature and abundance of its caterpillar's foods. It is because an organism's needs are multifaceted that we talk so much about "adequate habitat". While we worry about all of these individual needs when we consider our crops and livestock, it is more efficient to simply insure that wild organisms have access to the habitats in which they evolved; given that, they can usually fend for themselves.

Part 2: The History of our Fields.

There are at least three basic ways for understanding which native species can exist in on-farm habitats:

1) We can look and see. Most of this report describes just such observations.
2) We can try to understand what is already known about the individual ecologies of the different species and try to guess which species may be most compatible with which habitats.

3) We can look at historical information. Because of the tremendous waxing and waning of agriculture in our region, we are presented with an experiment of a sort. Those species most closely tied to agriculture would be predicted to wax and wane in sync with agricultural activity.

In order to provide background for the last approach, we describe aspects of regional land use history. Such information also emphasizes both the fragility and resilience of our landscape: we can and have stripped it of much of its forests, and forest can and has returned. Our hand is powerful and its touch must be tempered. Yet, at the same time, Nature is not a crystal queen; she does not shatter at first touch and might be hoped to reward temperance.

So, what do we mean by 'fields' and whence did they come?

We define fields as being open areas dominated by grasses, sedges, or herbs. Pastures, hay meadows, and croplands including corn fields are, for example, all considered "fields". Fields are a precursor to another important farmscape habitat – shrubland. At what point an old field goes from being field to being shrubland is somewhat ambiguous. Generally, if an area was a grassy stretch with scattered woody plants, we considered it an over-grown field. If it were mainly woody plants, with perhaps occasional interspersed herbaceous patches, then we considered it shrubland. Because shrubland usually follows from field, we mainly discuss fields here. We are, by inference, also discussing the origins of subsequent shrublands.

In the centuries immediately preceding European arrival in our area, grasslands were probably relatively rare. Most natural grasslands occur where soils and/or climate limit extensive woody growth. Dry climate sometimes conspires with fire to exclude forests; fire, for example, seemed necessary to the ecology of the Great Prairies in the MidWest. In our area, natural openlands probably occurred for one of the following reasons:[1]

1) <u>beaver damming</u> - beaver meadows were formed when the ponds behind beaver dams eventually filled in with debris and plant life. These meadows eventually became forested and so the perpetuation of such grasslands in the landscape required constant beaver activity. Even before European agriculture took hold, extensive beaver trapping probably removed beaver as a major ecological force. They are returning.
2) <u>dry soils and fire</u> – sandy stretches such as those of the Albany Pine Barrens or at a few spots on Long Island could support grasses if fire knocked back woody vegetation. The control of fires probably reduced the extent of such grasslands after European arrival. Settlement pressure has also eaten up some of the largest natural grasslands in the northeast. Thin soils on rocky outcrops sometimes create park-like, if not grassland, habitats.
3) <u>fluctuating water level</u> – fluctuating water level as might be caused by seasonal wet/dry cycles, can hamper woody vegetation growth, creating sedge meadows or marshes.
4) <u>natural disaster</u> – aside from fire, extensive tree fall caused by wind, snow and/or ice also creates temporary grasslands.
5) <u>climate</u> – tundra-like grasslands occur on some of our highest peaks, where thin soils, drying, and severe cold combine to limit woody vegetation.
6) <u>Indian land management</u> - Although the extent is debated, there is little doubt that the indigenous peoples created grasslands or savannah-like areas by their agricultural practices and possibly by intentional burns meant to improve wildlife habitat. Like beaver meadows, such grasslands existed in the landscape only as long as their creators were at work.

How much of our area was field prior to European settlement? No one knows for sure. For at least a century or two prior to European contact, our area was occupied by Mahican (also called Mohican) Indians. Part of the Algonquian language group, these people mixed hunting and gathering with a corn-squash-beans agricultural system. This type of farming had probably been occurring here for about half a millennium when the first Europeans arrived. As such, it is likely that they created a mosaic of temporary openings relatively near their villages. When European disease swept the East Coast, many indigenous villages died out or were abandoned. By the time Europeans arrived in person, they apparently found convenient cleared reaches along many an East Coast river – the ecological remnants of former native villages.[2]

While certain wildlife probably relished the fields and subsequent brushlands created by indigenous activity, given the intervening history, it is hard to credit the current presence of any animal species to Indian activity. Doubtless, however, at least some of the species we associate with grasslands and shrublands were aided by indigenous land use, and reports of Indians managing habitat for game such as turkeys, rabbits, and deer are common. Certain plants may owe their presence to native agriculture – wild leek, Jeruselum artichoke, and wild plum. All of these were said to be cultivated by northeastern Indians. Whether these species arrived here naturally and were promulgated by indigenous agriculture, or were carried in by Native Americans from elsewhere and became established, is almost impossible to know.[3]

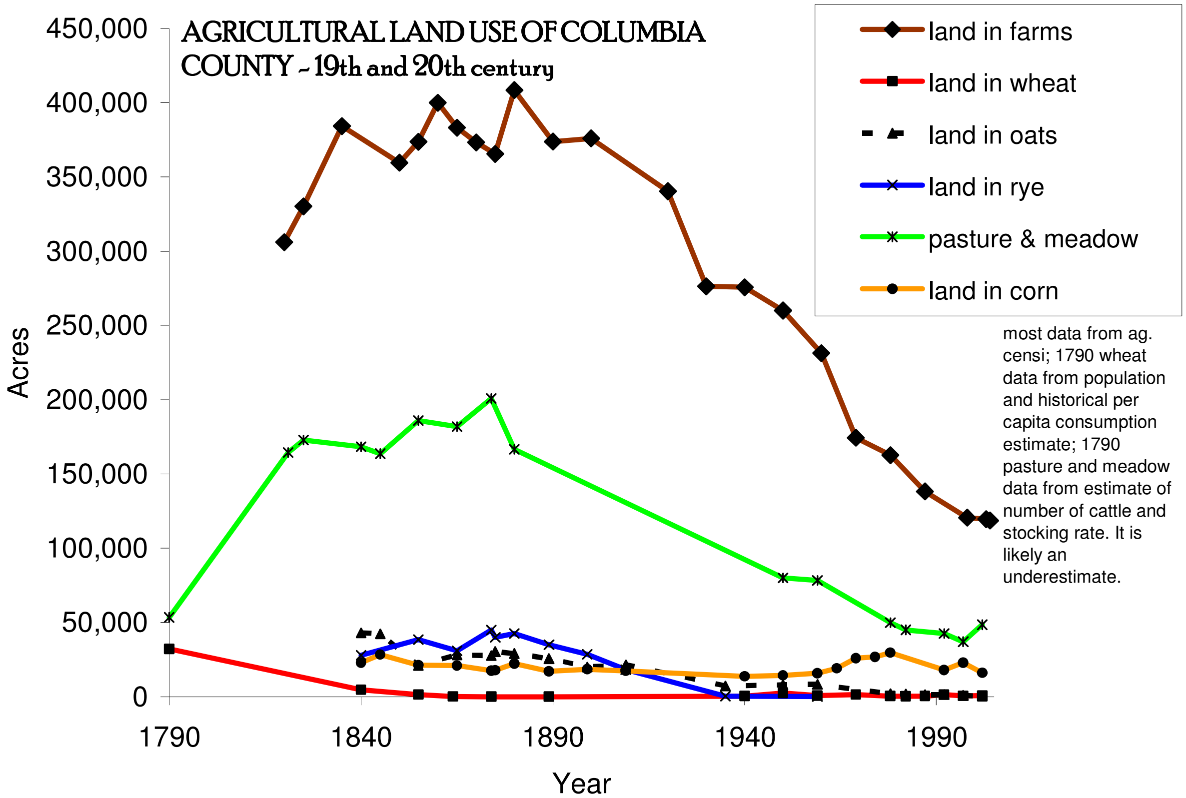
We have little particular information concerning Indian land use in Columbia County. The claim that "Claverack" is Dutch for "Clover Reach" and indicates that clover fields greeted the first explorers appears to be apocryphal. Nonetheless, the fertile lands along the Hudson were surely occupied, if not farmed, as the Tivoli Bays archeological site indicates. The stone projectiles found around at least a couple of the farms we studied indicate the possible presence of hunting camps, but tell us little about land use.

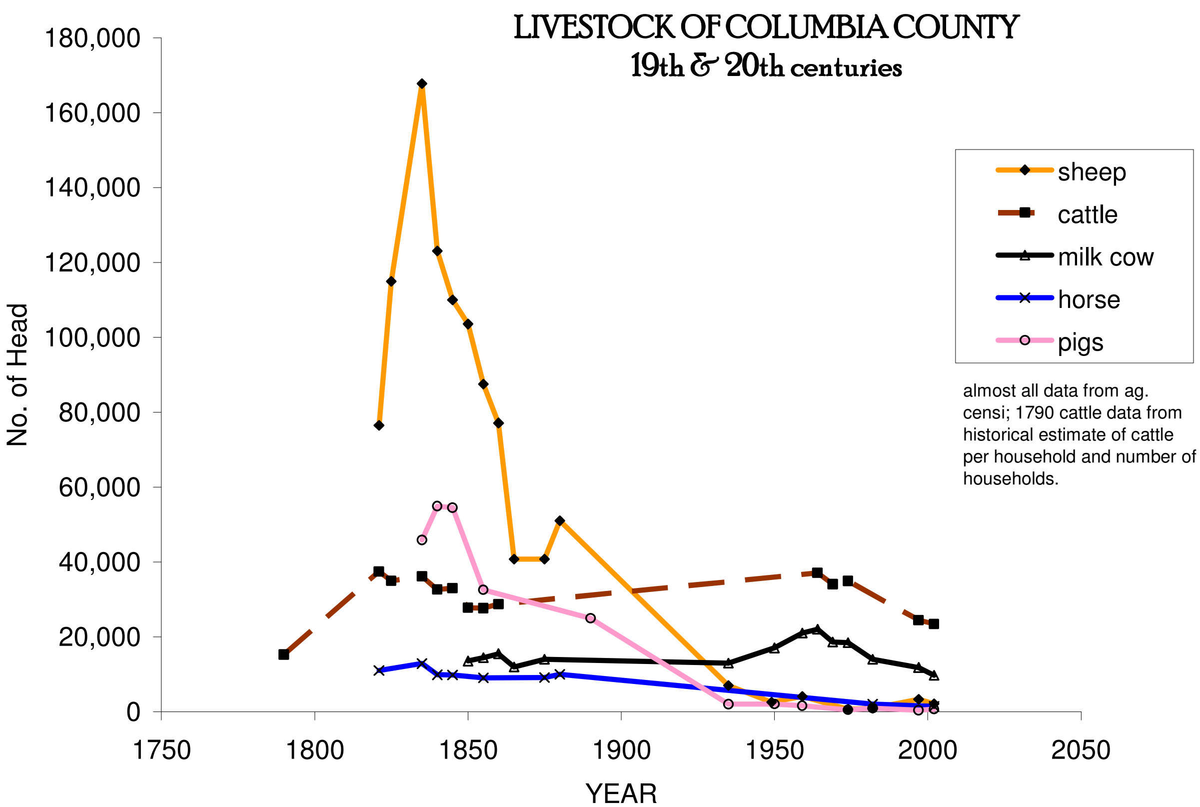
In sum, it seems likely that in the few centuries prior to European settlement, our landscape was mostly wooded. For natural and anthropogenic reasons, there was probably a scattering of openings, although little that would be a field to our eyes. Nonetheless, these periodic and shifting patches may have been enough to provide native grassland and shrubland species with a foothold in our area, one from which they could expand as European agriculture began to clear the land more extensively.

Initial Settlement

Ironically, the initial impact of European contact may have been to shrink those few openings that existed in our landscape. As was noted above, human diseases transmitted during early contact with Europeans and the extirpation of the beaver probably removed two of the main architects of openland in our area. The Europeans themselves, more specifically for us, the Dutch and French, were initially fur traders, and as such, their first goal was not extensive settlement and land opening. Accounts of early European settlement both in Manhattan and around Albany, say that settlers used land previously cleared by the Indians. Wildlife is described as abundant in early accounts, there being no indication that the Native Americans had substantially reduced populations, and, indeed, their activities may have increased the populations of some species.[4]

The European arrival to the County is generally marked as 1609 when Henry Hudson sailed up the river since named in his honor. By 1614, a spot called "Kinderhook" was already listed on a regional map, although permanent settlement probably occurred some thirty years later, by which time Mohican numbers had likely plunged. Until about 1700, European settlement seems to have been light and largely limited to the banks of the Hudson, although both the Livingston and Rensselaer manors were established before that date. By 1750, it had spread well inland with the founding of Chatham and Ghent from the west, and the inflow of English settlers into the eastern part of the County. The non-indigenous population of Albany County (which, until 1772, held Columbia, Greene, Rensselear, Albany, Schenectady, and Saratoga counties) went from around 2000 in 1700 to 10,000 in 1750 to over 40,000 in 1771. Conflicts between the Dutch and English may have made for a line of tension (and hence reduced settlement) running through the eastern portions of the County during the middle portion of 18th century. By the turn of the 18th century, there was probably something like 250,000 acres of farmland in the County; this compares to current levels of roughly 120,000 acres. These trends continued into the 1800s,





Figures 2.1 - 2.2. Statistical data on Columbia County agricultural production. The top graph shows agricultural activity in terms of acres under different uses. In some cases, acreage has been derived from production combined with historical estimates of production per acre. The bottom graph shows livestock numbers.

with maximum clearing in the County being reached by 1835, and the landscape persisting with little change in total cleared area for the rest the century.[5]

Evidently, species favoring agricultural habitats have had some 200-300 years to establish themselves in our area.

Subsequent Agricultural History

Early agriculture in the County was probably traditional diversified farming, providing mainly for a family's needs. However, we still need more information on the production from farms run by the Dutch patroons. Based on the information available for the 19th and 20th centuries, farming transitioned from more diversified production towards wool production (fueled by tariffs on British wool from about 1825 to 1845 and the proximity of the County's woolen mills). Once tariffs were lifted, the County appeared to move towards grains and hay. In the second half of the 1800s, Columbia County was one of New York's leading rye producers. Rye was apparently used mainly for paper and straw. Much of the production of hay, straw and grains went down the Hudson to feed and bed New York City horse power. Joel G. Curtis, owner of Hawthorne Valley Farm at the turn of the last century, left farming to pursue a career in this trade. More recently, Columbia County appears to have specialized in apples and dairy, and while their numbers have dwindled, these products have remained the mainstay of the County's agriculture. At present, the only growing components appear to be niche farms and horse farms. Agricultural activity has dwindled since the late 1800s, initially due to the opening of better soils farther west, and more recently, due to land pressure from development. The "farmscape" has not been fixed during its history. The naturalist looks at this changing picture and asks which wild species came along for the ride. Figures 2.1 and 2.2 outline aspects of our agricultural history.[6]

European activity obliterated most, if not all, traces from previous indigenous cultures and is a major factor in determining the landscape that we see today. Because of that, we concentrate substantial effort on understanding the ecological effects of that activity. The land around us is not wilderness, and its dynamics can not be understood by simply studying its current ecology and supposing a steady-state. What we see today reflects a mosaic of effects – current land use, historical land use, and the natural ecological tendencies of the players. In the pages that follow, we present our results according to the broad categories we followed in our fieldwork (plants, butterflies, amphibians, etc.). Where possible, after describing the current scene, we try to dissect the influences of these various factors so as to better understand where we are and where we are headed.

Part 3: The Farms We Looked At.

The majority of the work presented here was conducted on Hawthorne Valley Farm. Hawthorne Valley Farm is a 400 acre commercial farm that is a component of the Hawthorne Valley Association, an educational non-profit. Approximately 300 acres of the land is in agricultural use, as are an additional 500 acres or so of land owned by others but worked by the Farm. The Farm has a dairy herd of about 60 animals and 12 acres of vegetable gardens. In addition, there are a few pigs and beef cattle. The milking herd is rotationally grazed during the summer and mainly hay-fed during the winter; no corn or other grains are grown. The Farm is organic/biodynamic and located in Harlemville, New York, roughly in the middle of Columbia County. Figures 3.1 and 3.2 illustrate this property.

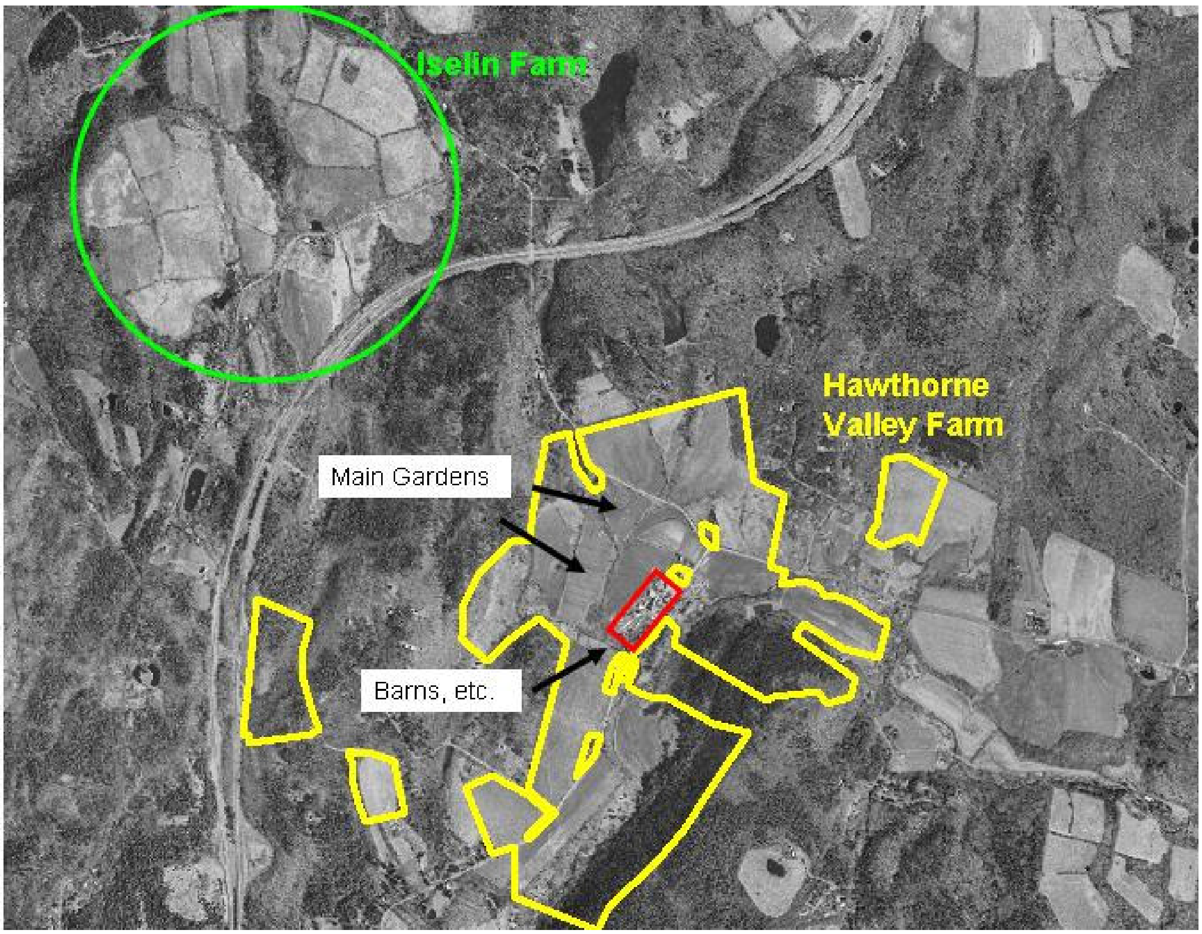


Figure 3.1. An aerial image of Hawthorne Valley Farm in 2004. The property of the Hawthorne Valley Association, the Farm's parent organization, is outlined in yellow. The "Iselin Farm", circled in green in the Northwest corner of the image, is not owned by Hawthorne Valley, but is used extensively for hay and pasture; information from this area has been included in that assigned to Hawthorne Valley Farm.

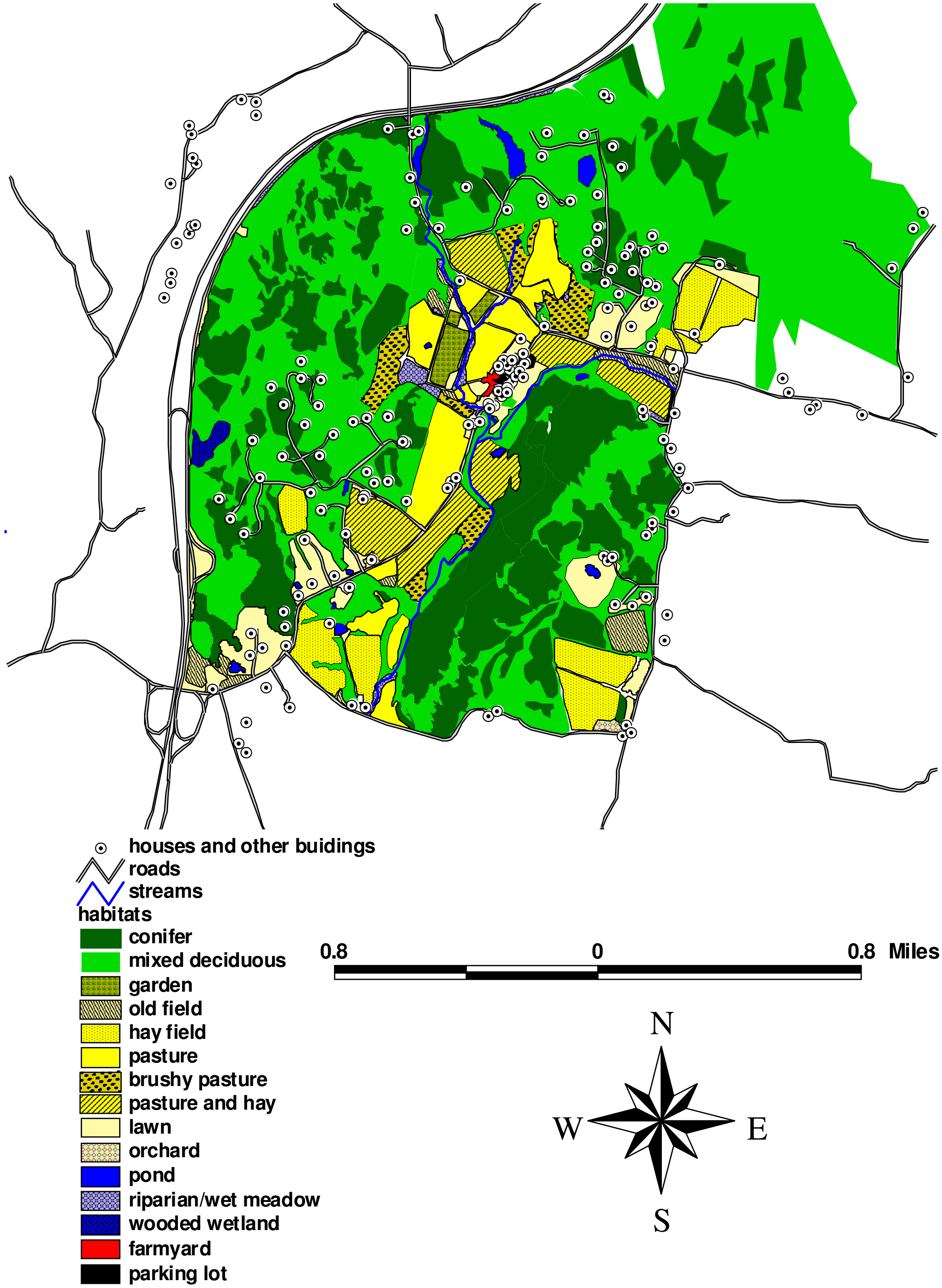


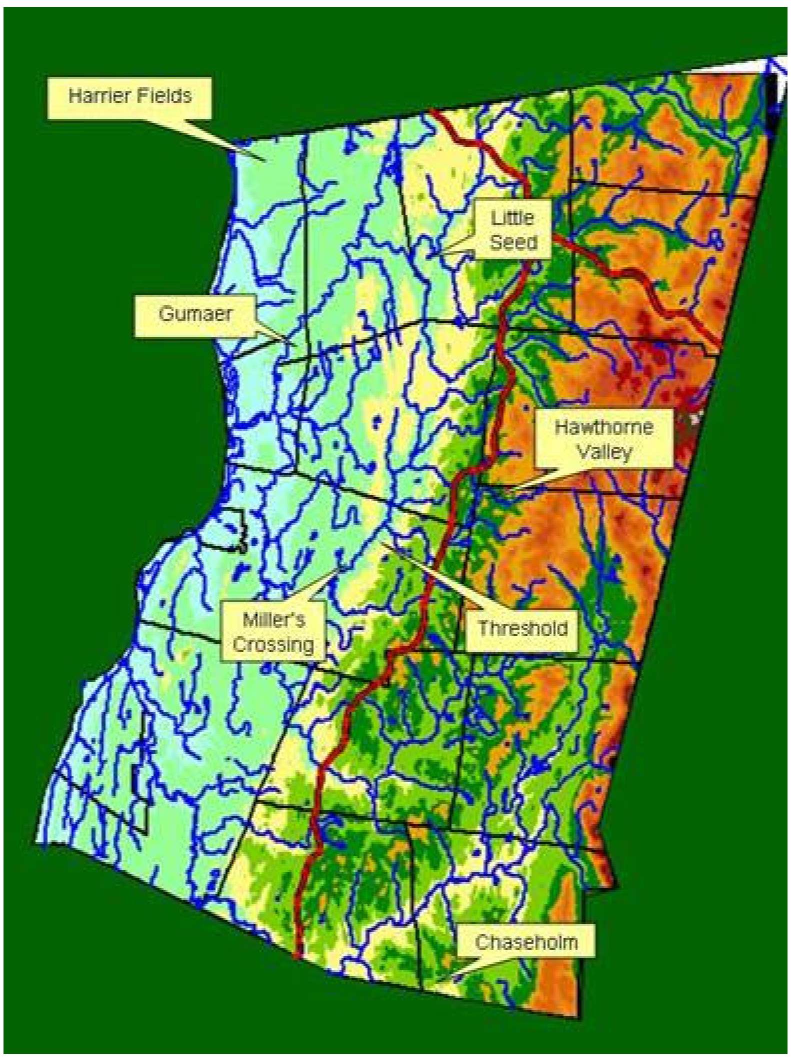
Figure 3.2. Habitat Map of Hawthorne Valley. This is a rough habitat map based mainly upon aerial photography, with ground-truthing for Hawthorne Valley Farm properties but not adjacent areas. Some of this land is neither owned nor worked by Hawthorne Valley Farm, but was included for context. Please see previous figure for outline of property boundaries.

In 2005, we began working on six additional farms in Columbia County. These are, working from south to north, the following:

Chaseholm Farm – a 329-acre dairy farm located in Ancramdale. Herd size is roughly equal to that of Hawthorne Valley's. Cows are fed corn and other grains (almost all of which is grown on-farm), along with hay and grazing. Some herbicides are used. The farmland is a combination of grain and hay fields with a few pastures. There are wooded sections around the periphery.

The Farm at Miller's Crossing –this 200 acre organic farm grows mainly vegetables, although it also has a small, mainly grass-fed beef cattle herd. It is located between Philmont and Hudson, in the township of Claverack. Situated along the Agawamuck, the farm has garden plots, plus some hay fields and pastures together with riparian forest and wooded draws.

Threshold Farm – at 40-acres, this is the smallest farm we studied. It is a mixed production organic/biodynamic farm, specializing in apples, pears and peaches. It has also has a few acres of vegetable gardens and a small cattle herd. It is located just south of Philmont. The Farm is a long-term lease; the leased area itself includes only the fields, gardens and orchard, but it is completely surrounded by forest.



Little Seed Gardens – an 87-acre organic farm located on the banks of Kinderhook Creek and the Stony Kill. This farm mainly produces vegetables although it also has a pair of cows. Aside from the vegetable gardens, there are also stretches of old field and riparian woods.

Gumaer Farm – Gumaer Farm is a low-input, conventional dairy farm of roughly 60 animals. The herd has a corn-based diet, and much of the land is in corn production with at least a couple of hay fields. There are two interesting woodlots – one a wooded wetland where Rusty Blackbirds were seen during migration. The other is a stretch of riparian woods along Kinderhook Creek.

Harrier Fields Farm – This organic 60 acre farm in Schodack Landing specializes in grass-fed Red Devon cattle for beef production and breed conservation. The farm is mainly pasture with no woodlot but with a small, old orchard. Due to its location on high ground near the Hudson, it receives many migrating birds.

Figure 3.3. A shaded elevation map of Columbia County showing creeks (blue), major highways (red), and the outlines of townships (black). The seven farms included in our work are labeled.

Part 4: Farmland Plants

Introduction

It is obvious that plants play a central role in agriculture. They are cultivated for human consumption or animal fodder, seeded for ground cover, and/or planted as wind breaks, living fences or shade trees. But aside from these cultivated plants, intentionally put in certain places by the farmer and carefully tended to ensure their establishment and growth, wild plants also make their home on farms. Some of them contribute directly to agricultural production as components of pastures or hayfields. Some may provide more subtle benefits to agriculture as food plants for beneficial insects, such as pollinators and pest predators. Notorious are the "weeds", which by their presence, interfere with the growth of cultivated or agriculturally more productive species. However, the presence of the right amount of the right kind of weeds has also been suggested to benefit agricultural production.[1]

Many native wild plants maintain or find a foothold in the "neglected", i.e., less intensively managed, areas of farms: along cow lanes; in hedgerows and field margins; in riparian areas; on the shores of ponds; in wet meadows, shrubby swamps, and old fields. Finally, most farms maintain woodlots composed in large part of native vegetation. Our main questions about farmland plants are: What role (if any) do farms play in the conservation of native plant species? What are the beneficial and detrimental effects of native plants on agricultural production? And finally, what can be done to enhance the farms' role in native plant conservation and to increase the beneficial, while reducing the detrimental, effects of native plants on agricultural production? These "big" questions are our roadmap, and we won't be able to tell you all the answers quite yet. However, our first two years of research have yielded sufficient information to start "chipping away" at these big themes and to discuss promising directions our work might take in the future.

In this chapter, we will begin to answer the following specific questions:

- Which species of plants grow wild on Columbia County farms and what proportion of the flora of Columbia County is represented on farms?
- What proportion of the wild plants on farms is native to the region? Which general habitats do farms provide to native plants?
- More specifically, which native plants benefit from or are dependent on agricultural activity? What are the specific habitats they thrive in and which agricultural management practices contribute to these specific habitats?
- What are the interactions and trade-offs between native plant diversity and agricultural productivity?
- Are there any invasive species on the Columbia County farms that might merit attention?

Study Methods

During the years 2003-2005, our most intensive work was focused on the flora of Hawthorne Valley Farm. The first year was dedicated to initial pasture surveys and to learning how to identify the most common pasture plants at different stages of development. Throughout the three-year period, we collected botanical voucher specimens whenever the identity of a plant could not be determined in the field. We visited all pastures and open wetlands on the Farm at least once during 2003 and started to compile lists of the plants found in each pasture and wetland. As a tool for the plant inventories, we compiled sheets to aid with the identification of common grasses and legumes from vegetative material (Appendix 1).

In Spring of 2004, we continued these surveys and developed the methodology for standardized between-pasture comparisons of the vegetation. During June/July of 2004, we conducted these standardized surveys on the 16 pastures grazed by the dairy herd of Hawthorne Valley Farm. For each pasture, we recorded all the plants and estimated their percent cover within 15 sample plots of one square foot. each. The sample plots were placed in a stratified random manner. Their precise location was determined by blindly throwing a frame at regular intervals, with the intervals adjusted to the size of the pasture to assure representation of the whole area. The intervals were paced along straight transects chosen to traverse the entire pasture in a direction that led through the range of obvious site differences found in each pasture. After the standard surveys, we occasionally visited the meadows and wetlands until the end of the growing season and so added to the plant records for each unit. During 2004, we also started to expand our plant inventories into other habitats of Hawthorne Valley Farm. The woody plants in hedgerows were documented in a standardized way and that research aspect is presented in the following chapter. In addition, forest plants, garden weeds, and wild plants in the farm yard, field edges and cow lanes were recorded as we noted them on exploratory walks into the different parts of the Farm's land and during fieldwork into other aspects of the farmscape ecology.

In 2005, we began plant surveys on six additional farms in Columbia County. Each of these farms was visited two or three times throughout the growing season. On exploratory walks into the different farm habitats, we recorded plant species as we noted them. On these six farms, the most effort went into recording the plants of meadows, of fallows and of open wetland areas actively managed or maintained by agricultural activity. However, we recorded interesting observations from forests and riparian areas, especially if they represented plants hitherto not found at Hawthorne Valley Farm. Throughout the 2005 growing season, we also continued our visits to the different habitats at Hawthorne Valley Farm, recording plant species that had gone unnoticed during the preceding surveys.

All these observations were combined into a master list of the farmland plants in Columbia County (Appendix 2). Alphabetically sorted by common name, the list gives the corresponding scientific name, the general habitat(s) in which each species was found, and on which farm it was observed. The habitat categories in the appendix are broad and not mutually exclusive. For example, the category "Meadow/Hayfield/Fallow" includes any vegetation that is dominated by herbaceous plants (seeded or not) and provides a continuous cover of the soil. It also includes open wetlands and shrubby pastures or old fields, as long as the herbaceous vegetation still covers more area than the shrubs. The category of "Wetlands" is also very broad, including aquatic plants and plants found along the shores of creeks and ponds, on beaches, in swampy forest, in open wetlands, and on grazed wet meadows. If a plant was found in a wet meadow, it was marked as occurring in wetlands and meadows. The appendix also notes the growth form (herbaceous, vine, shrub, liana, or tree) of each plant and whether it is considered native to our region or invasive. Plants of conservation interest are marked if they are of recognized conservation concern (legally protected or considered regionally rare/scarce) or if they were uncommon on the farms we studied. Most of the botanical identifications are ours; few of them have yet been verified by taxonomic specialists. Only species of quite certain identity have been included in the list. A number of unidentified voucher specimens, mostly of grasses and sedges, are still awaiting careful inspection. This will doubtlessly lead to the addition of species to the master list.[2]

What We Found & What We Think It Means

WILD PLANTS ON FARMS

Appendix 2 lists all the wild plants documented to date on Columbia County farms. At least 536 plant species grow wild on farms (including their woodlots) in Columbia County. This means that the seven studied farms provide habitat for 42% of the 1289 species known to occur in Columbia County. Even more impressive, Hawthorne Valley Farm alone harbours at least 486 wild plant species, or 38% of the flora of our county.

Native plants on farms

At least 350 species (65%) of the plants documented on the farms are considered native to our region. This is basically the same proportion of native plants as in the flora of the entire state of New York.

Native plants occur throughout the range of general habitats found on farms. However, some of these habitats have a higher diversity of native plants than others. Also, plants of conservation interest tend to occur preferably in certain habitats. Table 4.1 provides a summary of the number of plants found in each general habitat type.

Table 4.1. Distribution of plants in general habitats on farms in Columbia County.

Habitat	total # of species	# of native species	% of native species in habitat	# of species of conservation interest		% of native species in habitat that are of conservation interest
				# of species of conservation concern	# of uncommon species	
Meadows/Hayfields/Fallow	350	186	53	24	22	25
Forest	204	184	90	30	0	16
Wetlands	203	127	62	14	14	22
Hedgerows	105	73	70	4	4	11
Garden/Row crops	55	10	18	0	1	2
Farm yards/Lanes	37	15	41	1	0	3

Although by far the largest number of plant species was found in meadows, the number of native species was almost equally high in meadows and forests. The other two habitats with considerable numbers of native plants were wetlands and hedgerows. The proportion of native plants was highest in the forest, somewhat less in the hedgerows and wetlands, and, finally, just above 50% in the meadows. The number of native species of conservation concern is highest in the forest and meadows, but still significant in the wetlands. In all three habitats, more than 10% of the native plant species are of conservation concern.

Native plants that depend on agriculture

The above comparison of the plant diversity in general farm habitats strongly suggests a negative correlation between the suitability of a habitat for most native plants and the intensity of agricultural management in that particular habitat. A third of all the native plant species documented on farms occurred exclusively in forest. These species are expected to thrive in appropriate forest habitat, independent of whether or not the forest happens to belong to or abut a farm. An additional 15% of the native species were found in forest and well drained or wet meadows, and sometimes also in additional habitat types. Although three species of conservation concern (false mermaid weed, halbert-leaved tearthumb, and sensitive fern) are included in this category and occurred in wet meadows at Hawthorne Valley Farm, we have no reason to believe that agricultural activity is crucial for the survival of any of these plants in our region as long as appropriate forest habitat is available.

In the following section, we will have a closer look at the distribution patterns of the approximately 50% of the native species that we found on farms and which we do suspect benefit to some degree from agricultural activity. For that purpose, we grouped the species by similar habitat requirements, and we will discuss the importance of each specific habitat for the conservation of native plants.

Hedgerow plants

The details of woody plant distributions in hedgerows are described and discussed in the next chapter. In summary, only very few of the native plants documented in hedgerows were found exclusively in this habitat. Examples are **carrion flower**, **greenbriar**, and **smooth sumach**. Columbia County seems to be at the edge of the range of the latter two species. We don't have a good idea why carrion flower was so uncommon on Columbia County farms. The regionally scarce **giant ragweed,** which was found on only two farms, occurred in riparian areas resembling hedgerows.

Many of the other plants in hedgerows were forest plants that found a suitable home also in the hedgerows, including the uncommon and New York State vulnerable **winterberry** and **flowering dogwood.** Were contiguous forest tracts to become rare in Columbia County, hedgerows on farms might become important for plant conservation by providing refuge to forest species. However, such forest decline seems unlikely at present.

Around the intensively grazed meadows and cultivated fields, it is mostly along the hedgerows and fencerows that the widespread late-flowering native plants (most notably the **asters** and **goldenrods)** are able to flower and go to seed in any number. Depending on the surrounding agricultural matrix, hedgerows might be locally important for plant conservation as seed sources for meadow species that are not able to reproduce adequately in the surrounding, intensively-grazed meadows or cultivated fields.

Ubiquitous open-land plants ("native weeds")

Only around 5% of the native plants found on farms fall into this category. Most of them are very common and thrive in a range of open situations; examples include common ragweed, common milkweed, fleabane, horseweed, and common evening primrose. Such species no doubt benefit from agriculture, but they also seem to find suitable habitat in other man-made environments, and there is currently no reason to worry about their long-term survival in our region, with or without agriculture. However, some other "weedy" species were rarely encountered in our surveys and agricultural habitat might be crucial for the survival of the following rare or uncommon species in our region:

False pimpernel, found once in a muddy farm lane in the vegetable garden at Hawthorne Valley Farm

Longleaf ground-cherry, found in pastures and hedgerows at Chaseholm Farm.

Plants of open wetlands and wet meadows

Approximately 23% of the native plants found on farms belong to this category, which makes it the largest ecological group after forest plants. More than 50% of the species in this group also occur(red) in Midwestern tallgrass prairies, of which only small remnants remain today. Before agricultural colonization of the Northeast, these species were probably mostly growing in beaver meadows, transitional swamps, and riparian areas. Agricultural activity at least temporarily increased the area suitable for these species by creating additional wet meadows and artificial ponds, as well as expanding and maintaining open riparian areas. However, many of these species have probably declined again due to the drainage of wet meadows for intensified agricultural management or, more recently, for housing or commercial development. Many of the remaining wet meadows were taken out of grazing and subsequently grew back to forest. Therefore, the species in this group (the approximately 80 species marked in Appendix 2 as occurring only in wetlands or in wetlands and meadows) are expected to benefit from the continuation of certain agricultural activities, e.g., the continued grazing of remaining wet meadows, provided no additional drainage of wetlands occurs.[3]

Of recognized conservation concern among these wet meadow plants found on Columbia County farms are the following (the first four species are recognized by the State of New York as exploitably vulnerable):

Cardinal flower, of which several individuals were detected along an intermittent creek in a pasture ("Valley Field") on Hawthorne Valley Farm

Marsh fern, which grows in colonies in several of the grazed wet meadows on Hawthorne Valley Farm ("Valley Field, North Hill, West Hill)

Nodding lady's tresses, which maintains a small population in a grazed wet meadow and adjacent upland pasture at the base of "North Hill" at Hawthorne Valley Farm

Turtlehead, found scattered in the wet pastures of "Valley Field", "North Hill", and "West Hill"

Common blue-eyed grass, which is recognized as endangered in New Jersey and several Midwestern states, occurs in small numbers in about half the pastures at Hawthorne Valley Farm and has also been found at another farm

American mannagrass, considered regionally rare by Hudsonia, occurs on Hawthorne Valley Farm in the grazed wet meadow at the base of "Atelier" field and in the adjacent wetland along the cow lane

Green-headed coneflower, considered regionally scarce by Hudsonia, grows scattered along the "Farm Creek" at Hawthorne Valley Farm.

In the same wetland, we found **thin-leaved coneflower**, considered of uncertain status by Hudsonia, which forms a conspicuous patch along the lower Farm Creek. This species was also found on one of the other farms.

Squarrose sedge, considered regionally scarce by Hudsonia and recognized as a species of special concern in Connecticut, grows in the grazed wet meadows of the "North Hill" at Hawthorne Valley Farm.

The same meadows might also harbour **retrorse sedge**, a species considered of uncertain status by Hudsonia. The identification of that species needs to be verified by a taxonomic specialist.

Toad rush, considered potentially regionally rare by Hudsonia, was found once in a wet spot of a hayfield managed by Hawthorne Valley Farm (Iselin property)

In addition, we found the following wetland species to be uncommon on Columbia County farms and potentially declining compared to their historically reported abundance in the County:

Allegheny monkey-flower, **bulbiliferous water-hemlock**, **ditch stonecrop**, **dock-leaved smartweed** (not at HVF), **figwort** (not at HVF), **golden ragwort**, **mannagrass**, **marsh St.-Johns-wort**, **narrow-leaved speedwell**, **sunflower**, **swamp candle**, **water parsnip**, **water smartweed** (not at HVF), **wild onion** (not at HVF), and **yellow avens**.

Plants of upland (often dry) meadows

Only 14% of the native plants found on farms occurred exclusively on upland meadows. However this group is two thirds composed of species that occur(red) in Midwestern tallgrass prairie and also includes a number of species of conservation concern. These species do not compete well with the introduced species that dominate pastures on good soils, but they find their habitat on dry, hill-side pastures. However, these habitats are dwindling as they are abandoned to natural succession. At Hawthorne Valley Farm, parts of “Steep Hill”, “West Hill”, “North Hill” and “Indian Valley” represent this kind of pasture.[4]

A couple of species in this group occurred in a different agricultural environment: on fallow corn fields that had been left to spontaneous succession. Soil conditions were clearly not yet good enough to support the more demanding introduced pasture species, and the uncommon native meadow plants found a (temporary) niche.

Table 4.2 lists the upland meadow species of conservation concern and/or uncommonly found on Columbia County farms.

Most of these native grassland species used to have a large habitat in the Midwestern tallgrass prairies. Locally, they became more common with the opening of forest for agriculture and the formation of grasslands through grazing of the native vegetation. Eventually, as we will see in the section below, even grasslands that never were seeded with introduced grasses and legumes were colonized by a range of introduced pasture plants. The native plants often were able to maintain their foothold in dry soils, where the introduced species could not out-compete them. Thus, hill-side pastures with their thin layer of soil and multiple rocky outcrops remain a refuge for these species. These dry hill-side pastures appear to be a rare feature on farms in Columbia County. Because their agricultural productivity is low, they were the first areas to be abandoned and to grow back into forest when the peak of agricultural activity in the County was past. More recently, the remaining open hillsides have come under increasing pressure for housing development. Steep, occasionally mowed roadsides, such as portions of the Taconic Parkway, as well as the vegetation along railways and under power lines, provide habitat for some of these species (e.g., little bluestem), but given the huge loss of tallgrass prairies to large-scale agricultural monoculture, it would be nice to think that diversified farms in our region are able to provide some refuge for these prairie species.

Table 4.2. Upland meadow species of conservation interest.

Common Name	Species	Tallgrass Prairie Component[4]	conservation interest[2]	Hawthorne Valley	Steep Hill	West Hill	Valley Field (North Hill)	North Hill	Indian Valley	Chaseholm (initial observations)	Gumaer	Harrier Field	Little Seed Garden	Miller's Crossing	Threshold
Bee balm	*Monarda fistulosa*	x	uncommon on CC farms												x
Blue curls	*Trichostema dichotomum*		uncommon on CC farms	x					x						
Blue wax	*Cuphea viscosissima*	x	possibly regionally rare	x	x										
Common juniper	*Juniperus communis*		uncommon on CC farms	x				x							
Field milkwort	*Polygala sanguinea*	x	possibly regionally scarce	x										x	
Field thistle	*Cirsium discolor*	x	uncommon on CC farms							x					
Field-pussytoe	*Antennaria neglecta*	x	uncommon on CC farms	x	x			x	x						
Fragrant cudweed	*Gnaphalium obtusifolium*	x	uncommon on CC farms											x	
Grey goldenrod	*Solidago nemoralis*	x	uncommon on CC farms	x			x	x	x	x					
Little bluestem	*Schizachyrium scoparium*	x	uncommon on CC farms	x	x			x	x						x
Little sundrops	*Oenothera perennis*	x	uncommon on CC farms; endangered in Kentucky, threatened in some midwestern states										x		
Low bindweed	*Calystegia spithamaea*	x	uncommon on CC farms; protected or of special concern in neighbouring states											x	
Mountain-mint	*Pycnanthemum tenuifolium*	x	uncommon on CC farms	x	x		x								
Mountain-mint	*Pycnanthemum cf. incanum*		uncommon on CC farms							x					
New Jersey tea	*Ceanothus americanus var. americanus*	x	regionally rare	x	x										
Pasture rose	*Rosa carolina*	x	uncommon on CC farms	x	x			x	x	x				x	x
Ragged-fringe orchis	*Habenaria lacera*	x	protected as exploitably vulnerable by New York State, poss. reg. rare	x	x	x									
Silverrod	*Solidago bicolor*		uncommon on CC farms	x					x						
Smooth aster	*Aster laevis*	x	uncommon on CC farms	x				x							
Sweet fern	*Comptonia peregrina*	x	uncommon on CC farms, protected in some midwestern states	x	x				x		x				x
Tall white beard-tongue	*Penstemon digitalis*	x	uncommon on CC farms	x				x					x		
Whorled milkwort	*Polygala verticillata*	x	possibly regionally scarce	x				x							
Wild basil	*Satureja vulgaris*		uncommon on CC farms	x	x					x					

NATIVE PLANT DIVERSITY AND AGRICULTURAL PRODUCTION.

Native weeds in gardens and rowcrops

To our knowledge, native plants rarely become really toublesome weeds in market gardens and cornfields in Columbia County (compared, at least, to the headaches caused by certain introduced weed species). Probably the worst native weed around is ragweed. Common evening primrose, common milkweed, fall panicum, false nut sedge, fleabane, longleaf ground-cherry, wood sorrel and Pennsylvania smartweed also have been found in vegetable gardens or cornfields.

Native plant diversity and agricultural productivity of pastures

The agricultural productivity of 16 pastures at Hawthorne Valley Farm was compared by Laura Weiland (2004; available on-line at www.hawthornevalleyfarm.org/fep/fep.htm). The agricultural productivity of a pasture was measured as the herd's milk production on the day after the cows had grazed on the respective pasture. Data for the years 1999 through 2003 were studied. The standardized vegetation surveys yielded comparable information of native plant coverage. The milk production on each pasture was then compared to the average milk production for the herd during the particular year and season. The Figure 4.1 illustrates the relationship between milk production (1=much less than average; 2=less than average; 3=around average; 4=more than average; 5=much more than average) and the percentage of native vegetation cover in the pasture.

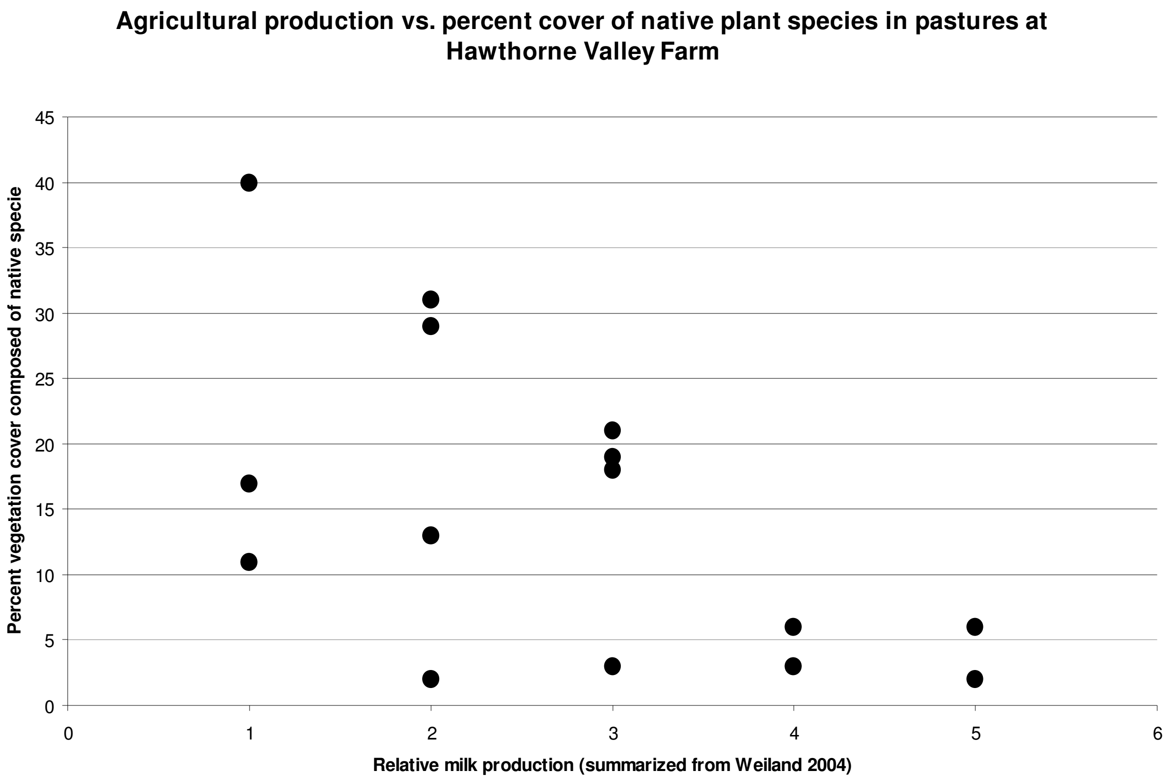


Figure 4.1. Relative milk production on Hawthorne Valley Farm pastures vs. *percent* of cover composed of native species.

There is a clear tendency for the most productive pastures to have a small proportion of their vegetation cover composed of native species. Some pastures have a low milk production and a low proportion of native vegetation, but the pastures with the highest proportion of native vegetation consistently have a low milk production.

Figure 4.2 shows the relationship between relative milk production and the total number of native species found in each pasture.

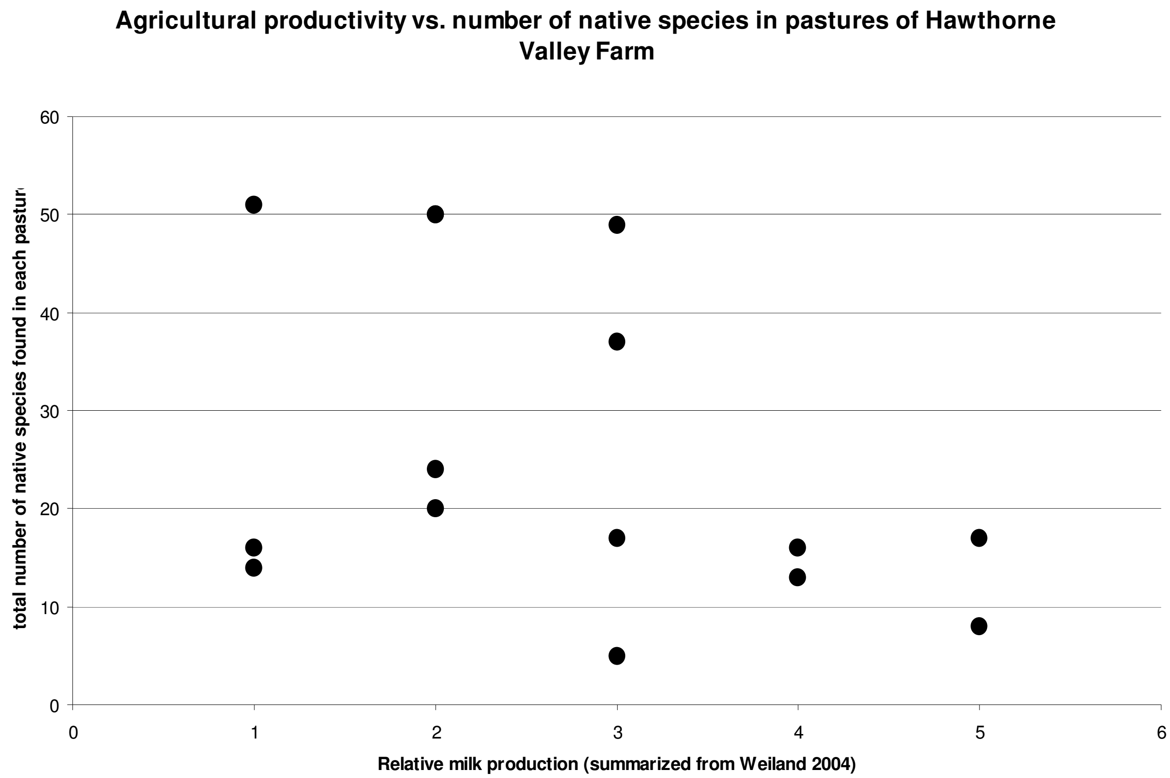


Figure 4.2. Relative milk production on Hawthorne Valley Farm pastures vs. *total number* of native species found in given pasture.

Again, the most productive pastures consistently do not provide habitat for a high diversity of native species, while the pastures with the lower production may or may not have a high diversity of native species. Interesting is the fact that there are two pastures (West Hill and North Hill), where average agricultural production is compatible with a considerable number of native species.

On Hawthorne Valley Farm pastures, milk production did not appear to increase with an increase in native species. While reasonable milk production seems possible in spite of the presence of many native species, native plant species may be out-competed by introduced plants on the best soils, and hence on the pastures supporting the highest milk production. Obviously, one can not expect farmers to let their most productive pastures degrade so as to provide more habitat for native plants. However, the knowledge that several native plant species depend for their survival on the continuation of grazing in marginally productive pastures might provide some justification for not letting those pastures grow into forest.

INVASIVE SPECIES ON COLUMBIA COUNTY FARMS

Of the invasive plants listed in the *New England Invasive Plant Atlas*, 33 were found on Columbia County farms (marked in Appendix 2). Most of them occur on the meadows and include such common pasture weeds as gill-over-the-ground, field garlic, bittersweet, creeping buttercup, moneywort, sheep sorrel, ragged robin, and reed canary grass. These seem to occur in tolerable densities on all studied farms and don't seem to worry the farmers.[5]

An invasive species that might merit more concern and active management is **spotted knapweed** which was found on most farms and in particularly dense populations on the dry hill-side meadows of Hawthorne Valley Farm. This species produces a chemical that inhibits the growth of other plants in the immediate area and might well contribute to the degradation of these already marginally productive meadows. Its population dynamics and interaction with more desirable native species, such as little bluestem, might be an interesting subject for further study at Hawthorne Valley Farm.[6]

A well-recognized nuisance on most farms is **multiflora rose,** which spreads quickly in hedgerows and into meadows. At Hawthorne Valley Farm, considerable effort is already going into keeping its population at bay. Of the other invasive shrubs found in the hedgerows, **oriental bittersweet** and **autumn eleagnus** might merit monitoring. The gardener of Hawthorne Valley Farm names **Canada thistle** as the most aggressive and hardest to manage garden weed. In the wetlands, **purple loosestrife** and **common reed** should be monitored and not allowed to spread extensively.

Of big concern at Hawthorne Valley Farm are the approximately one dozen clumps of **Japanese knotweed** that have established themselves along the shore of the Agawamuck. A concentrated effort over several years might be necessary to eradicate this highly successful invasive. If unchecked, it will certainly spread further along the creek and might eventually come to dominate its banks. In the forests of Hawthorne Valley Farm, one might consider the elimination of the **Norway maple** trees and the **Japanese barberry** bushes. **Garlic mustard** grows densely in the alluvial forest along the Agawamuck and might, in the long-term, have a negative impact on the exceptionally rich spring flora of that forest. However, the resident biologist, Craig Holdrege, who has been observing that flora for more than a decade, has the impression that the garlic mustard population within the alluvial forest waxes and wanes and does not seem to spread deeper into the forest of Phudd Hill. He also did not recognize any alarming trends in the native, co-occurring spring flora. This garlic mustard population might be another fruitful subject for further study and experimentation.

On three of the other farms, we noted individuals of the highly invasive **tree of heaven.** These might merit monitoring to avoid their unwanted spreading.

Concluding Thoughts on Farm Management

If the conservation of native plants is of interest to the farmer, the following general measures will likely be of benefit:

- Keep woodlots

- Don't remove established hedgerows. Don't keep field margins too tidy.

- Avoid drainage of wet meadows and continue the management that has kept them open, e.g., light grazing. Should wet meadows directly abut a creek, it usually is justified to restrict the access of grazing animals to the creek to reduce siltation, even if that measure may result in a reduction of habitat for native plants of open wetlands. The same is true for the shore of watering ponds. Restricted access reduces wetland plant damage from trampling and benefits the amphibians at the same time.

- If the farm has old fields or marginally productive pastures that are slowly being overgrown by shrubs, consider rotational brush-hogging or browsing and continuation of light grazing to maintain their suitability as habitat for native tallgrass prairie species. Where considerable populations of native grasses already occur, consider management for these grasses as forage.

Future Work

Depending on the interests of the collaborating farmers, we propose to continue the surveys for plant species of conservation interest, especially in open wetlands, wooded riparian areas, and in certain pastures of several Columbia County farms. At Hawthorne Valley Farm, we propose to start at least a monitoring, if not an active management program, related to some of the invasive plants mentioned in detail in the above section on invasive plants. Most interesting for future research on native plant conservation at Hawthorne Valley Farm are the dry hill-side pastures of Steep Hill, Indian Valley and North Hill. We propose to establish a monitoring program for the little bluestem populations already on these pastures, in addition to keeping an eye on the rare and uncommon native plants, and to start experimental removal of shrubs. More research is also needed to determine the potential forage value of the little bluestem and the best grazing schedule to encourage its spread within the pastures.

Part 5: Hedgerows, Fencerows & the Like.

Introduction

Hedgerows have a checkered reputation. From England comes the image of hedgerows and windbreaks as bastions of botanical diversity. Surely a truism once one has removed most of the forest. From the Midwest comes the demonizing of hedgerows as the eyries of raptors who fall upon hapless grassland birds. This is perhaps most true when hedgerows are the only trees in sight. The role of hedgerows, in our landscape, where forest abounds, is probably more subtle.[1]

When we discuss "hedgerows", we also mean windbreaks or fencerows – basically any stretch of woody vegetation bordered on either side by grass and/or brush. This can include riparian woods along the banks of a stream that winds through agricultural land. At what width a stretch goes from being a hedgerow to being a patch of woods is arbitrary and depends upon which woodlike attribute one chooses to focus on. For some small insects, a 6-foot wide strip of trees may feel sylvan indeed. For a large buck, such a slim portion would seem poor forest grounds.

Hedgerows can arise through several different routes:[2]

1) as relicts – the last standing remains of what was once a forest blanket.
2) as spontaneous incidentals – the woody "weeds" that happen to grow up along walls and fences as those areas escape the repeated clearing occurring on the fields that they border.
3) as plantings – shrubs or trees intentionally planted as living fences or windbreaks.

Mixed origins are possible, but these scenarios help one think about what hedgerows can represent ecologically. Relict fencerows are probably the rarest in our part. Judging from historical images (Figures 5.1 and 5.2), most of our farmland was probably well cleared of forest before it was laid out in fields. Most of our hedgerows probably grew in of their own accord – certainly the 1948 aerial photo of Hawthorne Valley show thinner fencerows. Hedgerow planting is probably most common as a form of domestic gardening rather than farming. There may have been sporadic agricultural attempts at 'live fences' (i.e., fences constructed by planting rows of certain spiny trees or bushes), but none seemed to be widely successful. Multifloral rose, initially introduced for live fencing, has taken up hedgerow building of its own accord. It is one of the first species to appear along new fences or field margins. However, it is generally too invasive for farmers to willfully want to encourage it.

Figure 5.1 - 5.2. Early images of local farmland. The top image is an etching of Philmont (the nearest large town to Hawthorne Valley Farm); it was published in 1881. Below is a 1948 aerial photograph of Hawthorne Valley. The barns are in the middle of the picture.

Study Methods

Our hedgerow work has so far has focused on Hawthorne Valley Farm. We spent late autumn and early winter of 2004 mapping the woody vegetation of many of that Farm's hedgerows. Our goal was to better understand what subset of plants makes their home in such areas and to gain a better idea of how these hedgerows may have arisen and evolved. With the help of a GPS, we mapped individuals of the larger or scarcer woody plants and outlined patches of the more abundant species. We summarized these results in terms of the number of native species found in roughly equal stretches of fencerow. We also explored the distributions of individual species so as to better understand the diversity patterns.

What We Found & What We Think It Means

The diversity of native woody plants was highest where hedgerows abutted forest and lowest in the center of the farm (see Figure 5.3). Two collaborating factors probably resulted in this pattern. On the one hand, because these are mostly spontaneous hedgerows ("planted" by birds, squirrels and the whims of wind blown seeds), they are most diverse nearest the source of such seeds, i.e., the forests. At the same time, the more centrally-located stretches are probably the ones most heavily influenced by farming activities such as the grazing which may well partially control their growth.

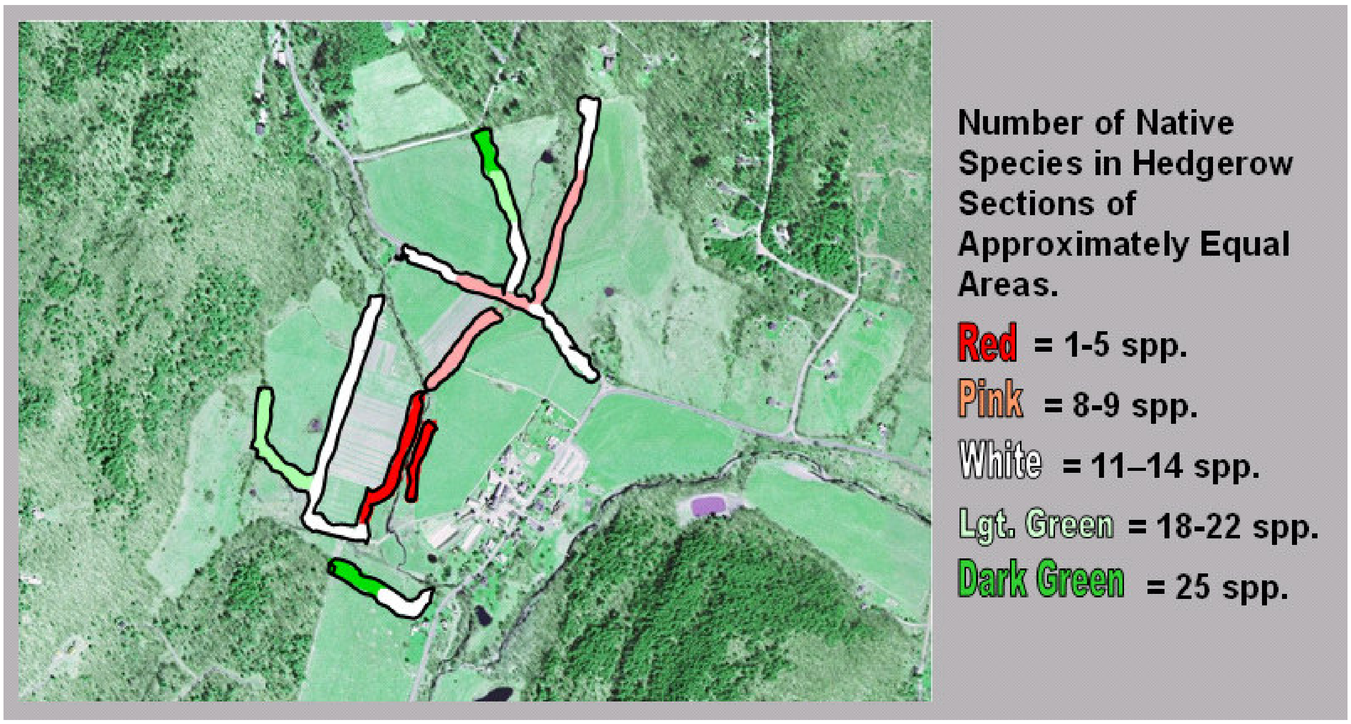


Figure 5.3. Diversity patterns in the hedgerows of Hawthorne Valley Farm.

We have divided the fencerow species into five different ecological groups based upon their distribution patterns and their means of seed dispersal.

The most abundant fencerow species are the *Super-Colonizers*. These are species which have many small, bird-dispersed seeds; which are thorny (and thus deter browsing) and fast-growing; and which prosper in full sunlight. The archetypical species in this group are the multiflora rose and the various brambles (blackberry, raspberry and their ilk). These species were found in almost all hedgerows, although, because of their sun-loving nature, they probably become less common in those fencerows with taller, more forest-like woody vegetation. See Figure 5.4.

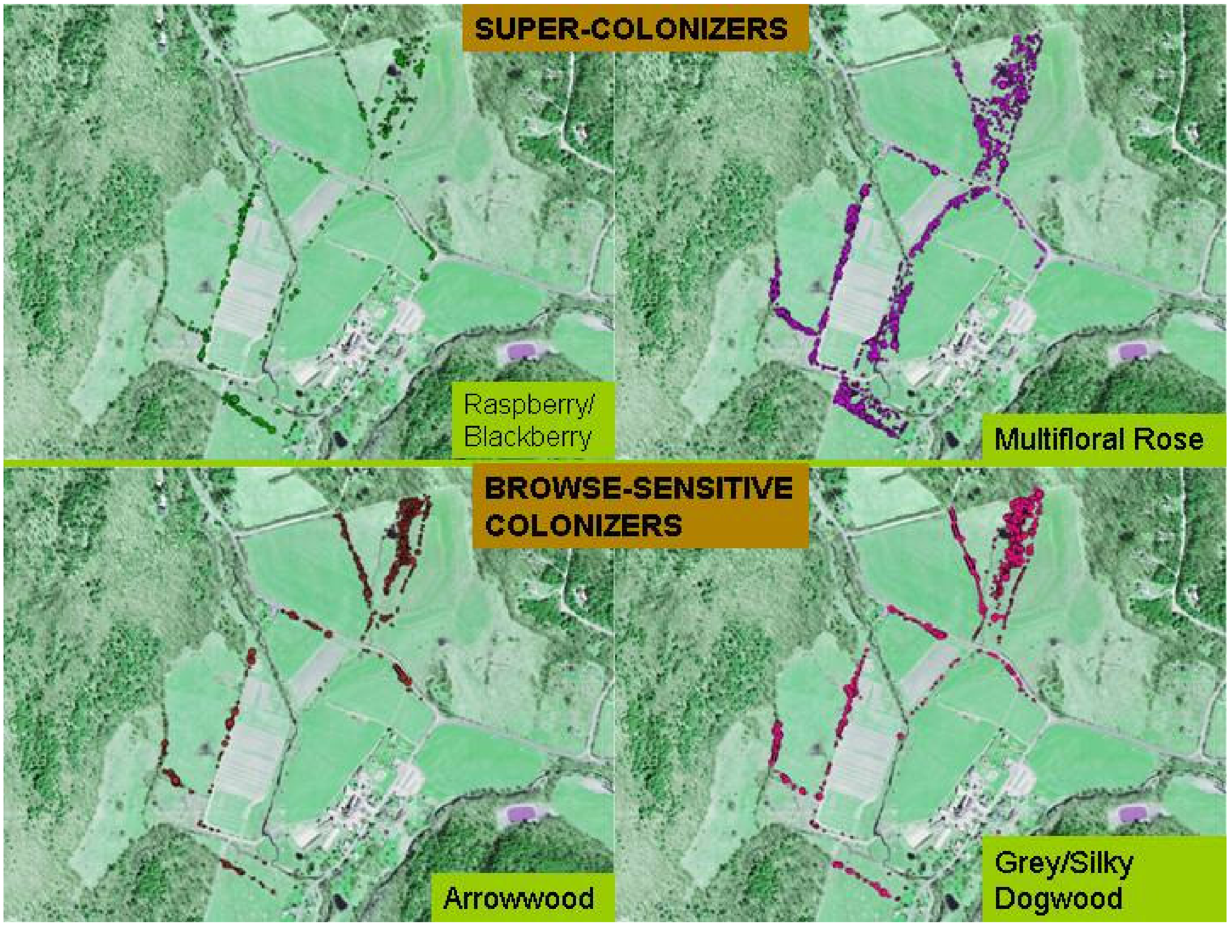


Figure 5.4. Species distributions of select woody species in the hedgerows of Hawthorne Valley Farm. Colored dots indicate the location of individuals or patches of given species. See text for further explanation.

Next in apparent abundance are the *Browse-sensitive Colonizers*. These are species which share the love of sunlight and ease of seed dispersal characteristic of the first class, but who are unarmed. Their smooth stems do little to deter browsing. Exemplars of this group are arrowwood and the dogwoods, both native taxa. While they range widely in the hedgerows, they are largely absent from the most intensively-used central stretches. See Figure 5.4.

The *Weedy Trees* are also fairly widespread. They produce fruits and have bird-dispersed seeds, or they have light, wind-dispersed seeds. They are apparently dispersed widely, and they are eager to grow in sunlit spaces. Being slower growing, and perhaps more delectable to browsers, they are somewhat rarer than the earlier classes. Typical of this group are black cherry, hawthorn, apple, and American elm. At least with black cherry and elm, one begins to see hints of greater abundance near forested areas. See Figure 5.5.

Bringing up the rear are the *Adventurous Forest Trees*. These species tend to have heavier seeds; some are still wind-dispersed, others distributed by mammals and gravity. They are likely browse-sensitive. Representatives of this group include red maple, white ash, red oak, and the hickories. Here the pattern of greater abundance near forests is readily apparent. See Figure 5.6.

Finally, there are a few species whose distributions may be more affected by soil conditions; for example, the lovers of moist soil such as willows, red-osier dogwood, speckled alder, and Spirea species.

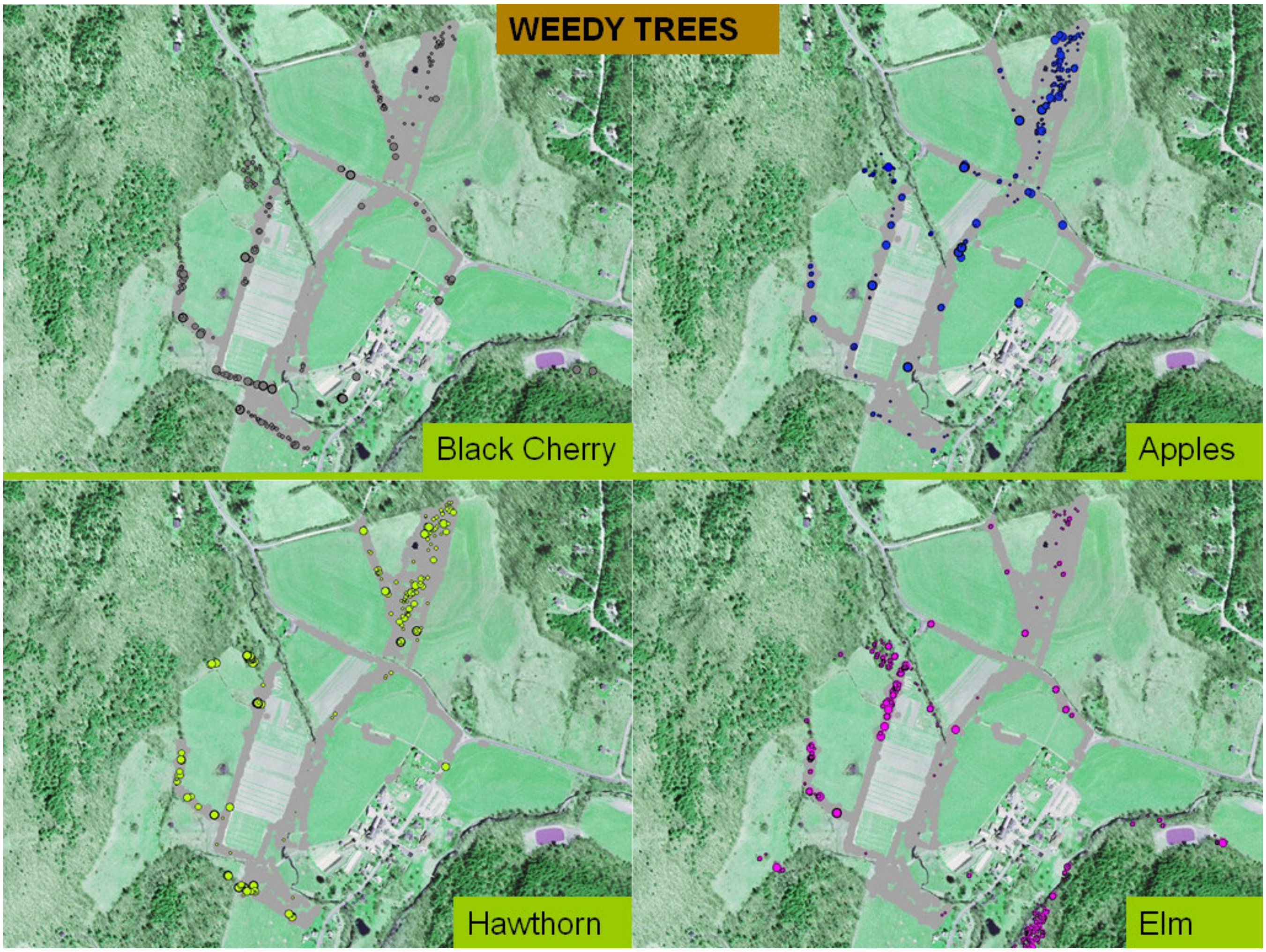


Figure 5.5. The species distributions of “weedy trees” in the hedgerows of Hawthorne Valley Farm. Colored dots indicate the location of individuals or patches of given species. See text for further explanation.

That our hedgerow species can be rather neatly categorized into these groups provides, together with historical research, strong evidence that our hedgerows evolved spontaneously as fencerows went uncleared.

Our results also support an interesting supposition more strongly developed by other researchers: the idea that those woody plants growing along fences may differ from those growing along overgrown stonewalls. Picture for a moment a wire fence and a stone wall. Likely as not, a bird will fly into your image of the first and a chipmunk scurry into your vision of the latter. Think then about what these animals eat, and you will quickly realize how plants such as black cherry, multiflora rose, and Viburnums may quickly arrive below fences, and how oaks and hickories may rapidly colonize stonewalls. In our case, the pattern may be somewhat confused by the fact that most of our “stonewalls” are probably more accurately described as long stone heaps, piles that field-clearing farmers created as they threw stones beneath wooden fences that were subsequently replaced by wire. Thus, both bird and rodent have likely visited our stone wall “fence lines”. However, the hedgerows along simple barbed wire do show an abundance of bird-dispersed species such as cherries, brambles and roses.

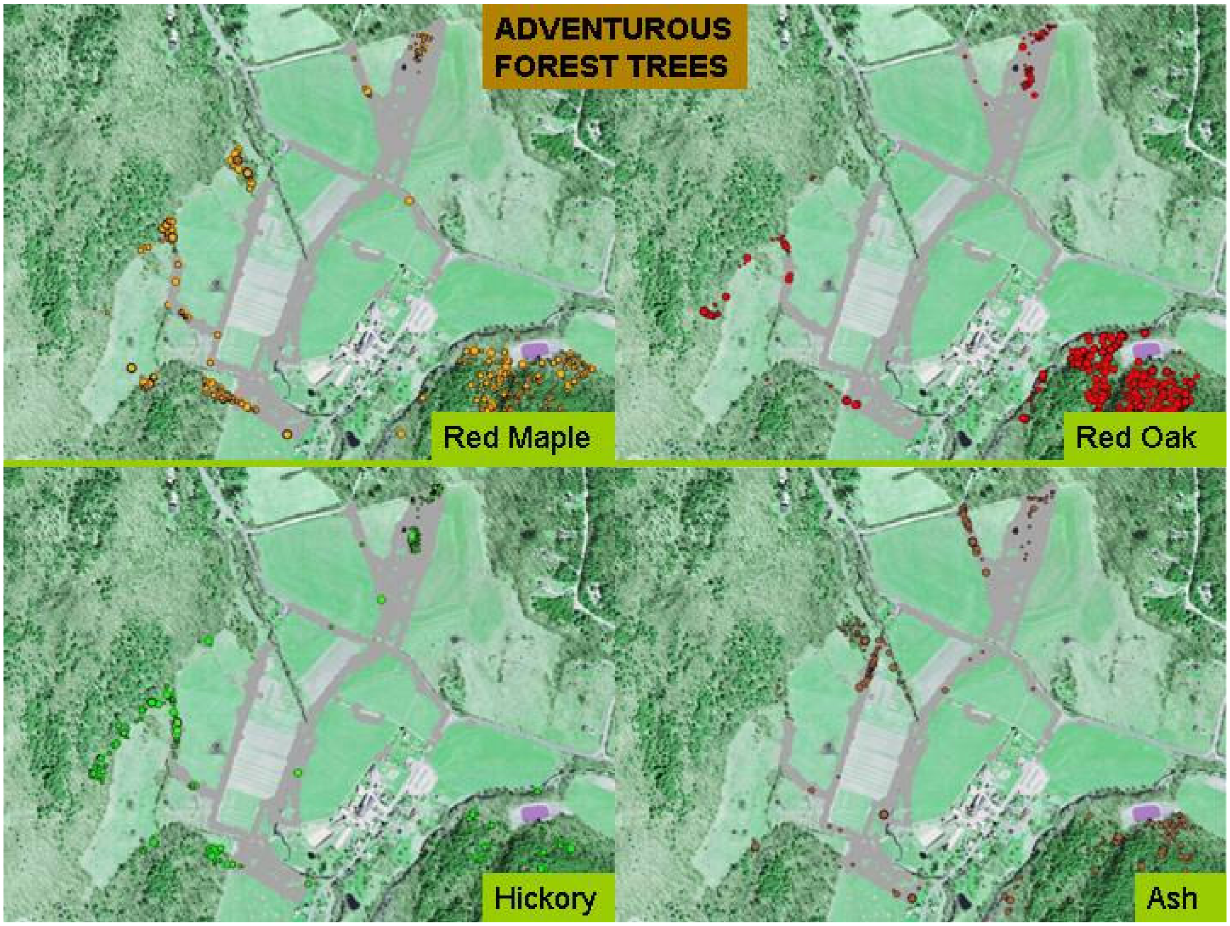


Figure 5.6. The distributions of "adventurous trees" in the hedgerows of Hawthorne Valley Farm. Colored dots indicate the location of individuals or patches of given species. Where available, the distribution of the given species in surrounding forest has also been indicated. See text for further explanation.

So what? What role do hedgerows play in on-farm conservation? We have already alluded to their probable value as buffers to riparian areas. But what value do they have in their own right for native plants and animals? While few of the woody plants that we found in hedgerows were unusual, the growth of a few native woodland shrubs, such as beaked hazel and nannyberry, seemed particularly exuberant in certain hedgerows. As mentioned in the preceding chapter, winterberry and flowering dogwood, two woody species of conservation interest, were found in hedgerows. Hedgerow also happened to be the only place we found green briar, carrion flower, smooth sumac, and common elderberry at Hawthorne Valley, although these are not generally considered unusual species. We did not systematically survey the herbaceous plants of hedgerows, however see Part 4 above for an account of our incidental observations.

Researchers in Quebec looked at the role of hedgerows as reservoirs of weeds and avian pests and as sources of native plant biodiversity. Studying both woody and herbaceous plants, these workers found that the lowest weed density was in natural, woody fencerows, as opposed to planted hedgerows or mainly herbaceous ones. This work implied that, from a weed's perspective, rather than periodically cutting back hedgerows, they should be allowed to develop into wooded margins. Such hedgerows also were home to a higher number of native plants of "conservation interest". No evidence was found that hedgerows in their area were home to high numbers of crop-damaging birds.

We did tally Groundhog holes along our fencerows. In slightly over 3 km of fencerows, we found the entrances to roughly 140 Groundhog holes, with the highest densities in the hedgerows around the vegetable gardens. Because Groundhogs may dig numerous burrow entrances and because probably not all of these holes were active, this is not an estimate of Groundhog numbers (thank goodness), but it does indicate patterns of occurrence. Some holes were found at a distance into the neighboring fields, and whether the Groundhogs were looking for hedgerows *per se* or simply for less-utilized land near the gardens was not clear. While removing hedgerows might make Groundhog control easier in and of itself, it might not reduce their populations.[3]

Probably the strongest ecological reason for maintaining hedgerows, aside from their afore-mentioned buffering ability along streams, is as wildlife corridors and homes to shrubland birds. While we are still assembling our winter tracking data, we have followed mink, fisher and bobcat through (mainly riparian) hedgerows of Hawthorne Valley Farm. Such wooded links provide corridors by which forest animals can easily pass between woodland patches. We did record around 50 bird nests in about 3 km of hedgerows (Figure 5.7). Although we were not able to positively identify which birds made which nests, our bird watching has told us which species frequented these habitats. Those data are summarized in the next chapter of this report.

Figure 5.7. The location of birds nests (brown dots) in the hedgerows (indicated by grey) of Hawthorne Valley Farm.

Hedgerows are also sometimes considered in relation to agricultural productivity. Their effects on windspeed and evapotranspiration apparently result in a slight net positive influence on crops, at least in large Midwestern and Australian agricultural settings. Their importance for agriculture at the scale practiced in Columbia County has been less thoroughly researched. The swirling air associated with our small fields and hilly terrain, coupled with a climate that perhaps does not see the growing season extremes of more continental areas, may reduce their microclimatic benefits. Their agricultural influence through biotic effects is probably mixed. On the one hand, as mentioned, they do harbour weeds and certain invertebrate and vertebrate pests that can plague crops; on the other hand, they are also home to native pollinators and beneficial birds. Greater research is needed to clarify all these effects. However, given the general abundance of forest in the region and the often relatively small field sizes, it may be hard to document any strong effects on production.[4]

Part 6: Farmland Birds

Introduction

Generations of farmers come and go. Each farmer works the earth in their own way, reaps their own crops, creates their own patterns on the landscape. Birds are watching this, generations of birds. Ever hopeful for a good nesting site, a variety of birds reads the hand of the farmer on the land, looking for just the right combination of habitat characteristics. The pattern created by the distribution of nesting birds across a farm provides us with one way to view a farm's imprint in Nature's clay. What do these birds want? What do we now provide? What can we easily provide and yet don't? Our goal in studying farm birds is to better understand which birds are using our county's farms, and then to explore the implications of those distributions for designing mutually beneficial (or at least tolerable) interactions between these birds and farm management.

Who are the farm birds? Given that our definition of a farm includes its woodlots, potential farm birds are all the birds that might occur in the County. However, we'll concentrate on the birds of grasslands and shrublands. These are the habitats which farms are most directly responsible for creating and maintaining. The declines in North American grassland birds have been widely recognized. The declines in shrubland birds are only beginning to come to light.[1]

Given the fact that prior to European settlement much of our region was forest, one can well ask why grassland birds and their habitats should be preserved in the Northeast at all. The decline of farming (and hence the loss of grasslands) in the Northeast was paralleled by the expansion of agriculture in the Midwest. The result was that as grassland birds lost ground in our region, their original native prairies were likewise disappearing. Reportedly less than 10% of original North American grasslands remain. Due to this decline in their demographic heartland, Northeast grasslands became relatively more important for these birds. The Table 6.1, taken directly from the paper by Wells and Rosenberg, shows the percent of total grassland breeding bird populations estimated to live in each of six different regions. Northeast grasslands provide fairly good habitat for several grassland birds, especially when one realizes that the Midwest region here defined is nearly twice the size of the Northeast.[2]

The justification for the preservation of shrubland habitats is a bit different. As we shall discuss later, most birds which we consider to be shrubland species were probably associated with shrubby wetlands prior to the extensive shrublands created by agricultural edges and abandoned farmland. It is likely that they have recently experienced a population boom from which they are only now receding as farmland reverts to forest or development. Unlike the case for grassland birds, it would be difficult to argue that shrubland bird populations saw anything but a national increase over the past 300 years. Thus, as agriculture wanes, their populations naturally decrease towards earlier levels. There would be little justification for concern if it weren't for the fact that much of the scattered natural habitat that they once relied upon has disappeared. Overall, in the continental United States, it is estimated that wetlands have declined more than 50% during the past 200 years, from nearly 215 million to around 105 million acres. In NY, Pennsylvania and southern New England, acreage has decreased from about 7% of the surface area to 3%. The majority of this loss was due to draining of lands for agriculture and development along the banks of streams, rivers, ponds and lakes. Thus, if shrubland birds were to be forced to rely upon their former haunts, their populations would likely drop to nearly 50% of pre-European settlement levels. Furthermore, we limit some of the natural disturbances, such as flood and fire, which can result in successional shrublands.[3]

Table 6.1. Wells and Rosenberg's table showing the estimated percent of important grassland bird breeding populations believed to occur in several regions of North America.

Species	Region					
	NE	SE	MW	GP	SW	CAN
Upland Sandpiper	0.3[a]	0.0	5.6	85.0	0.0	9.1
Horned Lark	0.1	0.1	6.0	47.5	13.7	19.4
Savannah Sparrow	1.6	0.0	9.1	5.1	0.0	81.7
Grasshopper Sparrow	3.6	2.2	19.8	70.0	4.1	0.2
Henslow's Sparrow	21.3	0.0[b]	78.6	0.0	0.0[c]	0.0
Vesper Sparrow	0.6	0.0	15.1	31.7	0.0	46.6
Bobolink	13.7	0.0	32.6	17.0	0.0	36.5
Eastern Meadowlark	5.4	31.9	23.3	3.6	35.1	0.6

Note: NE = Northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia); SE = Southeast (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee); MW = Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin); GP = Great Plains (Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming); SW = Southwest (Arizona, New Mexico, Oklahoma, Texas); CAN = Canada.

[a] Estimate may be low because BBS abundance was not calculated for most northeastern states.

[b] Small, recently discovered population in North Carolina.

[c] Large, recently discovered population in Oklahoma.

Thus, there is reason to suppose both that farmland habitats have been crucial to the populations of grassland and shrubland birds and that these species are now experiencing substantial declines in their habitats. There is therefore good cause to consider how the populations of these birds can be supported within the Farmscape.

Below, we profile the grassland species recorded from Columbia County farms and consider their history and possible management in more detail.

Study Methods

We collected bird information in two ways. First, we kept running lists of birds that we saw during farm visits and used lists assembled by others. Mike Scannell of Harrier Fields Farm is an astute birder and for many years has kept a list of the birds that he sees on his property. Hudsonia, a respected regional ecological research group, surveyed the birds of Roxbury Farm, and Jean-Paul Courtens of Roxbury shared that list with us. Our own list is most extensive for Hawthorne Valley Farm because that is where we have the most field time. Given the varying durations and efforts associated with these lists, they don't represent standardized descriptions of each farm's bird population. However, they do help us identify the most common farm birds of our region and, to a certain degree, allow us to talk of geographic patterns.[4]

In order to have a more standardized set of data that might let us compare fields more specifically, we conducted point counts. During 10-minute point counts, we tallied all birds which we saw within a 100 foot radius circle. Point counts were completed between sunrise and 9:30 a.m. during early summer. We tried to locate one or two point counts within each farm field, depending upon its size. Precise location was largely determined by how to fit census circles into field confines. Birds which flew over the circle in a straightline and at a high height were not included in the count tally. However, birds, such as swallows, who were foraging overhead, or whose behaviour suggested they were considering landing in the circle were included because we felt they were "using the space". Any additional bird seen or heard during the survey was also tallied on a separate list and included in the more generalized lists described above. We did a total of 147 point counts, amounting to 24.5 hours of observation.

As part of our point counts, we collected basic information on habitat. This included a generalized description of the site (e.g., cornfield, pasture, hayfield), maximum common vegetation height, and proximity of woody vegetation. We took two photographs at each site, and these helped us complete our habitat descriptions. We also recorded geographic location with a GPS.

There are several sources of historical data on birds. Since 1966, the breeding bird survey has taken annual standardized surveys of birds along fixed census paths. These data provide important information on breeding bird distributions and, importantly, regional bird population trends over the past forty years. More detailed distribution information is available from the New York State Breeding Bird Atlas project. The first edition of the Atlas was compiled in the late 1980s and the second edition has just finished collecting its field data. These data are available on-line and provide more specific distributional information, and comparison of the two editions gives general information on population trends.[5]

There are three major sources of information regarding earlier bird population levels in New York. John Bull's *Birds of New York* (1974) provides information on bird populations during at least the middle part of the 20th century. Elon Eaton's *Birds of New York* (1914) is a rich source of information for the turn of the century. He summarizes information for each county and from certain previous, regional bird lists. Finally, James De Kay's contribution to the Natural History of New York (1844) provides our first systematic account of New York bird species.[6]

What We Found

Appendix 3 lists all the species recorded on the eight farms for which we have data, the number of farms upon which they were found, probable breeding status, and historical data. This information includes birds seen anywhere on the farms (even in woodlots) and was collected over varying time periods. As such, it's best considered a first approximation of farmland birds, with some indication of relative frequency of occurrence. However, because some birds (e.g. crows, which were found on all farms) are much more apparent than others (e.g., grasshopper sparrows, which we didn't detect), this information should be treated with caution.

Our point counts give us a somewhat more rigorous tally of farm birds. Because we tried to identify and record all birds within each of our census plots and because we used a standardized technique, we can begin to compare bird populations among farms and fields. The Table 6.2 shows all species found on each farm during our surveys. In an effort to compare relative abundances, the figures presented for each species are in terms of "number of individuals seen per point count". However, because we did markedly more point counts at some farms than others (largely because of differences in the amount of grassland), our chances of recording rare species differed among farms. The physiographic region used for regional, "Northern New England", actually includes only the Taconic Hills portion of Columbia County, but it seemed the most relevant point of comparison amongst the result summaries available on-line. Vesper and Grasshopper Sparrow, while not sighted or reported on any of the farms in this study, were included in our table because they were recorded from the County by the most recent surveys of the New York State breeding bird atlas and are considered grassland bird of conservation importance.

We explored habitat relations of our grassland birds. Table 6.3 summarizes habitat characteristics for each grassland bird species found during point counts. We discuss the significance of these results below.

What We Think Our Results Might Mean

The Current Status of our Farmland Birds

Many of the grassland and shrubland birds we found on farms are, according to the National Breeding Bird Survey, experiencing significant declines nationally. Of the 31 birds we chose to explore in depth (because they occurred in our data and were grassland or shrubland species), 23 (or nearly 75%) are declining in North America. This is a stunning number given that it includes not only such relative rarities as Henslow Sparrows and Northern Bobwhite, but also such familiar birds as Red-winged

Blackbirds, Baltimore Orioles and Eastern Kingbirds. While the breadth of these declines indicates the need for broad action, much of what is happening continentally is reflected locally - thirteen of these

Table 6.2. Grassland and shrubland birds recorded during our study or of particular regional conservation interest. For abundances, dark red = rare, pink = uncommon, grey = present, light green = common, dark green = abundant. For population trends, dark red = significant declines estimated at greater than 3% yearly, pink refers to significant declines of less than 3% yearly, grey = no siginificant decline, light green = significant increase of less than 3% yearly and dark green = significant increase of more than 3% yearly.

		HISTORICAL ABUNDANCE						POPULATION TRENDS		
Species	Habitat	1830-1840	1880-1910	1950-1970	2000	% study farms upon which it occurs	Sightings per hour of point count	Local (Columbia County)	Regional (Northern New England)	North America
Bobolink	grass					62.5	3.02			
Eastern Meadowlark	grass					25	0.04			
Field Sparrow	grass					50	0.37			
Grasshopper Sparrow	grass					0	0		-	
Henslow Sparrow	grass					12.5	0	-	-	
Horned Lark	grass					25	0		-	
Killdeer	grass					87.5	0.16			
Northern Harrier	grass					37.5	0	-		
Red-winged Blackbird	grass					87.5	2.69			
Savannah Sparrow	grass					87.5	1.27			
Song Sparrow	grass					100	1.39			
Upland Sandpiper	grass					12.5	0	-	-	
Vesper Sparrow	grass					0	0			
American Goldfinch	shrub					87.5	0.98			
American Woodcock	shrub					37.5	0	-		
Baltimore Oriole	shrub					100	0.2			
Blue-winged Warbler	shrub					62.5	0			
Black-billed Cuckoo	shrub					12.5	0			
Brown-headed Cowbird	shrub					100	0.45			
Brown Thrasher	shrub					25	0	-		
Chestnut-sided Warbler	shrub					50	0			
Common Yellowthroat	shrub					62.5	0			
Eastern Bluebird	shrub					50	0			
Eastern Kingbird	shrub					62.5	0.08			
Eastern Towhee	shrub					50	0.04			
Grey Catbird	shrub					75	0.12			
Indigo Bunting	shrub					75	0.04			
Northern Bobwhite	shrub					12.5	0	-	-	
Northern Mockingbird	shrub					37.5	0.04			
Prairie Warbler	shrub					12.5	0.04			
Yellow Warbler	shrub					75	0.08			
Common Grackle	other					62.5	0.12			
European Starling	other	-	-			62.5	0.69			
House Sparrow	other	-	-			62.5	0.33			
Northern Flicker	other					87.5	0.04			
Plieated Woodpecker	other					37.5	0			
Scarlet Tanager	other					50	0.04			
Wild Turkey	other					50	0			
Wood Thrush	other					75	0			

Table 6.3. Habitat use by grassland bird in terms of average number of birds sighted during 10-minute point count. "N" refers to the number of point counts with the given habitat characteristic. For example, 25 of our point counts were done in areas where the vegetation was less than half of a foot high.

All values are average number of birds seen per pt. count in 100' radius circle.

BIRD SPECIES

Habitat Characteristic	balt oriole	barn swallo	bluejay	bobolink	catbird	chipping sparrow	cow bird	field sparrow	flicker	flycatcher	goldfinch	grackle	house spa	indigo bunting	Killdeer	kingbird	meadowlark
hgt of vegetation = <.5' (N=25)	0.00	0.84	0.04	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.16	0.00	0.16	0.00	0.16	0.00	0.00
hgt = .5-1.5' (N=60)	0.03	0.88	0.02	0.33	0.03	0.07	0.05	0.05	0.00	0.03	0.07	0.03	0.02	0.00	0.00	0.02	0.00
hgt=1.5'-2.5' (N=36)	0.08	0.44	0.08	0.83	0.03	0.00	0.08	0.06	0.00	0.00	0.19	0.00	0.03	0.03	0.00	0.00	0.03
hgt= 2.5'+ (N=26)	0.00	0.15	0.00	0.92	0.00	0.27	0.00	0.15	0.04	0.04	0.35	0.04	0.08	0.00	0.00	0.04	0.00
No woody plants nearby (N=126)	0.04	0.52	0.04	0.59	0.01	0.08	0.06	0.02	0.01	0.00	0.14	0.02	0.03	0.00	0.03	0.01	0.01
Some woody plants in or near (N=21)	0.00	1.38	0.00	0.00	0.10	0.05	0.14	0.33	0.00	0.14	0.29	0.05	0.19	0.05	0.00	0.05	0.00
alfalfa/clover (N=7)	0.00	0.14	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00
corn (N=11)	0.00	0.18	0.00	0.00	0.00	0.64	0.00	0.18	0.00	0.00	0.55	0.00	0.18	0.00	0.00	0.00	0.00
hay (N=59)	0.03	0.15	0.07	1.07	0.00	0.00	0.00	0.00	0.02	0.00	0.07	0.03	0.00	0.00	0.02	0.02	0.02
hay/pasture (N=5)	0.00	0.40	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pasture (N=48)	0.06	1.40	0.02	0.10	0.06	0.06	0.13	0.15	0.00	0.06	0.25	0.02	0.04	0.02	0.04	0.02	0.00
veggies/fallow (N=10)	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
total number of invididual sightings for given bird species	5	94	5	74	3	11	11	9	1	3	24	3	8	1	4	2	1

	mocking bird	mourning dove	prairie warbler	robin	RWB	savannah sparrow	scarlet tananger	song sparrow	spotted sandpiper	starling	swallow	swift	towhee	tree swallow	waxwing	yelo warbler
hgt of vegetation = <.5' (N=25)	0.00	0.00	0.00	0.20	0.04	0.16	0.00	0.20	0.04	0.32	0.24	0.00	0.00	0.20	0.00	0.00
hgt = .5-1.5' (N=60)	0.02	0.02	0.02	0.02	0.23	0.42	0.00	0.15	0.00	0.13	0.13	0.02	0.02	0.27	0.00	0.03
hgt=1.5'-2.5' (N=36)	0.00	0.08	0.00	0.08	0.89	0.06	0.00	0.28	0.00	0.00	0.06	0.00	0.00	0.00	0.03	0.00
hgt= 2.5'+ (N=26)	0.00	0.00	0.00	0.00	0.73	0.00	0.04	0.38	0.00	0.04	0.23	0.00	0.00	0.12	0.04	0.00
No woody plants nearby (N=126)	0.01	0.03	0.00	0.06	0.48	0.25	0.01	0.15	0.01	0.13	0.17	0.01	0.01	0.17	0.01	0.00
Some woody plants in or near (N=21)	0.00	0.00	0.05	0.05	0.29	0.00	0.00	0.71	0.00	0.05	0.05	0.00	0.00	0.10	0.05	0.10
alfalfa/clover (N=7)	0.00	0.00	0.00	0.00	0.71	0.86	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
corn (N=11)	0.00	0.00	0.00	0.00	0.27	0.00	0.09	0.36	0.00	0.09	0.64	0.00	0.00	0.00	0.00	0.00
hay (N=59)	0.00	0.07	0.00	0.03	0.66	0.07	0.00	0.14	0.00	0.12	0.10	0.02	0.02	0.25	0.02	0.00
hay/pasture (N=5)	0.00	0.00	0.00	0.00	0.20	0.60	0.00	0.20	0.00	0.80	0.80	0.00	0.00	0.40	0.00	0.00
pasture (N=48)	0.02	0.00	0.02	0.10	0.23	0.33	0.00	0.38	0.00	0.08	0.06	0.00	0.00	0.10	0.00	0.04
veggies/fallow (N=10)	0.00	0.00	0.00	0.10	0.40	0.10	0.00	0.10	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00
total number of invididual sightings for given bird species	1	4	1	9	66	31	1	34	1	17	22	1	1	24	2	2

bird species appeared to be absent or declining locally. These are grim statistics that reflect dramatic changes occurring in our bird fauna.

So, what has driven these declines? The large-scale answer is habitat loss, although this is happening for different reasons in different areas. In the Northeast, grasslands have mainly been lost to reforestation. Currently, (sub)urbanization is probably also a major factor. Below, we explore this pattern in relation to Columbia County. Background to this historical information was presented in Chapter 2.[7]

Local Grasslands: Historical Considerations

Between 1800 and 1900 Columbia County was part of the USA's breadbasket. At the peak of agricultural activity (ca. 1830-1900), more than 75% of the County's land was actively being farmed. This meant that there was a lot of habitat for grassland birds. Subsequent to 1900, farmland declined precipitously and forests rebounded. Figure 6.1 summarizes this history. "Improved Land" was the name applied to worked farmland, as opposed to land the farmer owned but did not work. There is something of a grey area here given that forests were sometimes pastured and were certainly used for wood. However, for the most part, "improved land" probably meant fields. Forest area was estimated by assuming most land that was not in farms, or that was on farms but "unimproved", was forest. Data available since 1950 suggest such an estimate is roughly accurate. Our shrub estimate is based upon change in forest cover and the supposition that what becomes forest must previously be shrub. It was calculated based on change in forest extent, because there were no direct tallies of this habitat. Most of the data shown below come directly from agricultural statistics on land use. However, the earliest values were calculated based on livestock numbers and their estimated grazing requirements.[8]

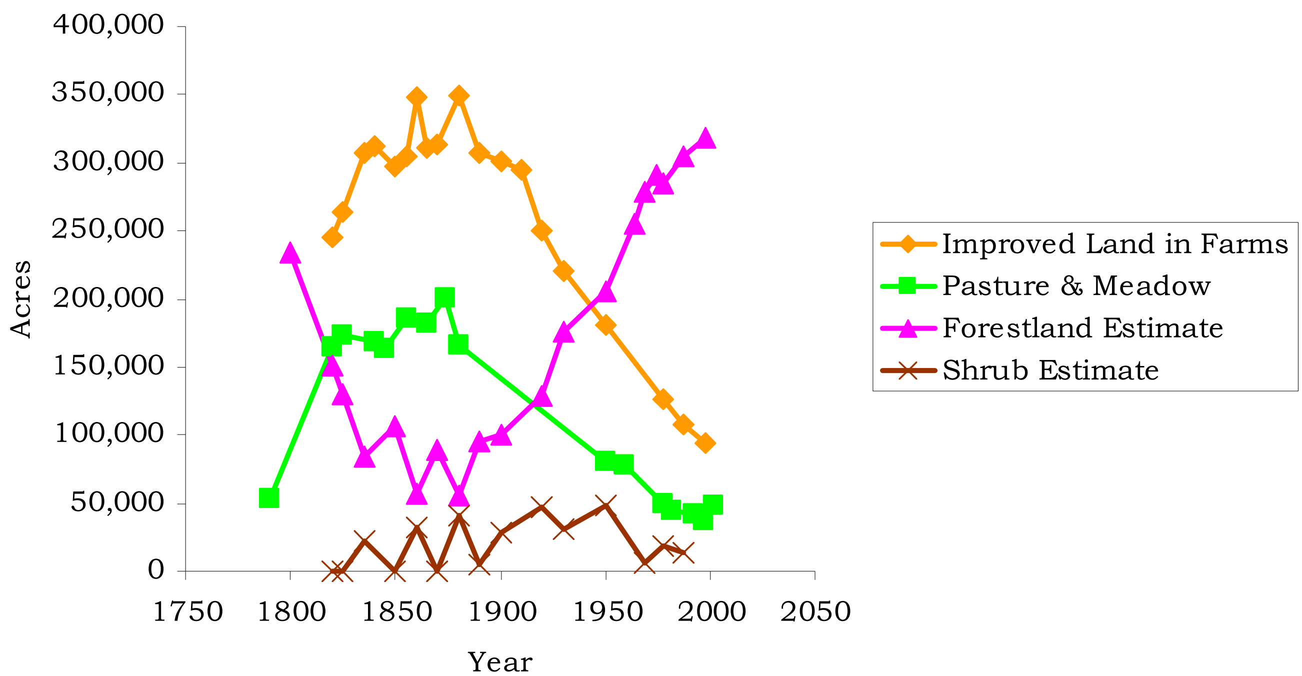


Figure 6.1. A graph showing the estimated historical extents of different habitat types in Columbia County.

The figure above makes obvious why our grassland birds have declined – forests have replaced grasslands. At the end of our agricultural era (ca. 1900), grassland birds were substantially more abundant than at present. Grasshopper Sparrow, Vesper Sparrow, Northern Harrier, Upland Sandpiper, Loggerhead Shrike and Northern Bobwhite were all reported to breed in the County around the turn of the 19th century. Few if any of these species currently do so. Eastern Meadowlark, while still present, is apparently rarer. Only Bobolink and Savannah Sparrow are still fairly frequent breeders in the County, although even they may be less common.[9]

The relative importance of (sub)urbanization in recent Columbia County grassland loss is difficult to quantify. However, a small case study from the Route 9 corridor north of Kinderhook illustrates some of what has occurred over the last 50 years (see Figure 5.2). First, apple orchards, and then, fields have been housed over.

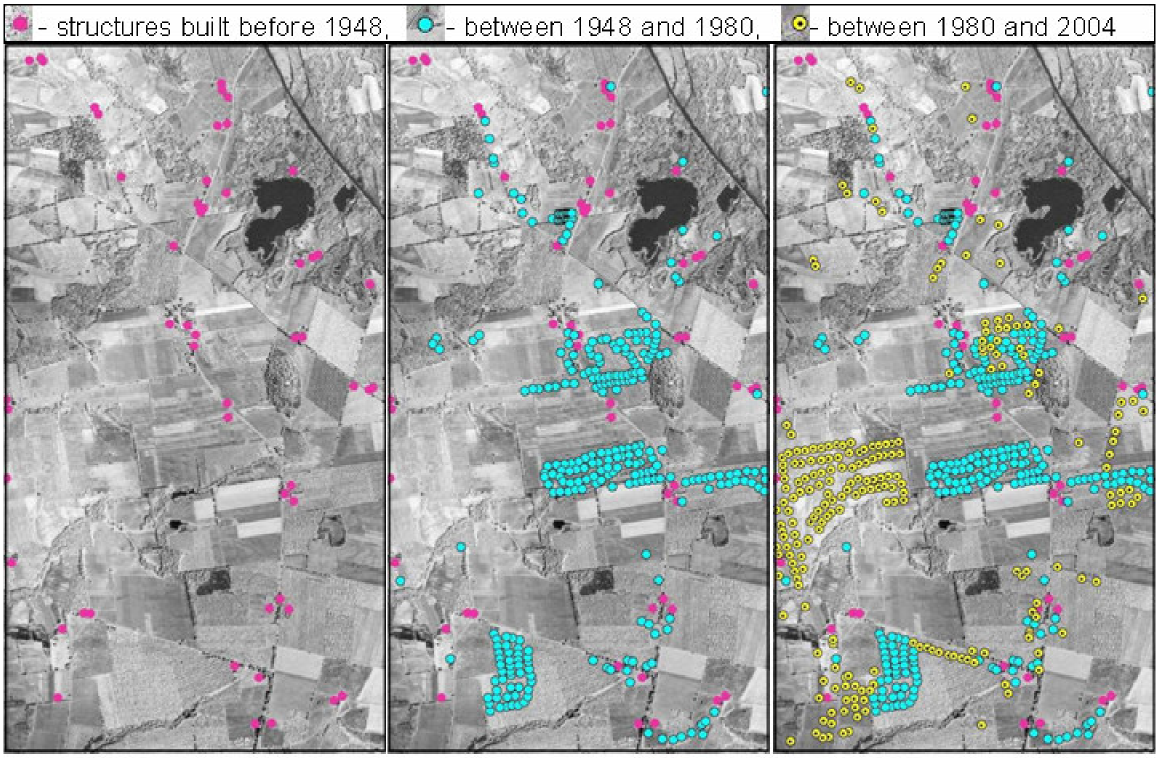


Figure 6.2. Images of the Route 9 corridor north of Valatie, Columbia County. The base photo is from 1948; subsequent housing development was outlined from more recent aerial photographs. Notice how first apple orchards and then fields have been converted to housing development, and how the extent of grassland habitat shrinks.

Given the historical landscape, it is surprising that some grassland birds remained in the County for as long as they did. According to the local Breeding Bird Survey data, Vesper Sparrows, Grasshopper Sparrows and Horned Larks were all registered with some regularity in the County prior to 1980. Does this indicate that we are not so far from supporting such populations again or, rather, that there is an ecological lag-time during which a species persists in the area even if populations are not self-supporting? Woodland birds, such as Pileated Woodpecker and Wild Turkey, rebounded after 1980, suggesting perhaps that some habitat watershed had been reached where forest integrity returned at the expense of grasslands. Forest mammals (e.g., Bobcat, Fisher and Black Bear) likewise rebounded during this period.

In sum, grassland birds are declining nationally and at least some of the factors responsible for this decline are probably also functioning locally. There is good reason to be concerned for the future of these species and to believe Columbia County farmland can play a role in their conservation.

Shrubland Birds

If grassland birds are the Hollywood stars (albeit battered ones) of North American bird conservation, then shrubland birds live on the "wrong side of the tracks". Shrubland, like vernal pools, is often mistaken for a good habitat gone awry. In other words, many people don't even consider brush to be a habitat of its own. “Wasteland”, “old field”, and “abandoned pasture” are all names which suggest that shrubland is not a habitat in its own right. But it is.

Shrubland is a successional habitat. That means that it is a habitat that usually exists for a relatively short period of time as one habitat develops into another. Specifically, in our area shrubland is a transition between grassland and forest. As such, it arises in at least three different ways: human clearing, natural disaster (e.g., hurricane, tornados, ice storms, fire) and wetlands (marshes, swamps, bogs, wet meadows, and the damp areas on the margins of ponds, lakes, streams and rivers). Historically, although there is substantial debate, the extent of shrublands created by the Indians of our region was probably relatively small. No doubt, they did set fires and open patches for agriculture, but historical studies suggest that these habitats were probably of minimal ecological importance. The Northeast does experience natural disasters. The risk of hurricane damage is highest nearest the coast, but even there the frequency and extent of damage may be relatively low. Likewise, our generally moist climate and the fact that lightening strikes are usually accompanied by rain in our region, all serve to reduce fire damage. Hence, while other factors had effects, it seems that the brushy areas in and about wetlands are probably the main natural habitats of what we consider shrubland birds.[10]

The importance of wetland shrubs is emphasized by Table 6.4 which lists the ‘natural habitats’ of our shrubland birds. In the absence of natural disturbance, it would appear that almost all used wetland-associated habitats As we have already mentioned, the fact that natural wetlands have declined by over 50% regionally does not bode well for these species in the long term.[11]

Table 6.4. The natural habitats of shrubland birds. The key question is Which habitats did these species use in the absence of agriculturally-created ones?

Species	Natural Habitat
American Goldfinch	Flood plains, early forest
American Woodcock	Forest openings, shrubby wetland
Baltimore Oriole	Forest edge, riparian forest
Blue-winged Warbler	Wetland and forest edge, savannah
Black-billed Cuckoo	Wooded wetlands
Brown-headed Cowbird	Prairie, prairie/forest edge
Brown Thrasher	Wetlands
Chestnut-sided Warbler	Areas of natural disaster, beaver meadows, stream banks
Common Yellowthroat	Woody wetlands, brushy burns
Eastern Bluebird	Barrens, savannahs, wetlands, open forest
Eastern Kingbird	Wetlands, natural disturbances
Eastern Towhee	Edges, have found around wetlands
Grey Catbird	Early successional areas and wetlands
Indigo Bunting	Tree falls and wetlands
Northern Bobwhite	Early woody regrowth, brushlands
Northern Mockingbird	Forest edge
Prairie Warbler	Forest-prairie or water edges; savannahs, barrens
Yellow Warbler	Wet thickets

Our shrubland birds include relatively common and stable species such as the Grey Catbird, Yellow Warbler and American Goldfinch, but also such declining birds as Blue-winged Warbler, American Woodcock, Brown Thrasher, Eastern Towhee and Field Sparrow (see trends information in Table 6.2). A key component of any effort to help these birds is to realize that shrubland is not an ecological wasteland but rather an important homeland for some species.

<u>The Habitat Requirements of Grassland Birds</u>

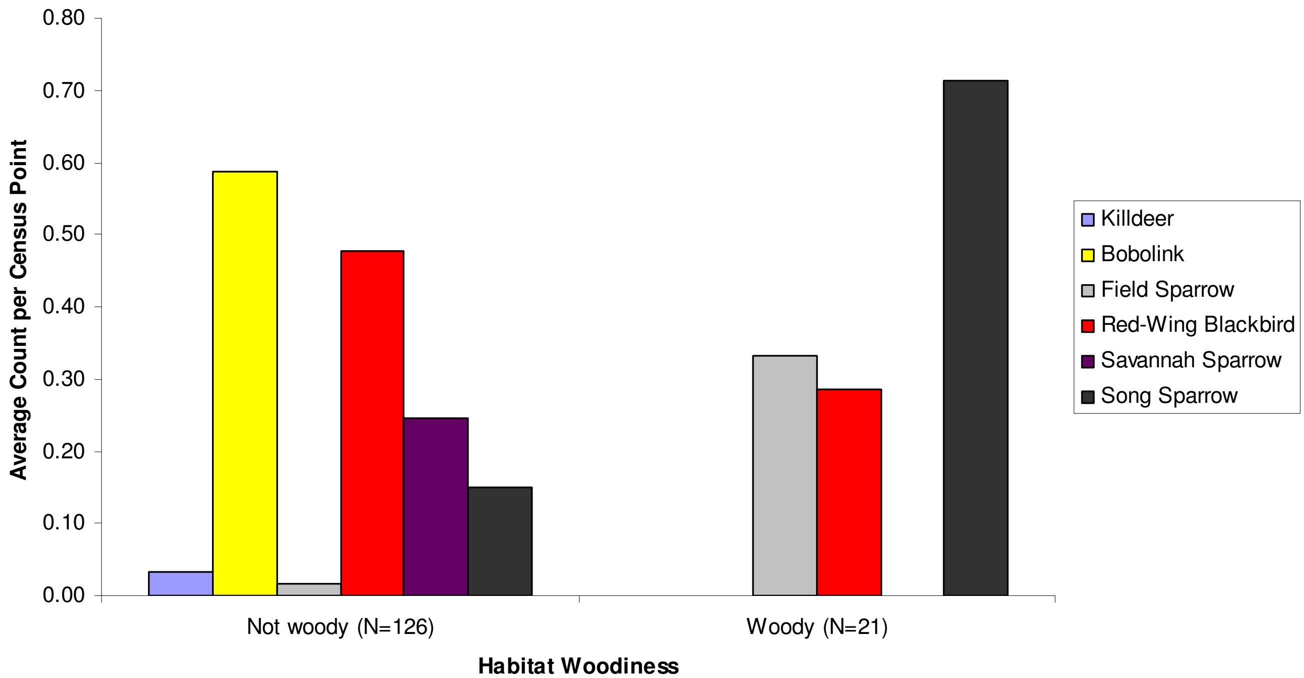
As with many species, “habitat” seems to be a key ingredient for healthy populations. In part, as discussed in the first chapter, this is because “habitat” serves a range of needs for most species: source of food, source of shelter, nesting location, and component of predator protection, just to name a few. The benefits of adequate habitat can be overwhelmed by influences such as hunting, poisoning or disease; however, in most cases, habitat is key. Thus we ask for our birds – what do they need in terms of habitat?

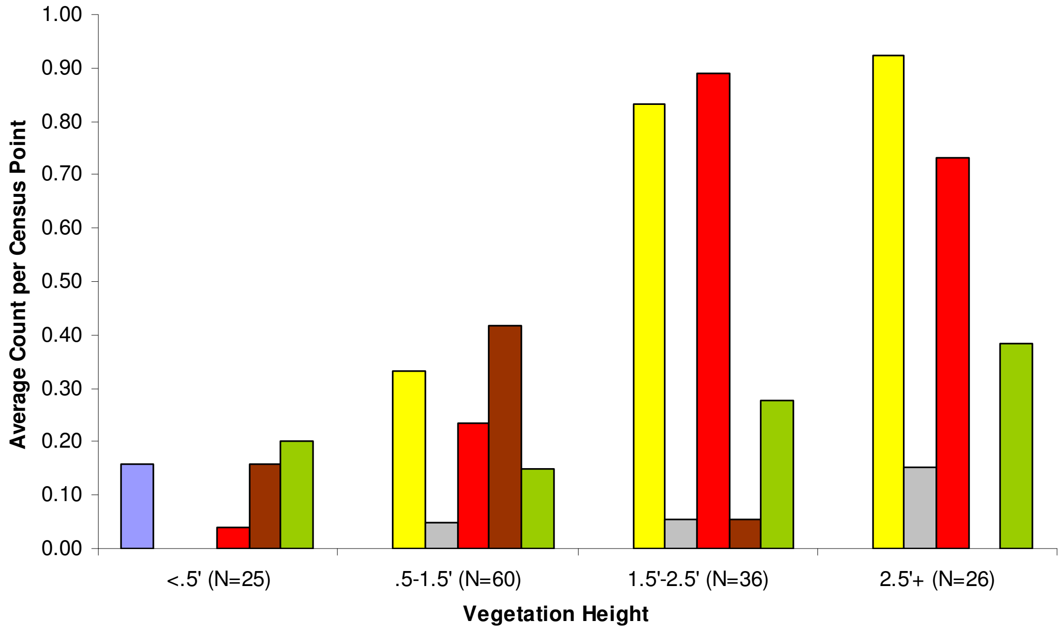
The physical structure of the habitat appears to be important. Thus, we need to define habitats well with respect to structure. For example, when we say “grassland”, what do we mean? From a nesting bird’s perspective, a closely grazed pasture is quite different from a long hayfield which, again, is little like a wet meadow.

We will consider, in turn, the habitats of the grassland species and then of shrubland species highlighted earlier.

“Grassland” is a broad term, and for us at least, it includes some not terribly grassy habitats such as ploughed fields and fallow corn fields. We need to be broad in our definition because, when taken as a group, grassland birds are broad in their definition of suitable habitat. Taken as a whole, these species exploit a range of “grassland areas” from the very short to the very long, from the immaculate to the shrubby. Before we can talk about management, we must therefore define, for each species, our target habitat type. Our initial point count results help us begin this process.

We considered three inter-related aspects of grassland habitat – vegetation height, habitat type and the occurrence of nearby brush.





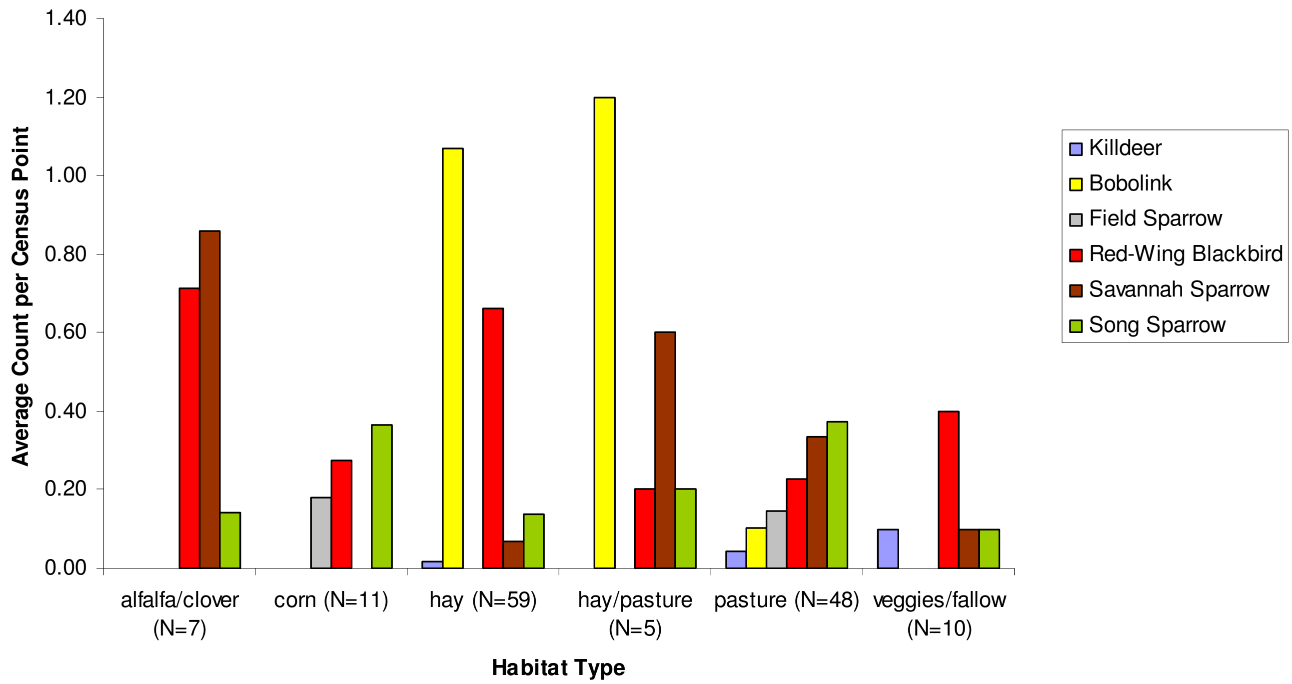


Figure 6.3 – 6.5. A series of graphs showing grassland bird habitat characteristics based upon point count data. "N" refers to the number of point counts conducted in the given habitat class.

Several important patterns are evident in Figures 6.3-6.5. Bobolink and Field Sparrows definitely favor higher vegetation. Neither is present in the lowest vegetation class. However, they differ in their preferred habitats, with Bobolink occupying hay fields (or fields used for hay and pasture), while Field Sparrows were found in pastures and cornfields. Indeed, that latter species favored brushy areas, while the former restricted itself to open grasslands. Field Sparrow straddles the fence between being a grassland and being a shrubland species. Song Sparrows were ubiquitous, occurring at all vegetation heights and in all habitat classes. They appeared to favor areas with some woody vegetation. Red-winged Blackbirds favored similar vegetation height to Bobolinks, but were more wide-ranging in their choice of habitat types and more tolerant of woody vegetation. Finally, the Killdeer sought the lowest vegetation, found mainly in and around gardens or in short-cropped pastures. These results parallel the findings of other researchers.[12]

Where would our two other, unseen species of interest, the Vesper Sparrow and the Grasshopper Sparrow, fit? The Vesper Sparrow is considered a "short grass" species. It appears to favor areas that have not only low vegetation, but also ample open ground and little or no accumulated plant litter. Others have found it nesting in short pastures and crop fields (e.g., potato and strawberry fields). Mike Morgan (Audubon New York, personal communication) reports that he has found this species in corn stubble. Of the birds which we did find, its tastes might most closely resemble those of the Killdeer, although it may be more tolerant of brush. The Horned Lark also appears to be an associate but, as we personally saw none of these during our censi, that doesn't help us understand local habitats.

The Grasshopper Sparrow is found on generally higher, drier ground. Sometimes co-existing with, although much less conspicuous than, the Savannah Sparrow. The Savannah Sparrow apparently has a broader habitat preference, occurring not only in the dry grassy areas with the Grasshopper Sparrow, but also extending into somewhat brushier terrain and thus having higher populations in landscapes that are "growing out of" their fields. In general, this species seems to prefer fields with vegetation clumps, be they from bunch grasses or cultivated alfalfa or clover. It apparently extends into older, less luxuriant pastures (e.g., those with poverty oat grass, bent grass, and dewberry), but seems relatively intolerant of brushy areas. Areas with at least some open ground appear to be preferred.[13]

One trait that makes grassland birds especially susceptible to habitat loss is their apparent reliance on grassland patches of a certain size. A postage-stamp of grass is rarely enough. Others have estimated, for example, that Upland Sandpipers usually choose areas with at least 100 acres of contiguous, suitable habitat. As farmland goes from being the matrix in which the rest of our habitats are embedded to being scattered outposts midst forest and houses, many of such species disappear. Some grassland species have more modest land requirements, and some of the species which still persist in the County, Savannah Sparrow, Bobolink, and Eastern Meadowlark, for example, apparently need fields (or field blocks – birds probably view fields separated by narrow fence lines as single patches of habitat) on the order of at least 25 acres in size.[14]

<u>Early-Cut Hayfields: Ecological Traps</u>

Birds choose their nesting sites based in large part on what they see when they arrive in Spring. Unfortunately, they have no way of knowing that what might look like a beautiful habitat in April or May, may be cut or ploughed in June. Aside from habitat loss, historical changes in haying schedules have severely impacted some grassland species. Many fields are now hayed as early as mid-June, especially when fields are cut and wrapped green for "haylage". In the 1800s, at least, most haying did not happen until substantially later: a New York almanac from 1842 gives July 5th as the average *starting* date for haying. That one month can be crucial - when haying occurs before the young birds are fledged, pairs may be unable to raise any young. Some birds do renest, but some fields are also re-cut. A field which looks good in Spring but whose nesting habitat disappears prior to fledging can be considered an *ecological trap;* that is, a place which attracts birds but then proves unproductive if not fatal. ("Fledging" is the growth stage at which young birds first fly.)[15]

While we are most interested in fledging date, there is much more information on date of egg laying. A rule of thumb, at least for song birds, is to suppose that fledging begins approximately one month after egg laying. Further, some individuals may lay their eggs at least a month after the earliest nesters (in birds with more than one brood, nesting continues well after that). Hence, estimated fledging dates are from one to two months after the earliest eggs. Based on this and using Bull's information on egg laying dates, we calculated fledging dates for our grassland birds (Table 6.5). While these dates are very rough, one can probably assume that the majority of fledging has occurred by the end of the indicated period.

Table 6.5. Approximate first-clutch fledging dates for grassland birds in New York.

Approximate Fledging Date in New York State*

Species	Start	Stop
Bobolink	18-Jun	18-Jul
Eastern Meadowlark	9-Jun	9-Jul
Field Sparrow	16-Jun	16-Jul
Grasshopper Sparrow	27-Jun	27-Jul
Henslow Sparrow	17-Jun	17-Jul
Horned Lark	28-Mar	28-Apr
Killdeer	ca. 21 May	-
Northern Harrier	ca. 4 July	-
Red-winged Blackbird	26-May	26-Jun
Savannah Sparrow	11-Jun	11-Jul
Song Sparrow	17-May	17-Jun
Upland Sandpiper	ca. 15 June	-
Vesper Sparrow	5-Jun	5-Jul

*-derived from Bull's *Birds of New York*

Early cutting appears to most affect the late hayfield nesters such as the Meadowlark, Bobolink, Vesper Sparrow and Grasshopper Sparrow. Species which can make do in pastures, which may utilize brushy/marshy areas for their nests and/or which nest earlier (e.g., Killdeer, Field Sparrows, Savannah Sparrows and Red-winged Blackbirds), seem less affected by hay schedules.

The Habitat Requirements of Shrubland Birds

Just as "grassland" includes a variety of bird habitats, so does "shrubland". Some species, Grey Catbirds, for example, are not too picky. They seem to recognize most of what we call brush or shrub to be usable habitat. In other cases (for example Brown Thrashers and Prairie Warblers) there seems to be some more specific needs. For our purposes, we will distinguish five kinds of on-farm shrublands: somewhat uniform thickets established on abandoned fields, patchy thickets on lightly-managed but still utilized pastures, hedgerows, forest edges, and wetland margins. To give an idea of where these habitats occur, we've highlighted the different habitat types on Hawthorne Valley Farm.

Which birds do you find in each habitat? That is a question that we hope to explore in more detail next year. Below are informal assignments of our species to different shrub areas based upon field notes and recollections:

old fields/brushy pastures – Prairie Warbler, Brown Thrasher, Clay-colored Sparrow, Northern Mockingbird, Song Sparrow, American Woodcock, Eastern Towhee, Eastern Kingbird, Field Sparrow, Yellow Warbler, Brown-headed Cowbird

forest edges – Baltimore Oriole, Bluebird, Chestnut-sided Warbler, Indigo Bunting, Blue-winged Warbler, Common Yellowthroat

wetland margins – Brown Thrasher, Chestnut-sided Warbler, Eastern Towhee, Grey Catbird, Common Yellowthroat, Indigo Bunting, Common Grackle, Yellow Warbler

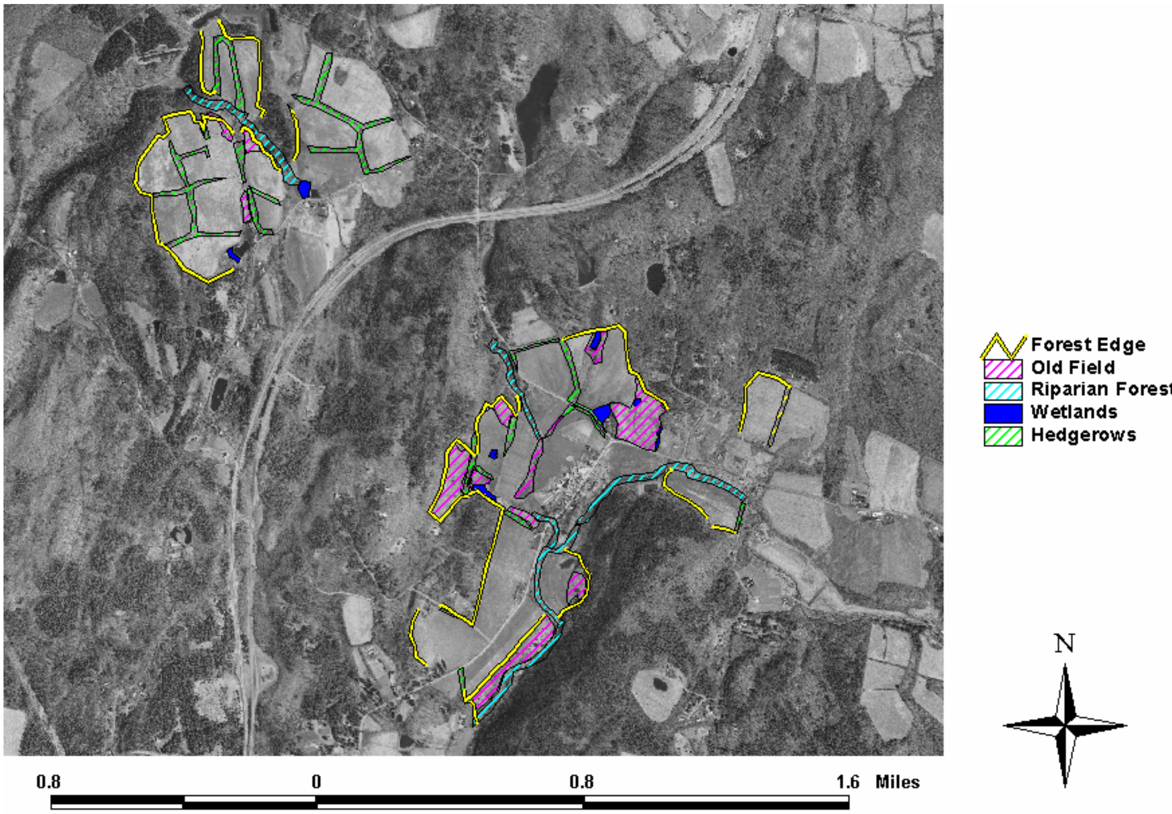


Figure 6.6. The location of shrubland bird habitat as exemplified by an over-view of Hawthorne Valley Farm.

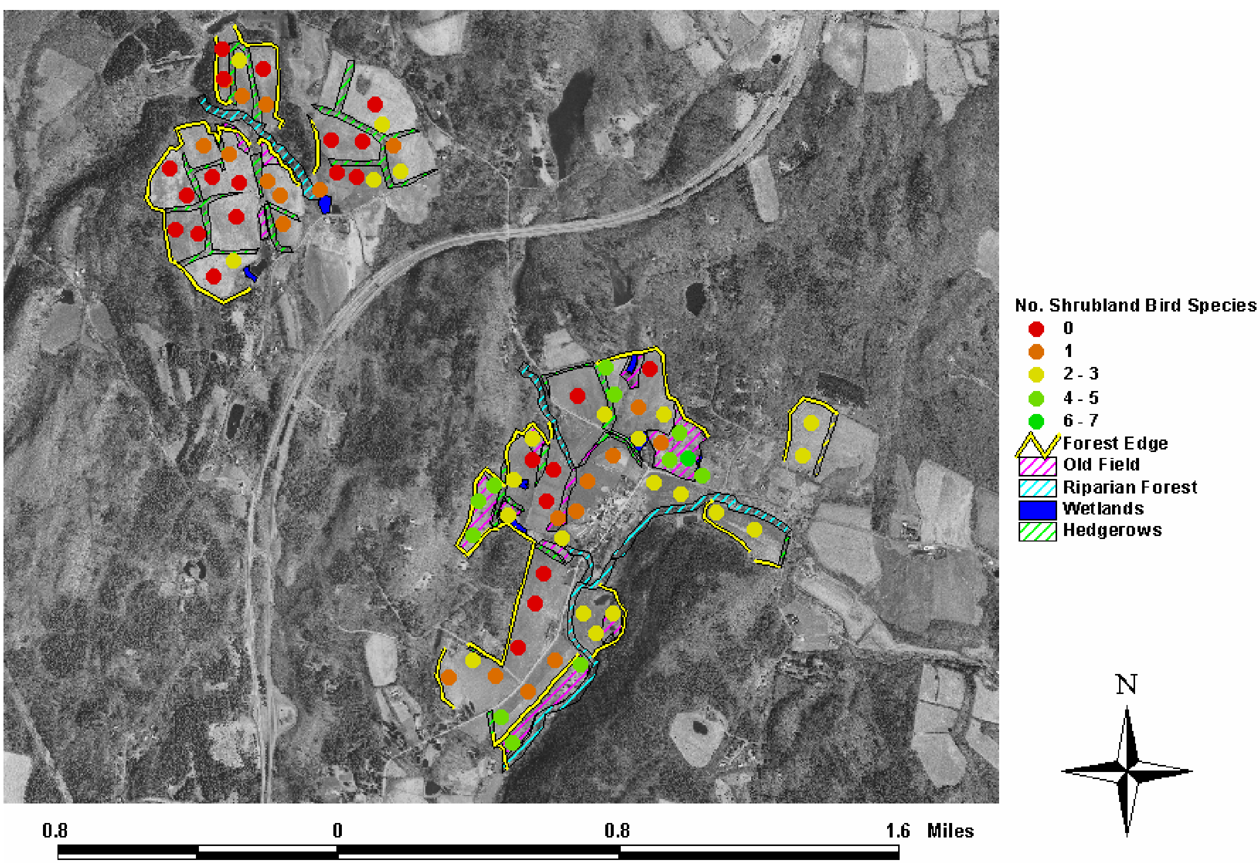


Figure 6.7. Shrubland bird diversity in relation to the habitats already illustrated in Figure 6.6.

hedgerows – Grey Catbird, Yellow Warbler, American Goldfinch, Song Sparrow, Common Yellowthroat, Eastern Kingbird, Brown-headed Cowbird

Figure 6.7 shows the number of shrubland birds in relation to different types of edge habitat. Isolated fields that are far from forest, wetland or old field are relatively poor, whereas those fields nearer shrub habitats, especially old fields, are richer. It is our patchwork of relatively small, sometimes partially overgrown, fields midst a sea of forest that apparently enhances on-farm shrubland bird diversity.

Unlike grassland birds, shrubland birds do not seem to require especially large habitat patches. This makes evolutionary sense in that they probably evolved in part to exploit small patches of edge habitat. Nonetheless, many of these species, too, are declining. Some, such as Northern Bobwhite, appear to be on the verge of disappearing (a single, historical sighting by Mike Scannell is this study's only record). Others, such as Brown Thrasher, Field Sparrow, Eastern Towhee, and Black-billed Cuckoo were occasionally found during our own work, and yet local, regional and/or national trends suggest that they are in trouble.

Management Ideas

Why manage for grassland or shrubland birds? Prior to the widespread introduction of herbicides and pesticides, substantial works came out on the "economic" value of birds. Authors detailed bird diets and behavior and tried to surmise relative value of each species. Other than saying that surely some birds are beneficial to farming, it doesn't seem productive to follow this thinking too far at this point. Estimating such benefits is difficult. So the answer to the "why" question is probably "because one likes birds". If you don't get any kick out of knowing what birds are sharing the land with you, you probably won't care about management. This doesn't mean that we assume "love is blind". Obviously, many different factors go into determining how one farms. We provide the following suggestions not as a prescription for what a farmer must do, but rather as some hints for what one can do if one likes the birds.

At the risk of sounding self-serving, we believe the first step in management is to better understand what one has on a given farm. This doesn't mean one has to know all the birds, but one can easily learn a few and that knowledge can make any thoughts of bird-related management more practical and efficient. For example, in our experience, Bobolinks are rather picky – they definitely do not occur in all hay fields. The same is even more true for Meadowlarks. Rather than trying to *predict* where such species will occur or assuming they are in all hayfields, the most direct approach is to find those fields where they currently are and to focus any management on those few locations. While this is unlikely to immediately create new habitat, it may, at least, help maintain the old. And, once one has a better 'feel' for what the birds need, one can think more creatively about how farm management of other fields might or might not jive with those needs.

When one finds grassland or shrubland birds around one's farm, it indicates that, from the bird's perspective at least, one is probably doing something right. However, as alluded to in our discussion of "ecological traps", one may not be doing everything right. Once one knows that a certain species is present in a certain place, the question becomes not, How do I create the right habitat? (that, evidently, has already happened), but rather, How do I assure they are actually breeding successfully? The basic counsel here is to try to leave the habitat relatively unalterred until the birds have a chance to fledge. Some habitats, e.g. short pastures and garden fields, exist because you already graze them or have cultivated them, so it is not a matter of leaving areas untouched but rather of maintaining the *status quo*, whatever that may be.

<u>Hayfields</u>

A key example involves hayfields. The Boblinks or Meadowlarks arrived because they saw the hay, but not the mower. Cutting hayfields prior to fledging is a major factor causing the decrease of grassland birds. (Loss of farms is another, but we realize that your desire or ability to "stay in business" probably won't be determined by how much you like to provide nesting habitat for birds.) After you have learnt which species occur on your farm, you can estimate fledging date using Table 6.5. You can also go out and walk a field. Parental birds are usually very busy and fairly conspicuous; recently fledged birds are often noisy and a bit clumsy in flight. With a little practice, one can get a fairly good idea of when birds have fledged.

If at all possible, the most effective way of maintaining birds nesting in hayfields is to postpone mowing until after fledging. At Hawthorne Valley at least, we have enough hayfields (due in part to the tax advantages that cutting provides to the non-farmer land owners of hay fields), and it is relatively easy to shunt a few fields farther back in the mowing schedule. What can one do if such re-scheduling is not practical? Mowing around nests seems impractical and evidence suggests that nest predation is increased once nests are highlighted by habitat islands. There is a period when fledglings can fly, but are hesitant or unable to fly far. During this period, a reverse mowing pattern in which hay cutting begins at the field center and spirals outwards may push such birds out of harm's way rather than concentrating them at the field center which will, ultimately, be mowed.[16]

Meadowlarks and Bobolinks, the two most common hayfield nesting birds in our region, tend to prefer mature hayfields that, while regularly cut and not woody, also are more diverse than recently-planted and relatively uniform fields. Therefore, letting some fields go for several years without reseeding can be beneficial.

<u>Pasture</u>
Our main pasture-utilizing grassland birds were Savannah Sparrow and Killdeer. Vesper and Grassland Sparrows, although not found in our surveys, are other county residents that might utilize pasture. As these are ground- or grass-nesting birds, intensively used pastures may be unsuitable for nesting (although not necessarily bad for foraging). Intensive rotational-grazing may be just as detrimental as more conventional approaches, because trampling pressure can by substantial even if periodic. The Vesper and Grasshopper Sparrows seem to prefer some open ground, meaning that they are usually found on the poorer, sparser pastures. While we don't expect farmers to manage for poor pastures, bird use may give one justification for occasionally or extensively grazing some pastures that might otherwise not be bothered with.[17]

<u>Cropland</u>
Strawberry fields or potato patches aren't usually what one envisions as interesting bird habitat. Nonetheless, certain of our grassland birds – Horned Lark and Vesper Sparrow – apparently may use such areas. As mentioned, these birds are reported to seek areas with ample open ground and a smattering of vegetation No- or low-till approaches appear to be most conducive because tillage tends to destroy nests. Admittedly, this may not be practical with many organic crops.[18]

<u>Farm-level</u>
Except perhaps in the case of orchards and agroforestry, most farmers do not manage for anything remotely similar to shrubland. Rather, this habitat "manages for itself", springing up where management is least intense. Because it is an incidental habitat, it is more a product of overall farm management than specific production plans. Shrubby pastures seem ideal if one can afford it. Unfortunately, one can't just forget about a field and hope it will stay as shrubland – left to its own devices, it will eventually grow up to woodland. This is true even if occasional cattle grazing occurs. Hence, periodic brush-hogging (preferably after the nesting season) or visits by browsers may be useful. In order to maintain shrubland birds, some sort of rotational clearing may be best. That is, one clears only part of the shurbland in any one year, rotating through all the "peripheral fields" every five to ten years.[19]

Maintaining streamside/riverside areas, aside from reducing nutrient runoff and erosion, can also support shrubland birds. As we have already noted, the natural habitat for many of these species is just such areas. While certain government programs may require buffer strips of a certain width, anything helps. Maintaining wet meadows, especially when they are brushy, can also provide good shrubland bird habitat. Sometimes water level does a good job of reducing woody plant density, in other cases, periodic grazing helps. Again, when it is feasible, keeping such areas out of production can help bird populations, even when the areas are relatively small.

In the grassland bird literature one can find advice to remove hedgerows. The logic is that they provide roosts for raptors and Brown-headed Cowbirds, and corridors for other predators such as mink, opossum or the like. While the ecological role of hedgerows is probably mixed, most of these recommendations apply to large grassland expanses where one is trying to encourage grassland breeders which require extensive, unbroken habitat. Here in Columbia County, given our forest/field patchwork, the grassland birds that remain with us are ones which are able to survive in proximity to forest and shrub. Furthermore, the positive roles of hedgerows (corridors for woodland wildlife, habitat for *shrubland* birds, nutrient runoff absorption) would appear, in our minds, to outweigh the environmental costs.

There is some indication in the literature that reducing the use of herbicides and, especially, pesticides may help birds. Reducing herbicides can increase ground cover, and this can help some birds. Reducing pesticides likely increases foods available for insectivorous species. Pesticides can also be directly poisonous. Bird deaths from pesticide poisoning have been reported from our area (Dutchess, Columbia and Rensselaer Counties). Birds of prey and other meat eaters (such as Crows) appear to be the most commonly affected. However, any effects on young birds, which are almost always fed insects, are far less easy to detect. As mentioned earlier, any consideration of chemical effects has to be in the context of the associated landuse. For example, in our area at least, organic dairy farming is apt to be based upon rotational grazing, whereas conventional dairy farming is often corn based. Likewise, reducing herbicide use may increase required cultivation. It is difficult to separate any effects of being chemically organic from these differences in land use, and we have no direct observations bearing on the effects of herbicides and pesticides.[20]

Part 7: Farmland Butterflies

Introduction

The interaction of butterflies and regional agriculture is not as straightforward as that of birds. For example, there do not seem to be direct equivalents to the grassland birds. There appears to be no set of Prairie-exile butterflies searching for visions of their homeland on Northeastern farms. Instead, the butterflies of particular interest appear to be those which, rather than seeking only grassland, seek forest/field combinations. These are perhaps closer, in a habitat sense, to the *shrubland* birds which were discussed in the preceding chapter.

However, evaluating the status of even this group of butterflies is difficult because there are so few historical data. There is no equivalent of the breeding bird survey, although some places have undertaken “Fourth of July” counts. We are left to combine our own observations with relatively generalized accounts in the literature and national distribution maps. This is not to denigrate the excellent butterfly work that is out there – there is simply much less work being done than with birds.

A couple of reasons for the apparent differences between birds and butterflies in terms of landscape and continental distributions may relate to butterfly life histories. Only a few of our butterflies are migratory. Therefore, a greater proportion of butterflies than birds spend the entire year in our region. This means the habitat must support not just the foraging adults, but also the developing caterpillars. In addition, butterflies are, obviously, much smaller than birds. This can mean that relatively small habitat patches can suffice for butterflies, and, for example, vast expanses of grassland are not needed if grassy patches occur here and there.

The diets of the caterpillars of many (but not all) species are somewhat generalized. They seem satisfied with almost any plant in a large group (e.g., grasses, legumes), rather than requiring one or a few plant species. These butterfly species may exist almost wherever the caterpillar food plants occur near any of the many flowers that adults will accept for nectaring. As a result, the distributions of many of our species seem almost as generalized as that of many of the "weeds" the caterpillars can use as food. Before European colonization, their distributions were doubtless different but their ability to make do with relatively small patches may have made even their pre-European distributions relatively broad.[1]

In the section that follows we will describe the results from our first year of butterfly fieldwork and identify those species which might be most closely tied to the habitats that farms provide.

Study Methods

We only began butterfly work in 2005. Our basic protocol involved doing field-specific, timed butterfly surveys. We attempted to identify as many of the butterflies that we saw as possible, photographing those we were uncertain of. In most cases, we tallied whichever butterflies we saw, at any range, within the given survey patch. This means that the more conspicuous fliers were tallied much more frequently than the more reclusive ones. There is no doubt, for example, that Skippers are underrepresented, relative to Cabbage Whites. No doubt too that habitat also affected detectability, with the butterflies of short-clipped habitats being much more readily seen. Other than setting a minimum survey duration of 20 minutes per patch, we did not standardize the lengths of our surveys. Rather, we let the nature of the patch determine the duration of the survey, with larger, more complex patches requiring more time to tour thoroughly. Our goal was to make, to the best of our ability, a complete list of the butterflies using a given patch during our visit. The number of patches surveyed reflected the habitats found on each farm, rather than an effort to get similar sample sizes for each habitat type. Any comparisons of relative abundances across species or habitats need to be tempered by our relative lack of standardization.

Species seen outside of standardized surveys were also recorded, but did not enter our habitat analyses.

We used a mathematical process (TWINSPAN) to group farm habitats according to similarities in their butterfly species. Imagine, for example, a computer program that might categorize books based upon keywords. In our case, the "books" are habitats and the "keywords" are butterfly species. This type of analysis is most often used with vegetation data. It does not provide any tests of statistical significance.[2]

Aside from acquiring a generalized description of the habitat patch, we also noted down which plants were seen flowering when we did each survey.

What We Found And What We Think It Means

We recorded 49 species of butterflies on Columbia County farms during 90 surveys lasting a total of about 22 ¾ hours. Table 7.1 presents a list of the species found. Table 7.2 summarizes our survey results in relation to agricultural habitats. While none of the species that we found are considered to be of conservation concern at the national level, Hudsonia's regional work highlights conservation issues for several of these species.[3]

Hay field, old field, orchard, wet meadow, and woody pasture were our most diverse habitats, averaging about 6-7 species per survey. The remaining habitats averaged only 3-4 species. In most cases, butterfly diversity seemed to parallel the diversity of plants in flower (see Figure 7.1). This does not necessarily mean that a higher diversity of flowers is attracting a higher diversity of butterflies. Rather, areas with a high diversity of blooming plants may have been more likely to have a higher diversity of caterpillar host plants (which may or may not have been blooming during our visits). Further, more different kinds of flowers may have sometimes translated into more nectar in general. We did not record density of flowering plants.

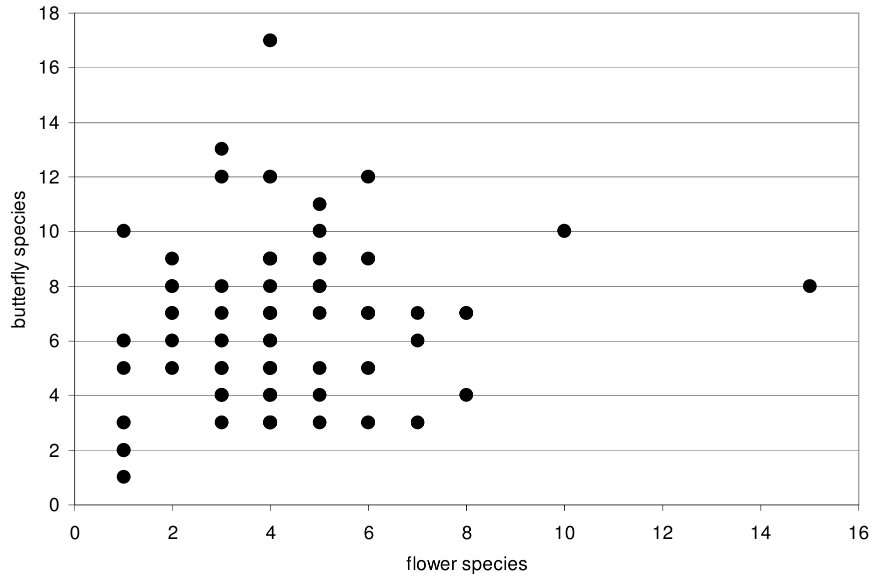


Figure 7.1 Graph indicating number of butterfly species found during survey vs. number of plant species observed flowering at the time in the survey patch.

Using TWINSPAN, two distinct habitat groupings were found. These generally followed the habitat groupings given in the preceding paragraph: certain butterflies were largely restricted to the taller, brushier, perhaps moister habitats (hay field, old field, wet meadow and woody pasture); others occurred both in these habitats and the shorter, more intensively utilized habitats (cropland, fallow field, garden and well-grazed pasture). Orchard classified with the latter group, but as an oddball in the group, and more information is needed from this habitat. See Table 7.2 for description of observed habitat use.

Cech and Tudor, in their book *Butterflies of the East Coast*, categorize butterfly natural history along a generalist-specialist gradient. In other words, How picky does a given butterfly seem to be in terms of what habitats it uses? We used their categorizations to understand the butterfly habitat use patterns which we saw. As Table 7.2 shows, many (nine out of 20) of the species confined to our brushier habitats were classified by those authors as "medium generalists" or "medium specialists", while only one of the 18 ubiquitous species was so classified. All remaining species were considered to be wide generalists. Four of the brushy-habitat species (Milbert's Tortoiseshell, Meadow Fritillary, Great-Spangled Fritillary, and Leonard's Skipper) are considered by Hudsonia to be regionally rare or scarce, whereas only one of the ubiquitous species (Black Swallowtail) was so designated.

These results lead us to highlight the brushy field/shrubland habitat species as the agriculturally-related butterflies of most conservation interest. This is especially true of those species which are classified as something less than complete generalists by Cech and Tudor. We created our "Farmland Butterfly Watch List" based on those brushy field/shrubland butterflies which were semi-specialists. Researchers in Europe appear to have reached similar conclusions regarding the ecological habitats of agriculturally-linked butterflies. We have added a few species of similar ecologies which we saw on farms but not during our timed surveys. We believe that the populations of the butterflies listed should be followed as landuse changes in our county. ***This list includes only those species we saw during our fieldwork.*** There are doubtless several other species of equal or greater conservation concern which we did not see during our work and which may or may not occur on Columbia County farms (e.g. cobweb skipper). Species such as the Monarch may also need consideration, but more because of their wintering habitat than their summer haunts. Almost all the Watch List butterflies are illustrated in Appendix 4.[4]

Table 7.1. A list of butterfly species encountered on Columbia County farms during 2005. Many thanks to Kent McFarland of the Vermont Institute of Natural Sciences for help with identification; mistakes are my own.

Common Name	Scientific Name
Caterpillars Feed on Forest and Field Foods*:	
Spring-Summer Azure	*Celastrina ladon*
Great Spangled Fritillary	*Speyeria cybele*
Aphrodite Fritillary	*Speyeria aphrodite*
Meadow Fritillary	*Boloria bellona*
Eastern Comma	*Polygonia comma*
Milbert's Tortoiseshell	*Nymphalis milberti*
Red Admiral	*Vanessa atalanta*
Caterpillars Feed Mainly on Field Foods:	
Black Swallowtail	*Papilio polyxenes*
Cabbage White	*Pieris rapae*
Orange Sulphur	*Colias eurytheme*
Clouded Sulphur	*Colias philodice*
American Copper	*Lycaena phlaeas*
Grey Hairstreak	*Strymon melinus*
Eastern Tailed Blue	*Everes comyntas*
Pearl Crescent	*Phycoides tharos*
Northern Crescent??	*Phycoides selenis*
Baltimore Checkerspot	*Euphydryas phaeton*
American Lady	*Vanessa virginiensis*
Painted Lady	*Vanessa cardui*
Common Buckeye	*Junonia coenia*
Northern Pearly Eye	*Enodia anthedon*
Little Wood Satyr	*Megisto cymela*
Common Ringlet	*Coenonympha tullia*
Common Wood Nymph	*Cercyonis pegala*
Monarch	*Danaus plexippus*
Wild Indigo Duskywing	*Erynnis baptisiae*
Common Checkered Skipper	*Pyrgus communis*
Common Sootywing	*Pholisora catullus*
European Skipper	*Thymleicus lineola*
Least Skipper	*Ancyloxypha numitor*
Leonard's Skipper	*Hesperia leanardus*
Sachem	*Atalopedes campestris*
Peck's Skipper	*Polites peckius*
Long Dash Skipper	*Polites mystic*
Tawny-edged Skipper	*Polites themistocles*
Northern Broken-dash	*Wallengrenia egeremet*
Hobomok Skipper	*Poanes hobomok*
Dun Skipper	*Euphyes vestris*
Caterpillars Feed Mainly on Forest Foods:	
Eastern Tiger Swallowtail	*Papilio glauca*
Spicebush Swallowtail	*Papilio troilus*
Banded Hairstreak	*Satyrium calanus*
Hickory Hairstreak	*Satyrium caryaevorum*
Compton Tortoiseshell**	*Nymphalis vau-album*
Mourning Cloak	*Nymphalis antiopa*
Red-spotted Purple	*Limenitis arthemis astyanax*
White Admiral	*Limenitis arthemis arthemis*
Viceroy	*Limenitis archippus*
Silver-spotted Skipper	*Epargyreus clarus*
Juvenal's Duskywing	*Erynnis juvenalis*

*- Caterpillar food information from *Butterflies of the East Coast* by Cech & Tudor.

**- Not yet found on working farm; encountered along forest edge of non-commercial orchard.

Table 7.2. The diversity of butterflies seen in nine different on-farm habitats.

		HABITAT TYPE								
		crop	**fallow**	**garden**	**hay field**	**old field**	**orchard**	**well-grazed pasture**	**wet meadow**	**woody pasture**
	Average Number of Plant Species Flowering	2.8	3.0	1.7	4.5	4.7	1.3	3.7	4.8	6.4
	Average Number of Butterfly Species Detected	4.0	4.4	2.7	6.3	7.0	7.0	3.8	7.2	7.2
	Number of Surveys	7	5	3	19	5	3	22	13	13
	Total Time Surveyed	3:10	1:38	0:49	10:44	3:17	0:55	10:49	6:43	8:40
	Total # of individuals seen	*Average # individuals seen per minute of survey*								
Admiral, Red	1	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000
Azure, Spring/Summer	3	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.001
Blue, Eastern Tailed	108	0.011	0.072	0.000	0.031	0.012	0.013	0.045	0.048	0.048
Copper, American	14	0.005	0.000	0.000	0.001	0.000	0.000	0.000	0.007	0.011
Crescent, Pearl	1144	0.010	0.097	0.027	0.344	0.053	0.116	0.125	0.967	0.474
Ctenuchid moth	5	0.000	0.000	0.000	0.007	0.000	0.000	0.004	0.000	0.000
Duskywing, Juvenal	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000
Fritillary, Aphrodite	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Fritillary, Great Spangled	21	0.000	0.000	0.000	0.002	0.003	0.053	0.003	0.018	0.011
Fritillary, large, unid	2	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
Fritillary, Meadow	27	0.000	0.000	0.000	0.004	0.000	0.000	0.001	0.024	0.028
Hairstreak sp.	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003
Hairstreak, Banded	2	0.000	0.000	0.000	0.000	0.000	0.022	0.001	0.000	0.000
Lady, American	5	0.000	0.000	0.000	0.001	0.000	0.000	0.009	0.000	0.000
Lady, Painted	3	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.002	0.000
Monarch	31	0.010	0.000	0.000	0.013	0.015	0.000	0.015	0.005	0.000
Ringlet, Common	240	0.014	0.033	0.013	0.090	0.038	0.258	0.044	0.049	0.169
Skipper, Checkered	19	0.000	0.027	0.000	0.013	0.000	0.000	0.004	0.015	0.000
Skipper, Dark unid	20	0.000	0.000	0.000	0.014	0.000	0.000	0.008	0.004	0.001
Skipper, Dun	7	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.000	0.000
Skipper, European	118	0.000	0.000	0.000	0.001	0.204	0.000	0.016	0.015	0.036
Skipper, Hobomok	8	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.007
Skipper, Least	100	0.191	0.012	0.018	0.026	0.040	0.000	0.028	0.048	0.003
Skipper, Leonards	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Skipper, Long Dash	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Skipper, Orange unid	49	0.015	0.000	0.000	0.009	0.030	0.022	0.019	0.010	0.022
Skipper, Peck's	135	0.006	0.000	0.000	0.033	0.035	0.013	0.060	0.075	0.062
Skipper, Sachem	1	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000
Skipper, Silver-spotted	21	0.000	0.000	0.000	0.008	0.003	0.129	0.006	0.007	0.000
Skipper, Tawny-edged	60	0.027	0.009	0.000	0.028	0.042	0.013	0.020	0.007	0.021
Skippers	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033
Sootywing, Common	73	0.011	0.036	0.000	0.043	0.000	0.000	0.052	0.000	0.000
Sulfur, Clouded	595	0.228	0.172	0.053	0.234	0.117	0.084	0.406	0.056	0.060
Sulfur, Orange	75	0.058	0.009	0.000	0.040	0.007	0.000	0.016	0.005	0.022
Swallowtail, B+R[29]Clack	24	0.000	0.018	0.067	0.010	0.003	0.000	0.006	0.012	0.010
Swallowtail, Dark	1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
Swallowtail, Spicebush	4	0.000	0.000	0.000	0.001	0.003	0.000	0.002	0.000	0.000
Swallowtail, Tiger	6	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.006
Tortoiseshell, Milberts	1	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000
Viceroy	5	0.000	0.000	0.000	0.002	0.003	0.000	0.000	0.005	0.000
White, Cabbage	562	0.199	0.292	0.191	0.290	0.078	0.249	0.244	0.196	0.085
Wood Nymph (northern)	3	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.008	0.000
Wood Nymph, Common	31	0.000	0.000	0.000	0.003	0.052	0.013	0.000	0.021	0.009
Wood Satyr, Little	81	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.055

[green] = Habitats of Highest Abundance

[yellow] = Habitats of Lowest Abundance
(for common species

Table 7.3. Columbia County butterflies that may be particularly affected by reductions in farmland.

FARMLAND BUTTERFLIES WATCH LIST

Common Name	Scientific Name	Caterpillar Food Plants*	Habitat**
Checkerspot, Baltimore	*Euphydryas phaeton*	turtlehead and English plantain	mostly wetland, riparian, expanding into drier?
Copper, American	*Lycaena phlaeas*	dock species	disturbed ares, pastures, roadsides etc
Crescent, Northern??	*Phycoides selenis*	asters	moist partially open woods
Duskywing, Wild Indigo	*Erynnis baptisiae*	wild indigo and now alfalfa	open (orig barrens)
Fritillary, Aphrodite	*Speyeria aphrodite*	violets	upland acid soils, moist grasslands
Fritillary, Great Spangled	*Speyeria cybele*	violets	open, moist
Fritillary, Meadow	*Boloria bellona*	violets	wet open places
Hairstreak, Banded	*Satyrium calanus*	oaks and hickories	edges, opens
Hairstreak, Grey	*Strymon melinus*	various field/brush plants	open, weedy,dist'd
Hairstreak, Hickory	*Satyrium caryaevorum*	hardwoods	edges of rich decid forests
Pearly Eye, Northern	*Enodia anthedon*	grasses	forest, hilly, oft near wet
Purple, Red-spotted	*Limenitis arthemis astyanax*	cherry	decid, often moist forest
Skipper, Leonard's	*Hesperia leanardus*	native grasses such as Little Bluestem	dry upland oft near moist nectaries
Skipper, Long Dash	*Polites mystic*	grasses	open grassy oft moist
Swallowtail, Black	*Papilio polyxenes*	parsely, carrot and other umbels	an array of open areas
Tortoiseshell, Compton	*Nymphalis vau-album*	birches and willows	forest openings and edges
Tortoiseshell, Milbert's	*Nymphalis milberti*	nettles	wet/damp near woods
Viceroy	*Limenitis archippus*	willow	moist, shrubby

*- from Cech & Tudor 2005
**- from Cech & Tudor 2005 and Opler et al 1995

Management Ideas

The most interesting farm habitats, from the perspective of butterflies, appear to be the mature meadows and brushy old fields. As we noted earlier for grassland birds, such habitats are rarely valued and often disappear under current landuse patterns. Such habitats are maintained only through periodic disturbance. Traditionally, this has been accomplished by brush hogging or burning. However, grazing is widely used in Europe, and our results from Hawthorne Valley would suggest that it can be useful. Cows are quite selective, and control of woody plants on occasionally-grazed pastures will require either periodic cutting or grazing by browsers such as goats or Highland Cattle. Aside from large old-field patches, farmland value can be enhanced by allowing the growth of ample nectaring plants along field edges and in other less-utilized portions of the farm. From our experience, clusters of wildflowers are often butterfly oases in intensively utilized areas.[5]

Part 8: Farmland Amphibians

Introduction

There is a pulse and flow between our woods and waters. Each spring, frogs and salamanders move from the forests, where they spent the winter, down to the ponds where they and many of their ancestors have bred. They come early, pushed by an instinctive fear of drying pools, trying to squeeze in mating, egg laying, development, and metamorphosis before spring rains turn to parched summer. Few sights seem odder than to watch Spotted Salamanders slip and slide across April pond ice. Later, the legged young will return to the forest, to forage during what remains of the summer, and then to find shelter for the winter. Hence do animals follow the flow of water and then defy it. Other species stray less far, lurking even as adults along creeks and pond sides, feeding at these concentrations of life. Others stray and return during their ontogeny, “realizing” that there are advantages to pond life but that the young must go forth to explore in case old ponds disappear and new ones appear.

Amphibians are of especial interest to us because they are considered sensitive indicators of water and aquatic habitat quality. A world-wide decline in frog numbers has been recognized. Although the exact causes of this decline are debated and may be multiple, habitat loss and agricultural pollution have been shown to have at least localized affects on amphibian populations. The exceptionally permeable skins of amphibians and their sometimes intricate life-cycles (depending, for example, upon BOTH healthy upland and wetland habitats and including ontogenetically complex metamorphosis) appear to make them particularly vulnerable.[1]

Below, we will describe what we have done to explore the interaction of farming and amphibians in our area, and we will sketch out our initial conclusions.

Study Methods

At Hawthorne Valley, ponds and pools were visited during daytime and early nighttime in the springs of 2004 and 2005. Any sighting or sign of amphibians was recorded.

Call censi for frogs were conducted bimonthly at the same Hawthorne Valley ponds until June of each year. Frogwatch (www.nwf.org/frogwatchUSA/) protocol was followed, with 3-minute listening periods in the early evening. Sporadic daytime visits were made to the same ponds to check for egg development and larvae. Call surveys were conducted by the authors, a trained field assistant, and two sets of volunteers. Volunteers were provided with CDs of frog songs and accompanied us in the field on at least two occasions.

Methods to survey Hawthorne Valley stream salamanders are detailed in the next chapter. Briefly, we chose 30-foot stretches of stream bank and turned over rocks looking for salamanders, keeping track not only of whom we found but also of how many rocks we turned over.

No systematic attempt was made to survey for salamanders away from ponds and streams. Periodically, midst other activity, we turned over rocks in wet upland areas to check for salamanders.

We have not done intensive amphibian surveys on other farms yet. However, we do have our own information from Chaseholm Farm, information from the farmers of Little Seed Garden (supplemented by our own observations), and Hudsonia's inventory of the lands shared by Roxbury Farm and the Martin van Buren National Historic Site. We make reference to these results below.[2]

What We Found

Table 8.1 lists the species which we have found and Appendices 5 and 6 provide pictures and identification information.

Table 8.1. Common and scientific names of amphibians found on or reported from Columbia County Farms. Data on Roxbury are from a Hudsonia report on that farm.

Common Name	Scientific Name	Farms where found
Bullfrog	*Rana catesbeiana*	HVF, Chaseholm, Little Seed, Roxbury
Green Frog	*Rana clamitans*	HVF, Chaseholm, Little Seed, Roxbury
Pickerel Frog	*Rana palustris*	HVF, Little Seed, Roxbury
Wood Frog	*Rana sylvatica*	HVF, Chaseholm, Little Seed, Roxbury
Spring Peeper	*Pseudacris crucifer*	HVF, Chaseholm, Little Seed, Roxbury
Grey Treefrog	*Hyla versicolor*	HVF, Chaseholm, Little Seed, Roxbury
American Toad	*Bufo americanus*	HVF, Chaseholm, Little Seed, Roxbury
Red-backed Salamander	*Plethodon cinereus*	HVF, Little Seed, Roxbury
Northern Two-lined Salamander	*Eurycea bislineata*	HVF, Little Seed
Jefferson's Salamander	*Ambystoma jeffersonianum*	HVF, Roxbury
Spotted Salamander	*Ambystoma maculatum*	HVF, Chaseholm, Little Seed, Roxbury
Northern Dusky Salamander	*Desmognathus fuscus*	HVF
Red-spotted Newt	*Notophthalmus viridescens*	HVF, Chaseholm, Little Seed

Figure 8.1 indicates the Hawthorne Valley Farm ponds where amphibians were found during our two annual surveys (the southern-most set of ponds was only visited during 2005). During the first survey, the timing of our visits and our own relative inexperience prevented us from distinguishing Jefferson Salamanders and their sign from Spotted Salamanders.

Most of our information on stream salamanders was collected during our stream quality assessment and is described in more detail in the next chapter. In summary, almost all salamanders found were Northern Two-Lined Salamanders, including a red form of this species. A few Northern Dusky Salamanders were also recorded. Most salamanders caught along the streams were larval, and, while our consultations assured us that most were larvae of Northern Two-lined Salamanders, we have missed some larval Duskies.

Red-backed Salamanders were the only species found beneath rocks and logs in upland areas away from creeks. One Jefferson Salamander was found at the base of a rock outcrop approximately 30 feet from the nearest stream.

What We Think Our Results Might Mean

The Cast of Characters

Until one bends down to look, until one turns over rocks and logs, until one sallies forth on the cold April nights when certain salamanders hurry to their breeding pools, until, in other words, one looks for them, our amphibians can easily pass unnoticed. Precisely because of this relative inconspicuousness, there is little historic information on their populations.

Aside from several rare species whose presence could not be expected (e.g., Leopard Frog, Northern Cricket Frog) and some who may be present but not yet detected (e.g., Marbled Salamander, which has been reported elsewhere in the County, and Fowler's Toad which we have found in County forests), we seem to have a fairly complete amphibian fauna. Apparently, the conditions in and around the Farm are adequate for their survival. The farmscape with its mosaic of woods and pastures (frequently dotted with ponds) provides for the wetland and upland needs of most of these species. Below, we briefly discuss each species in turn; their occurrences on Hawthorne Valley Farm are illustrated in Figure 8.1.[3]

The widespread occurrence of *Green Frogs* on Hawthorne Valley Farm is not surprising. This is a generalist species that seems relatively resilient to modern onslaughts. We found them along creeks and around ponds. It is commonly reported to be abundant elsewhere. They were also found at the three other farms for which we have data.

The sonorous *Bullfrog* is a widespread resident of larger ponds. Its tadpoles overwinter once or twice and thus can survive only in permanent water bodies that do not freeze solid. As adults, they are said to be the most consistently aquatic of our frogs. There is some debate about the original native range of Bullfrogs, and they are classified as an invasive species in some parts of the United States. However, it seems likely that they have long been native to this area (early travelers mention their dramatic calls and earlier scientific work such as DeKay and Eckel & Paulmier mention them as residents). Their populations bear watching because they are likely favored by the deeper and larger ponds that are now the fashion. They are eager carnivores and can reduce the populations of other amphibians which try to share their habitats. As wetlands are converted to standardized ponds, this conflict may be exacerbated. Hudsonia also reported it from Roxbury Farm.[4]

We were surprised by the relative abundance and widespread nature of the masked *Wood Frogs*. Aside from occurring widely at Hawthorne Valley, this species was also found at the three other farms studied. In part this surprise may stem from our own lack of awareness: Wood Frogs are normally conspicuous only during their brief spring breeding period. If one overlooks this period, their presence becomes much less evident. As their name implies, they are forest frogs as adults, and they were the most commonly encountered frogs on our wooded uplands. A key ecological question is How far are they willing to move across unforested habitat in order to reach suitable breeding ponds? From a farm management perspective, this translates into Is there a conservation advantage to locating farm ponds near forest when possible? The literature reports that they will travel 1500 feet from woodlands to ponds, and we have found them in field ponds 2-300 feet from woodlands. [5]

The tiny *Spring Peeper* was our most ubiquitous frog: it was found in all of the ponds and pools surveyed. It was the only species found at the Swim Pond (Site number 6 of Figure 8.1). In general, it appears to be one of the most common frogs in the Northeast. It was also found on at least two of the other three farms for which we have information.

Breeding by *American Toads* was detected more rarely than we had expected, given the frequency with which one happens upon them away from breeding ponds. In fact, of the amphibians whose breeding we did detect, it was recorded from only two ponds. Although rarely encountered during formal censi, their calls were commonly heard, at least in the distance, during the breeding season. Hudsonia reported them from around Roxbury Farm.

The *Grey Treefrog* was not frequently heard, but during breeding "parties" they were very common. They were also occasionally encountered in the forest. Given their excellent camouflage, this fact suggests that they are fairly common in the woodlands. For breeding, they seem relatively confined to ponds near woodlands. The one report from the fairly isolated Site 9 would be an exception; that site bears watching next year. Hudsonia found them near Roxbury Farm.

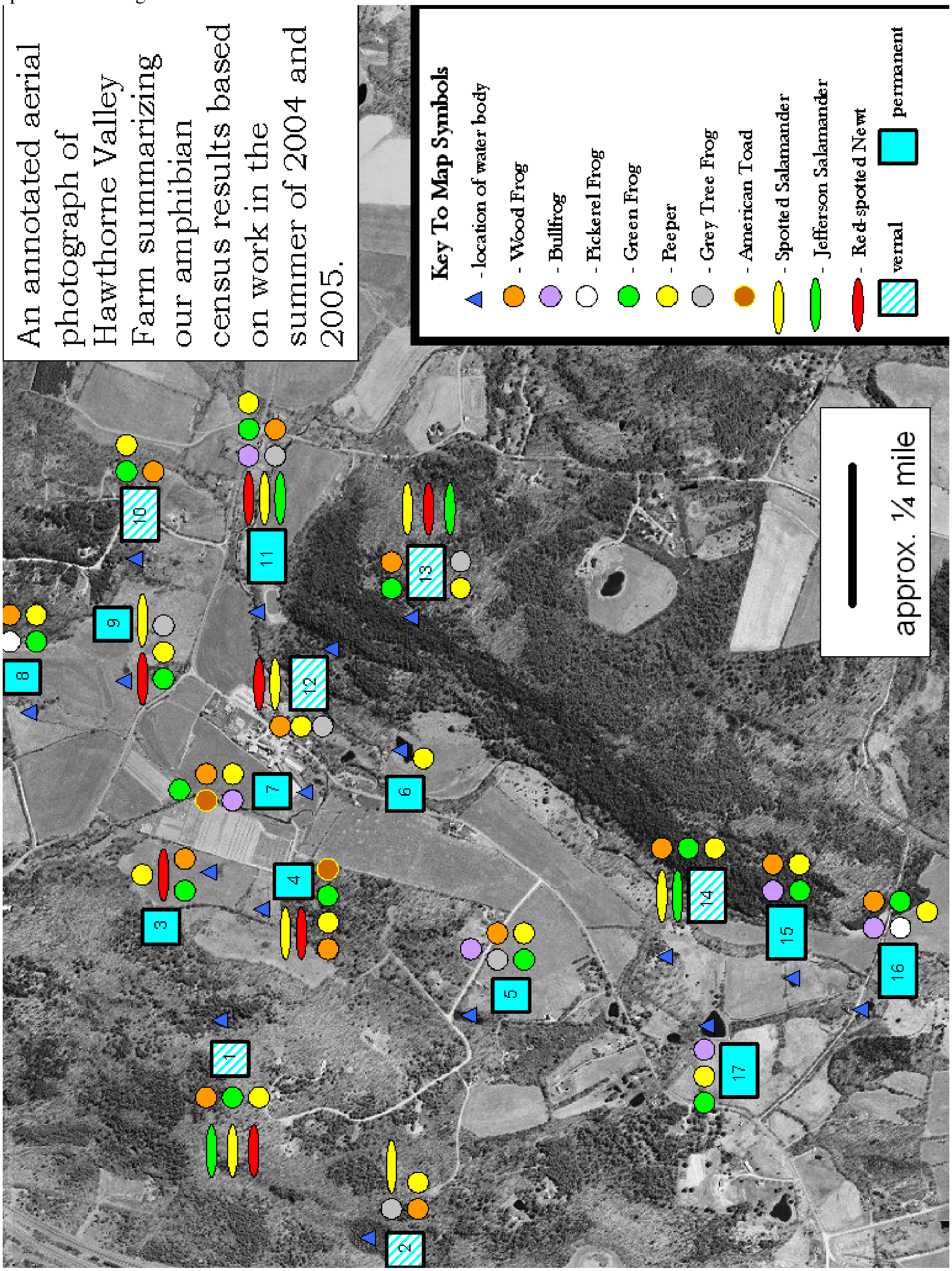
Pickerel Frogs were only reported from two sites. This frog was not seen or definitely heard at Hawthorne Valley during the summer of 2004, although we specifically looked for them (however Site 16, where they were most active in 2005, was not surveyed during 2004). During the summer of 2005 they were regularly found along the creeks and around the ponds. In some parts of the State they apparently are relatively rare (James Gibbs, personal communication). They were also recorded at Little Seed Farm and Roxbury.

We never heard nor observed *Leopard Frogs*. They were not reported at any of the other farms. Records suggest that they were previously more common in the State, when the timing of their arousal in Spring resulted in their being dubbed Shad Frogs.

The *Spotted Salamander, Red-backed Salamander,* and *Two-lined Salamander* are commonly found in the State's vernal pools, woodlands and streams, respectively. They were also relatively common at Hawthorne Valley. The presence of the Spotted Salamander is taken as one sign of an ecologically functional vernal pool. A "vernal" pool is a pond that dries out during part of the year; this drying precludes the presence of fish and Bullfrogs. Red-backed Salamanders seem ubiquitous in woodland moist spots; so far we have encountered only the Red-backed (as opposed to Lead-backed) form of this species. Two-lined Salamanders can be exceedingly common. For example, in one 30-foot stretch of the Agawamuck, we turned over 191 stream rocks and found 42 salamanders, or roughly one salamander for every four rocks. Spotted Salamanders were noted on all three other farms. Aside from at Hawthorne Valley, the Red-backed and Two-lined Salamanders were recorded only from Roxbury Farm, but we have simply not yet looked for them on the other farms.

Jefferson and *Dusky Salamanders* are considered a bit more unusual. The first has "special concern" status with the State, indicating a species which, from a conservation perspective, "warrents attention and consideration", but whose current condition does not appear to require the legal protections associated with endangered or threatened species. At Hawthorne Valley, Jefferson Salamanders seemed to be devoted to woodlands – they were not found in any of the ponds even partially isolated from forest. Dusky Salamanders, while not listed by New York, are described by Hudsonia to be "vulnerable and declining". We found them in and along wooded stream sections at Hawthorne Valley and elsewhere in forested seeps. Jefferson, but not Dusky, Salamanders were seen at Roxbury Farm.[6]

Figure 8.1. An annotated map showing the location of Hawthorne Valley waterbodies surveyed for amphibians and the species occurring therein.



Description of Amphibian Census Sites (Numbers refer to labels on Figure 8.1)

1. A chain of four vernal, wooded pools along a ridgetop depression. One appeared to maintain shallow water or at least moist ground through the year. No fish.
2. A wooded wetland owned by Hawthorne Valley Farm, but administered by The Nature Institute. Typical wooded wetland vegetation – alder, black ash, swamp white oak, spice bush, etc.; remains at least moist year around. No fish.
3. Permanent cattle pond surrounded by bull rushes. Isolated in middle of pasture. No fish.
4. Permanent cattle pond that backs up against a hedgerow/brushy area that is connected to woodland. No fish.
5. Permanent pond by roadside. Appears to be an impoundment. Wooded on three sides. Fish?
6. The “Swim Pond”, a man-made pond with brush along one side. Has at least Largemouth Bass and Carp. Little aquatic vegetation, has been treated with algae reducer in the past.
7. Permanent tailwater pond between cattle facilities and creek. Well “fertilized”, often completely covered with duckweed. No fish.
8. Man-made, permanent cattle pond at base of brushy draw attached to forest. At least Sunfish.
9. Man-made cattle pond surrounded by pasture and a little brush. Sunfish?
10. A small, vernal pool; may be man-made. Currently surrounded by brush, but there has been some attempt at landscaping. No fish.
11. A man-made fire pond. This was dug in a former wetland approximately six years ago. Fish, if present, are not yet abundant. Surrounded by an approximately 20-foot strip of grass and gravel but then by forest.
12. Small, forested vernal pool. No fish.
13. Series of three ridgetop pools, at least one of which appears to be man-made. Two maintained at least 2 feet of water year around, but the other dried. No sign of fish.
14. Vernal pool bordered by cattlefield on one side and woods on the other. No fish.
15. Permanent cattle pond in field near hedgerow. Fish?
16. Lawn pond in front of house, near woods on three sides. Fish?
17. Large, permanent pond, used by livestock and swimmers, bordered by woods and field. Fish?

Lastly, the *Red-spotted Newt* appears to be a resilient and widespread species. Because it is aquatic as an adult, it was found only in permanent ponds at Hawthorne Valley. Its poisonous skin appears to afford it some protection from fish and Bullfrogs with which it co-occurs. We saw it on two of the other farms.

Historical and Conservation Considerations

Because they *don't* cause nasty bites, afflict livestock, or provide an important raw material, and because they *are* generally small and retiring, amphibians have largely gone unnoticed in history. The reports that do exist are often confusing because of uncertain identification – who but an ardent salamander buff would attempt to distinguish a Northern Dusky Salamander from a Mountain Dusky Salamander?

Prior to 1800, we can probably assume that, while creeks were commonly dammed or diverted for mills and while certain wetlands were likely drained or harvested, these alterations were not extensive enough to profoundly affect amphibian populations. In the 1800s, clearing and drainage intensified. Drainage, although practiced since at least the late 1700s, became particularly common once clay tiles were introduced around 1850. An 1858 description of the "Empire State's Premium Farm", after reporting that over 17 miles of drain had been laid on this 344 acre farm, comments, "The work of improvement has gone bravely on … until there is not a wet spot on the farm." While this farm is hardly representative (and it *was* watered by a well and by extensive Lake Seneca shoreline), it is also apparent that as the need for good land intensified and agriculture mechanized, draining became more popular. The result, for New York State, has been an estimated 60% decline in wetlands since 1790.[7]

Images from our own county from the 19th century show sparsely watered landscapes with relative few, closely-grazed watering holes. These are somewhat idealized pictures, but the general pattern is evident. Unirrigated grains, rather than dairy, were the main products during most of the 1800s (see Part 2 of this report). The sheep craze around 1820 may have necessitated some watering areas, but these animals probably ranged widely and made do with what could be found in the hills. As dairy awoke in the last quarter of the 1800s, the need for watering holes probably became more immediate, especially while rotational grazing prevailed and indoor plumbing was lacking. This rebirth of watering holes probably lasted into the early 20th century, until corn supplanted grassland and in-barn watering became widespread. In addition, the mechanization of agriculture made dodging sloughs more unwieldy, while expanding the area a farmer could work. By the early 1900s, much of our land was returning to forest, and as aerial photographs attest, this process has been accompanied by the "rebirth" of older wetlands, the drainages of which were no longer maintained.[8]

Natural history accounts are sparse for much of this period. Table 8.2 summarizes some regional historical and current information. Evidently, some species persisted through the last three centuries of land use with little apparent decline. These species include Spring Peeper, Green Frog, Red-backed Salamander, American Toad, Grey Tree Frog, and the Red-spotted Newt. The status of several other species is less certain. Some of these (e.g., Marbled and Jefferson Salamanders) appear to be naturally rare, and so trends in their populations are not easily detected. Others are not rare, yet they may be less abundant than previously, although no clear threat is known (e.g., Pickerel Frog, Bullfrog). Included in this group are a couple of species whose habitats seem imperiled in some parts of our area and who are, at the least, not abundant everywhere (Wood Frog, Spotted Salamander). Finally, the Northern Leopard and Cricket Frogs seem to have experienced well-documented declines, at least in our region. Degraaf and Rudis, however, question whether Northern Leopard Frogs are even native to New England, (and hence, perhaps, to our region).

As we've noted, for much of the 19th century our county was profoundly agricultural and clearing was extensive. Yet, there is little evidence that this clearing per se caused major declines. Eckel and Paulmier's work published in 1902 parallels in many ways the abundances cited by DeKay sixty years before. The changes may have come more recently and may have resulted mainly from more recent events. Some of these (chemical pollution, habitat loss) may be partially related to agriculture, while others (acid rain, invasive species, climate change) are tied to more general trends. There is little to suggest that agriculture as it is currently practiced in most of our county is a major threat to any of these amphibians, and, indeed, most current habitat loss is likely due to commercial or residential development rather than agriculture. This is not to say that local amphibian populations have been unaffected by agricultural run-off or some aspects of farm land use. However, these species were evidently able to tolerate the historical clearing of our area, at least when accompanied by relatively un-intensive agriculture. The activities of our modern agriculture either continue to pose little threat or are so limited in extent as to be unimportant. It may even be that the Leopard Frog (which was also once called the "Marsh Frog" and is said to be found in wet meadows) benefited from some degree of clearing and has suffered as some meadows have been reforested.

Of late, our land has experienced several additional trends which, while not directly related to agriculture, may be relevant to our amphibians. First, there has been the pond-building boom. Much of this may be related to current tastes in landscaping. While these ponds may be a boon for some amphibians, these species may suffer when the ponds are dug in former marshlands, when landscaping results in closely-cropped margins and when ponds are stocked with fish. Second, houses are being built higher up on hillsides and ridgetops. While vernal pools can occur on lowlands, most of our remaining ones may be nestled in the dips of historically less-accessible hills. As houses move into these areas (see Figure 8.2), they may be destroying or damaging the pools and their surroundings.

Despite some declines, farmland wetlands are home to a surprising variety of amphibians, a result somewhat contrary to the common perceptions of amphibians as being sensitive to water quality and of farms as being sources of water contamination. However, we are not the first to comment on the value of farm ponds for amphibians. Perhaps some of these species are relatively insensitive to simple nutrient enrichment as occurs in many cattle ponds and can tolerate those conditions provided surrounding habitat is adequate and excessive agrochemicals are not introduced.[9]

Management Ideas

Adequate habitat is one of the key necessities of wildlife populations. For species such as Two-lined Salamander, Green Frog, Bullfrog, American Toad, and perhaps Pickerel Frog, this implies natural ponds and/or streams, with "natural" meaning waters free of toxins and at least some vegetation. Our sample size is tiny, but we had little indication that nutrient run-off itself was a major problem for these species on the farms we visited: American Toads bred in the tailwater ponds on two farms, and Green Frogs seemed ubiquitous. Bullfrogs seemed somewhat less widespread, but we don't have enough data to detect any patterns. For the Two-lined Salamander, our results suggested that sedimentation may have reduced habitat: of our five stream salamander sampling sites, the one with the lowest capture rates was also the most sedimented. These salamanders survive by eating aquatic life, and while they might be able to live through exposure to dirty or excessively tidy habitats, siltation may reduce their long-term survival by hiding food and reducing shelter from predators. Woodland amphibians (Tree Frogs, Peepers and vernal pool amphibians) require forests "within easy walking distance", see below. In addition, vernal pool amphibians (Spotted Salamander, Jefferson Salamander, Wood Frog) require temporary pools, or, at the least, ponds kept free of fish.

Table 8.2. Summary of historical and conservation information for Columbia County.

	De Kay (1842)*	Eckel & Paulmier (1902)*	Kiviat & Stevens (2001)*	Degraaf (1983)*
Persistently Common				
Green Frog	"one of our commonest species"	"haunting all kinds of water"		Common
Spring Peeper	"The species is common in the neighborhood of New York, and is frequently found on indian corn, grape vines, and also in greenhouses, under the leaves of plants during the heats of summer"	"probably all over the state"		Common to abundant
Grey Treefrog	"universally distributed through the State"	"The tree frog par excellence of our state"		Common
American Toad	(just gives description, but obviously sees it often)	"common everywhere"		Common
Red-Backed Salamander	"very numerous and widely distributed"	"the most abundant salamander"		Abundant
Two-lined Salamander	"said to be very common" but not observed by the author	"occurs all over the state"		Common to abundant
Red Spotted Newt	"I have met with this animal in brooks and in every part of the State"	"very common in ponds everywhere"		Common
Uncertain				
Woodfrog	(just gives distribution)	"common in woods"	Regionally Vulnerable	Common in good habitat
Bullfrog	"generally distributed throughout the Union" "well-known by its hoarse voice"	"found in larger ponds and streams, especially where there is underbrush"		Common but declining
Pickerel Frog	"used as bait", "wet meadows near ponds and streams"	"seen more frequently than any other frog in the grass"		Locally common
Spotted Salamander	(just gives distribution)	"probably generally distributed over the state"	Regionally Vulnerable	Common but declining
Jefferson Salamanader	"many of this species "in wet springy places in the neighborhood of Albany""	little known "possibly throughout the state"	State- Special Concern	Locally common to rare
Northern Dusky Salamander	"presumed to inhabit this State"	"one of the commonest salamanders"	Regionally Vulnerable and Declining	Common to abundant
Marbled Salamander	not seen first hand	just gives distribution	State- Special Concern	Uncommon
Rarer				
Northern Leopard Frog	"it abounds in most places"	"probably the commonest of frogs"	Regionally - Rare?	Patchy common, but rarer in some parts
Northern Cricket Frog	"It is very lively and noisy, frequenting most wooded places and the borders of ponds, and is often seen on aquatic plants"	just gives distribution	State-Endangered	Not found in New England

*- J.E. De Kay. 1842, Natural History of New York. Albany; E.C. Eckel and F.C. Paulmier. 1902. Catalogue of New York Reptiles and Batrachians. New York State Museum. Bulletin 51; E. Kiviat and G. Stevens. 2001. Biodiversity Assessment Manual. Hudsonia; R.M. Degraaf and D.D. Rudis. 1983. New England Wildlife: Habitat, Natural History and Distribution. U.S.F.S. General Technical Report NE-108.

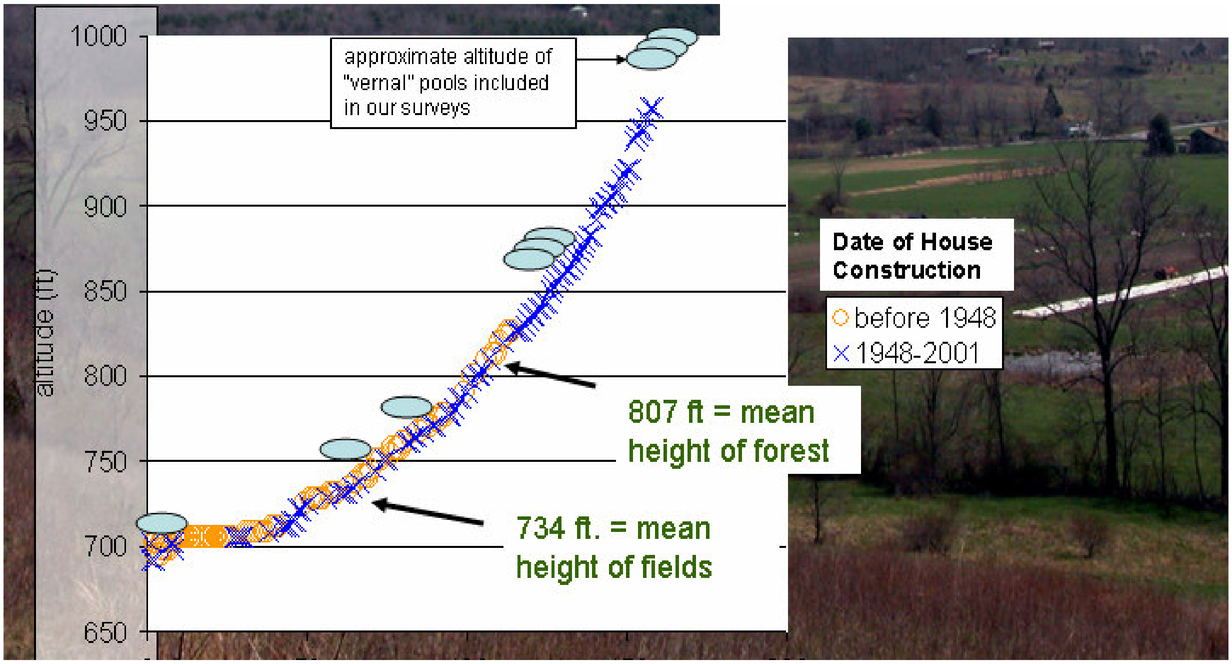


Figure 8.2. Image illustrating the progressive building of houses at higher altitudes around Hawthorne Valley and the potential interaction of that pattern with vernal pool locations. Each house is represented by a circle or cross; houses are sequentially ordered across the x-axis according to altitude.

Based on this, we present several habitat management suggestions:

Leave vernal pools intact – some of our rarest amphibians are those that require the vernal pools. Leaving these magnificent "puddles" can thus make an important contribution to amphibian conservation. Maintaining adjacent, wooded uplands is also import; see below.

Maintain marginal aquatic vegetation in at least some areas – as anybody who has tried to catch frogs knows, marginal reeds and rushes makes the task substantially more difficult; such structure likely provides useful shelter for amphibians. In addition, it provides substrate for the insects which are the prey of many of these animals.

Create a cattle-free zone in each pond - this relates to the above factor: unobstructed access to the entire pond will tend to destroy marginal vegetation.

When possible, locate ponds near wooded areas – a well-documented study in Maine suggested that having forest next to ponds was especially important for Spotted and Jefferson Salamanders. Just having ample forest in the surrounding landscape was important to these species and also to Wood Frog, Green Frog, and Red-spotted Newt. Leopard Frogs and American Toads had a more equivocal relation to forests, while Spring Peepers, Tree Frogs and Pickerel Frogs were not studied. Amphibian-friendly forestry recommends leaving more than 75% of the land forested when working within 100 feet of a vernal pool; 50% should remain forested within 400 feet of any pool. From our own work, we can hardly be so precise, but then again, neither can a farmer. So we simply state that the closer a pond can be to woodlands, the better. Creating or maintaining a brushy or wooded corridor to existing ponds, where feasible, might be useful. We found two cattle ponds (one at Hawthorne Valley and another at Chaseholm) where Wood Frogs and Spotted Salamanders apparently occurred. While cattle had access to both ponds, they also abutted brush or woods on one side, and this restricted cattle entry and provided direct links to upland habitats.[10]

Do not introduce fish – as has been well documented, fish can be amphibian predators. Even within our own ponds, we saw an apparent negative relation between vernal pool amphibians and fish: a pair of apparently adequate ponds from a habitat and locational perspective had neither Wood Frogs nor Spotted Salamanders, but did have ample fish populations.

Reduce stream sedimentation where possible – Sedimentation, as comes from upstream erosion and cattle activity, reduces shelter for existing amphibians and also alters the prey available. As we noted above, Two-lined Salamanders were least common at our most sedimented site, which was downstream from a cattle crossing.

Limit pesticide and herbicide run-off - we had little first hand basis for evaluating agrochemical impacts. Literature would suggest that farming techniques which reduce at least certain herbicide, pesticide, and fertilizer (e.g. ammonium nitrate) use can benefit amphibians. Hence techniques which reduce application and run-off of these chemicals likely help amphibian populations.[11]

What are the benefits of amphibians to agriculture? Why – other than to maintain the natural environment – might a farmer wish to have amphibians on the farm? A stock answer, which one can find on some web sites, would be that most amphibians eat insects and that at least some of those insects may be agricultural pests. This may well be true, but it is virtually impossible to provide a meaningful estimate of their relative importance. To do so would require estimating the total number of frogs which are active (remotely doable), the specific taxonomic, temporal, and spatial details of their diets (very remotely doable), the quantity of their consumption relative to the population dynamics of each insect species considered (essentially undoable), and as if that were not enough, how their consumption of insect predators affects insect prey (again, nearly impossible). Many of the insects that amphibians are reported to consume (e.g., mayflies, blackflies, worms, beetles) are not necessarily agricultural pests, although the flies may be nuisances to farmers and cattle. So, all we can say is that amphibians are one more ingredient of the natural world. Whether they play an important role in natural pest control is uncertain, but the wisdom of the doctor and mechanic would suggest you don't throw away the pieces.

Future Work

We believe a key regional question relating to amphibians is the effects of current landuse trends on amphibian populations. Our work to date only hints at possible patterns. Therefore, in collaboration with the farmers with whom we are already working and with the Columbia Land Conservancy, we hope to expand our sample size substantially, including more farm ponds and non-farm ponds in our surveys. To what degree, for example, are our conclusions regarding the potential benefits of farm ponds borne out by fieldwork? Does the new fashion in landscaping that calls for well-manicured ponds help or hurt amphibian populations? Aside from more extensive pond surveys, we plan to include measurements of water chemistry, surveys of dragonflies and damselflies, and aerial-photo based measures of landscape features such as distance to nearest forest and composition of surrounding landscape. Our key results will be management recommendations for enhancing amphibian habitats in our current landscape.

PART 9: The Chemical and Biological Quality of Streams.

Introduction

Farming and water interact in numerous ways. In the United States, there has been a strong emphasis in recent decades on the effects of agriculture on water quality. The reverse is more rarely explored, except in terms of simple water quantity. Farming can influence water quality in at least four general ways:

1) by affecting nutrient levels in the water
2) by altering physical conditions (e.g., amount of sediments, temperature, current)
3) by introducing toxins
4) by introducing new organisms (e.g., fecal bacteria)

Our central interest here is not so much in the details of these effects as in their consequences. In other words, What have these alterations meant for the native species living in our region's streams? Based on our own, limited work at Hawthorne Valley, we conclude that the results have probably been mixed with some species benefiting and others suffering. A central issue therefore becomes identifying which species are affected and considering the value of their conservation.[1]

Study Methods

Our data set is extremely limited geographically. The vast majority of data come from Hawthorne Valley Farm. However, on that farm we have conducted a standardized, multi-faceted sampling regime designed to describe the Farm's impact on stream water quality.

We chose sampling five points located at stream entry and exit points at Hawthorne Valley. See Figure 9.1. Each of these points was visited during May, July and September.

At each point, we ran simple water chemistry analyses (temperature, dissolved oxygen, pH, alkalinity, phosphorus, and nitrate nitrogen). The first four are basic descriptors of the aquatic environment (alkalinity is a measure the of water's ability to buffer acidic additions). Phosphorus and nitrate are two of the most common forms of nutrient pollution caused by farms. Because naturally low levels of these nutrients sometimes limit algal and plant microbial growth in water, their additions can bring about markedly enhanced growth of these organisms. This process, whereby the ecology of aquatic environments undergoes a shift towards more luxuriant growth of some organisms due to fertilization, is called *eutrophication*. While some organisms thrive, others suffer. Although the increased algae and plant life can enhance oxygen production during the daylight hours, the respiration of these organisms at night and of the decomposers at all times can result in net shortfalls of oxygen which threaten fish populations. Water chemistry was evaluated using a Hach portable colorimeter with the kind assistance of Leanna O'Grady of the Columbia County Soil and Water Conservation District.[2]

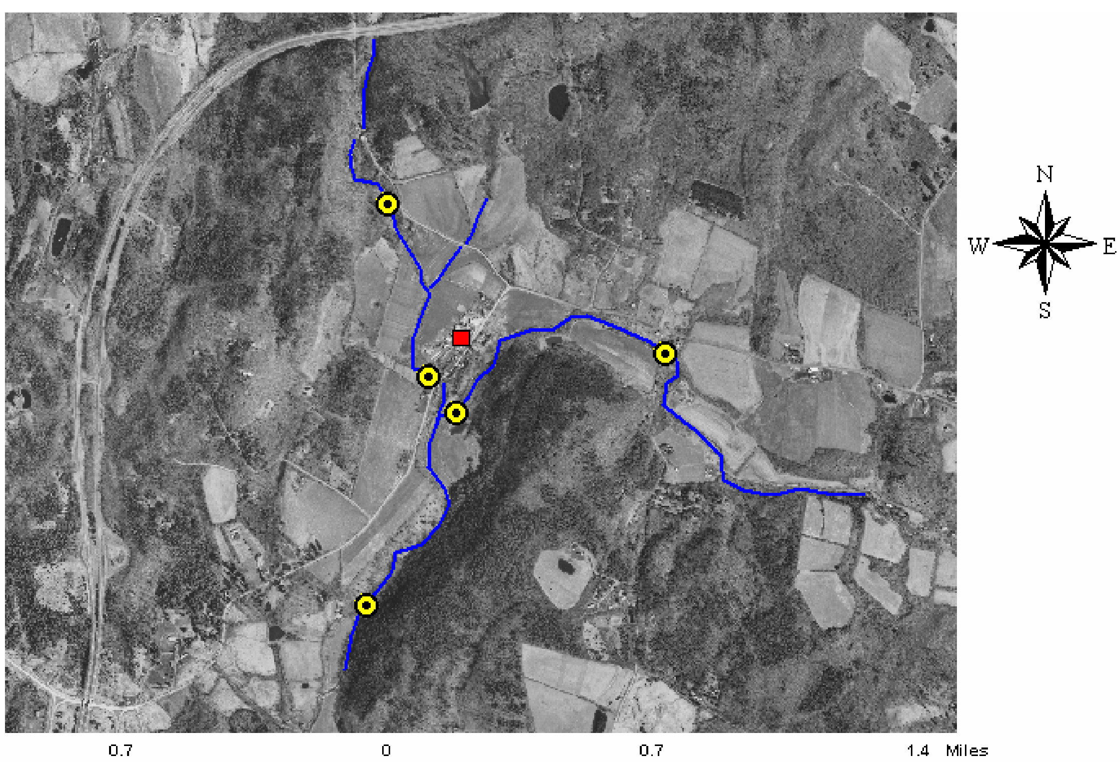


Figure 9.1. Sampling points (dot-in-yellow circles) at Hawthorne Valley. Approximate location of Hawthorne Valley Barn is shown by red rectangle. The streams all flow towards the bottom of the picture.

We also measured the growth of colliform bacteria using Micrology Lab's membrane-filtration colliform test kit. Colliforms are a group of bacteria commonly found in the mammalian gut. While most are innocuous, a few are pathogens, and in any case, their presence is taken as an indicator of fecal contamination. Common routes of contamination are the entry of cow manure or septic tank leakage.

We also looked at the diversity and abundance of three different groups of animals as a way of assessing water quality in terms of what can live in it. Such an approach is called *biomonitoring*. While less precise than chemical measurements, this approach has several advantages: it does not rely on testing for a particular, sometimes unknown, chemical; it detects *effects* rather than causes (effects are often more enduring or obvious and, hence, easier to catch); and it generally has more public appeal (the fate of fish or frogs generally grabs the attention more readily than fluctuations in obscure chemical concentrations). The basic logic involves identifying an "ideal" biological community, which is a scientific best guess about what would live in a pristine stream. The observed community is then compared against this ideal in order to assess relative degree of alteration. Often certain species or groups of species are found to be particularly sensitive, and their abundances are a key component of the evaluation.

The groups that we assessed were aquatic macroinvertebrates, salamanders, and fish. "Aquatic macroinvertebrates" are the insects, small crustaceans and other small, backbone-less animals that live in streams. "Macro" refers to the fact that we counted only those organisms visible to the naked eye. Many of these are the aquatic larvae of terrestrial insects, such as dragonflies, mayflies, and black flies. We assessed these using a protocol developed by the Hudson Basin River Watch, a non-profit organization dedicated to assessing the quality of stream and river waters in the Hudson Valley. Its approach parallels that used by the New York State biomonitoring program. Because the State has used this approach in its work, there is a relatively rich database of historical and geographic data. The field methods involved "kick-trapping" in which a hand-held, specially-designed mesh netting is held down-stream from one's feet as one does the "stream shuffle", scuffing the stream bottom so as to dislodge macroinvertebrates. These samples were returned to the lab where a subsample was taken and all organisms within that subsample were identified to the level of major taxonomic group (Order). Samples were not preserved, and the organisms, many of which were usually still alive, were returned to the stream. Working with live samples was more appealing to those who helped us and gave us insights into how these organisms live.[3]

Two indices (the "biotic index" and "percent model affinity") were calculated from the insect tallies – one is based upon the average pollution tolerance of the individuals in a given sample, and the other upon the similarities, in percent composition, between an actual sample and an ideal, pristine community. In both cases, certain ranges have been deemed to indicate non-impacted, slightly impacted, impacted and severely impacted waters. Of course, the precise cut-off points are somewhat arbitrary. However, taken together, the readings from our numerous samples can give us hints about our general water quality.[4]

Salamanders have not been so explicitly used in biomonitoring, but as noted in the preceding chapter, amphibians in general, perhaps because of the relative permeability of their skin and their complex metamorphosis, appear to be particularly sensitive to environmental conditions. Stream salamanders are an ecological grouping that includes those salamander species which live most of their lives in and about streams. The two species which we found in our area were Two-lined Salamander and, more rarely, Dusky Salamander. In most cases, the gilled larvae were found in the water, while the mature adults were found on-shore nearby. We used a simplified version of survey methods established by the US Geological Survey. We established 45-foot transects along the stream shoreline and flipped the rocks that were 3 feet on either side of the shoreline. We counted the number of rocks we turned over and the numbers of salamanders found in the process. For each sampling period at each site, we derived two statistics: "salamanders per rock turned in the water" and "salamanders per rock turned on land". During the census, salamanders were caught and kept in a bucket to avoid double-counting; they were returned to their habitat at the end of each census. New York State has completed a “Herp Atlas” describing the distribution of reptile and amphibian species within the State; however, we found no readily comparable data on stream-salamander *abundance* from the region.[5]

Fish do have a relatively long history of being used in biomonitoring, stemming from work done by a scientist named Karr in the 1980s. He derived an Index of Biological Integrity (IBI) from looking at fish diversity in sites of known water quality. In our area, the sensitivity of this index is limited due to the relatively low diversity of our stream fish community. However, there are published studies applying this approach to cold-water streams of Vermont, where fish diversity is similar to ours. We captured fish using a 16-foot bag seine with ¼-inch mesh. Whenever possible, fish were counted live and returned to the stream. To facilitate this we constructed a small, portable viewing aquarium and assembled a photographic guide to the live fish of our streams (see Appendix 7). Such a guide was necessary because the coloration of fishes differs radically based upon whether they are viewed in or, as is most commonly the case, out of the water. It was difficult to standardize effort due to variation amongst sites in water depth, current speed, bottom conditions, and amount of in-stream debris. So, while we did do some counting, in our final analyses we used only presence or absence of a given species. A few specimens were killed and preserved to assure proper identification. Dr. Bob Daniels, New York State ichthyologist, provided key help with identification.[6]

To provide a broader context, we mapped the county-wide distributions of each species we captured during our own work. These data, many of which go back to excellent, state-wide work done in the 1930s and 40s, were helpfully provided to us by Douglas Carlson, New York State DEC’s rare-fish specialist.

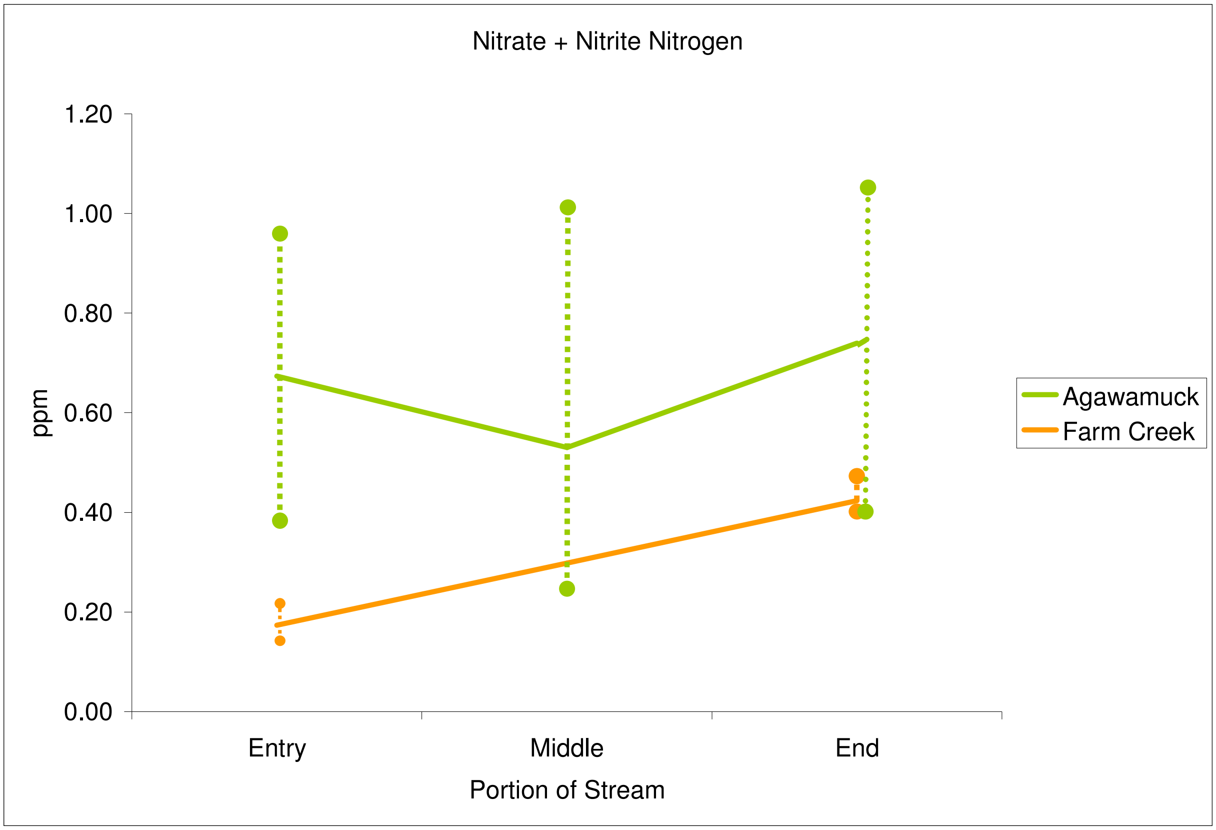
Below, we will first present our results for each of these measures and then consider their overall implications. In most cases, we have only very limited data from other farms. We will mention what we do have, but will not undertake any broad descriptions.

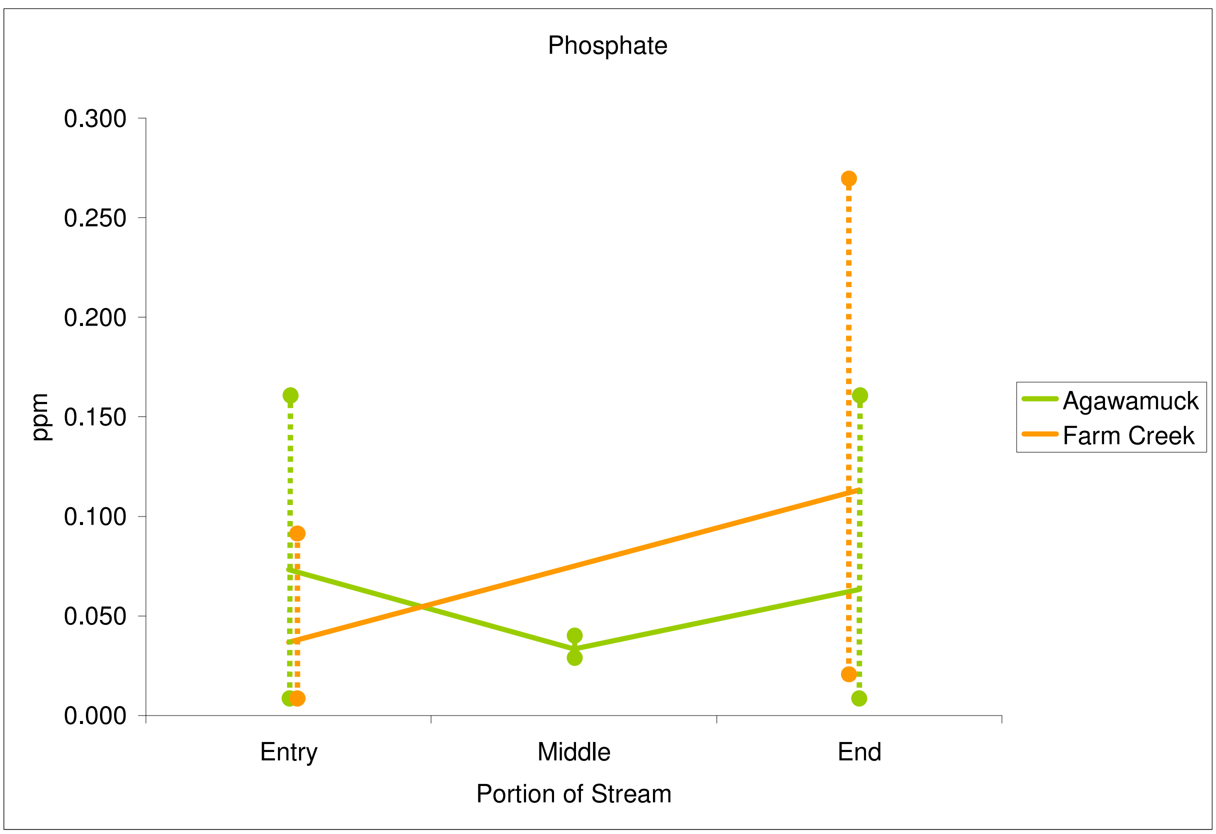
What We Found

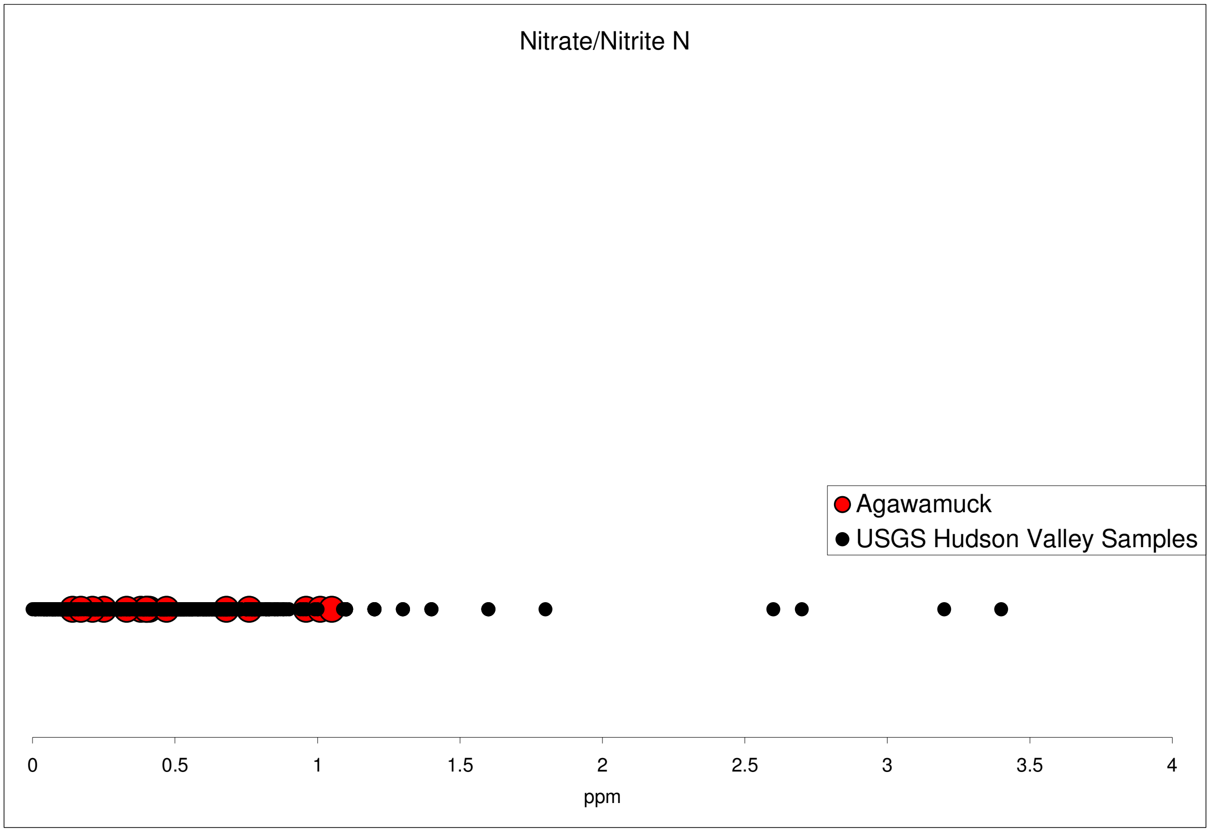
<u>Water Chemistry</u>

The graphics (Figures 9.3 and 9.4) below summarize our findings for Hawthorne Valley Farm nitrogen and phosphate measurements. Appendix 8 provides a complete tabular report of the results.

Nitrogen fertilization of our streams was detectable but relatively slight. Nitrogen levels (measured as the amount of nitrogen present in the two most common dissolved nitrogenous compounds – nitrate and nitrite) ranged from 0.17 to 1.05 parts per million (ppm). Natural levels in New York are thought to be less than 1.0 ppm. Nitrate values at or above 1.0 ppm were found only in July samples when water entering the Farm along the Agawamuck was already at .96 ppm and increased steadily to 1.05 ppm upon exiting the Farm. As the Farm Creek waters had only around .50 ppm when they entered the Agawamuck, most of this high level is probably attributable to upstream activities. While nitrogen values in the Farm Creek were low, they increased from entry to exit in all three seasonal samples, meaning that there was consistent nitrogen enrichment as the waters passed through our fields. Compared to nitrate nitrogen readings from elsewhere in the Hudson Valley, our readings were low to medium in value (Figure 9.5). A nitrate nitrogen level above 10 ppm is not permissible in drinking water; none of our readings ever approached this.[7]


Nitrate + Nitrite Nitrogen
1.20
1.00
0.80
0.60
0.40
0.20
0.00
ppm
Entry
Middle
End
Portion of Stream
Agawamuck
Farm Creek


Phosphate
0.300
0.250
0.200
0.150
0.100
0.050
0.000
ppm
Entry
Middle
End
Portion of Stream
Agawamuck
Farm Creek



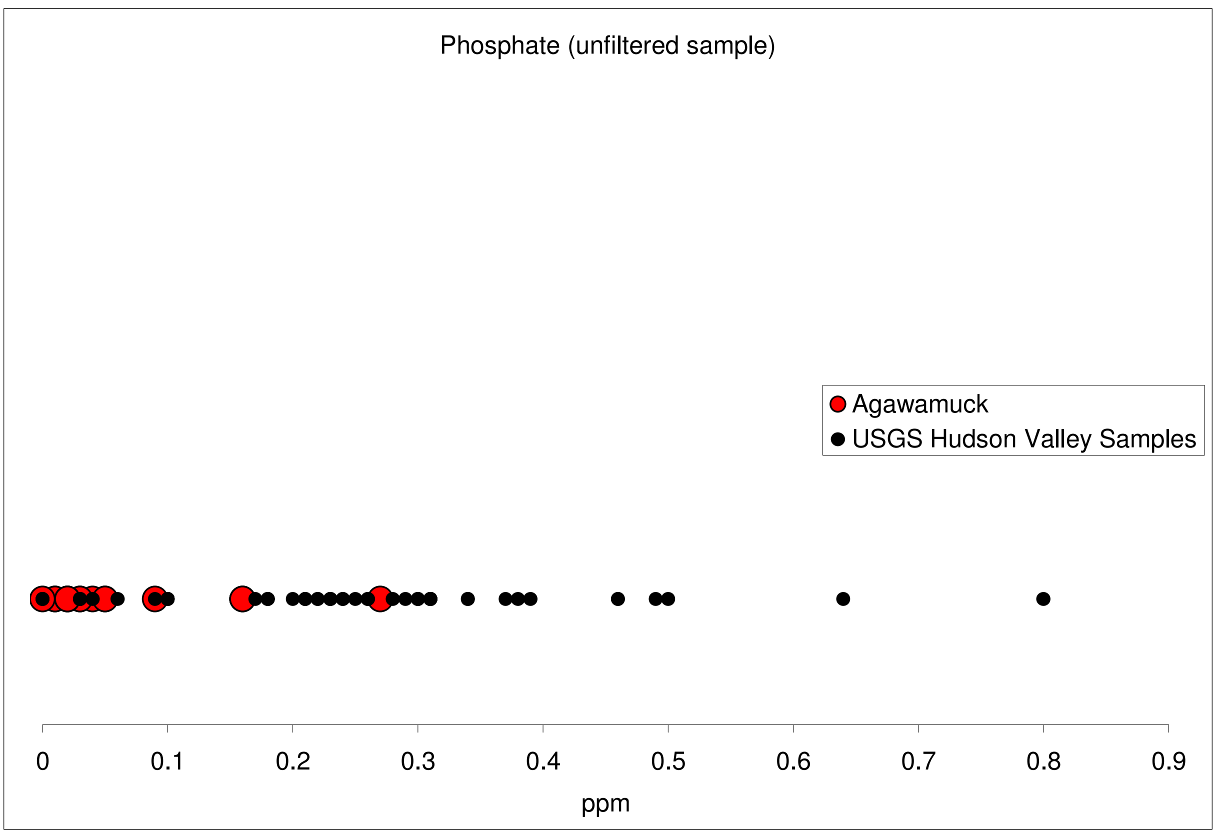


Figure 9.2-.5. Nitrate/Nitrite Nitrogen and Phosphate values recorded in the Agawamuck and also (bottom two figures) other places in the Hudson River watershed. In the figures on page 67, mean values for the three sampling periods (May, July, September) are connected by solid lines, while the dotted lines show the range of values around each mean. In the lower two figures, we have plotted our measurements together with those of other Hudson Valley waterways for context.

Phosphate levels did not show consistent patterns along the Agawamuck. They did, however, consistently increase from the beginning to the end of the Farm Creek. Values at the entry ranged from 0 to .09 ppm; values near the end of the Farm Creek (i.e., shortly before it joined the Agawamuck) were from .02 to .27 ppm. Background levels of phosphate are estimated at around .05 ppm. Readings in our streams regularly exceeded this with the maximum value being the .27ppm recorded in July at the end of the Farm Creek. In other words, while the highest nitrate pollution seemed to be associated with upstream inputs on the Agawamuck, the highest phosphorus contamination seemed to occur on-farm. Further, it would appear that, relative to accepted backgrounds, Hawthorne Valley's phosphorus run-off is a greater problem than that of its nitrogen. (Only two nitrate-nitrogen measurements reached or exceeded the background of 1.0 ppm; six of our phosphate measurements reached or exceeded the .05 ppm background). Relative to readings from elsewhere in the Hudson Valley (Figure 9.5), our phosphorus readings were mostly low, with one reaching medium levels.

For some downstream perspective, measurements taken in July where the Agawamuck flows through The Farm at Miller's Crossing showed nitrate-nitrogen levels of 1.44 ppm (higher than any measured at Hawthorne Valley) and phosphate levels of .21 ppm (near our maximum observed values at Hawthorne Valley). We have no idea what if any of this enrichment occurred on the Farm at Miller's Crossing itself; most may well have come from up-stream.

Phosphorus, rather than nitrate, seems the more potent fertilizer of aquatic systems. The growth of algae, for example, is often reported to be limited by available phosphorus. Thus, the ecological impact of phosphorus enrichment is often more marked than that of nitrogen, and indeed, algal growth was often apparent along the stream bottoms at Hawthorne Valley. From an agricultural standpoint, low soil phosphorus in Hawthorne Valley has prompted farmer efforts to import phosphorus. At the same time, we appear to be losing measurable amounts to run-off. Phosphorus conservation efforts might thus be appropriate for both ecological and agricultural reasons.

The only consistent pattern in microbial counts was for total, although not necessarily coliform, bacteria to increase across the Farm Creek. Surprisingly, relatively high counts were found in the middle Agawamuck in Spring; these probably do not come from Hawthorne Valley Farm activity, but rather from upstream contamination and, possibly, septic system leakage. Safety limits have been derived for total coliform bacteria, although there is disagreement given the benign nature of many coliforms. For drinking and swimming, values between 2500 to 5000 counts per 100ml for total coliforms are set by the State as upper limits. Four of our readings exceeded 2500 counts/100ml. More meaningful measurements come from counting *E. coli* colonies, because these are the coliform bacteria that most often cause illness. However, we did not gather good data on this group.

Measurements of pH, temperature, alkalinity, and dissolved oxygen varied seasonally, but showed few obvious geographic patterns (see Appendix 8 for individual values). The Farm Creek was roughly 2-3 ^{o}C warmer than the Agawamuck, but there was no measurable warming as the water crossed the Farm. The difference was most likely due to the warming of the waters in Acker Pond or other upstream, open wetlands. Dissolved oxygen levels were generally lowest in mid-summer, although we did have an anomalous (erroneous?) reading of 3.1 mg/L from the central Agawamuck in September. Nonetheless, values were usually above the 6.0 mg/L recommended for trout streams. In Autumn, when trout breed, most values were above the 7.0 mg/L recommended for trout spawning. Because of daily fluctuations in plant production of oxygen, dissolved oxygen levels can vary greatly during a 24-hour period; we did not attempt to follow daily variation, and so our conclusions are weak. Alkalinity ranged from 44 to 72 ppm and was consistently higher in the Agawamuck. Alkalinities above 20 ppm are thought to render streams relatively insensitive to acid rain. High alkalinity, measured as a water's ability to buffer acids, is most often attributed to the presence of carbonate or bicarbonate ions. These ions, in turn, are usually derived from limestone. Lakes located on granite, for example, tend of have low alkalinity and high susceptibility to acid rain. Columbia County geology includes a smattering of limestone, and it is likely that this contributes to our relatively high alkalinity and near neutral pHs (6.6-7.8). Our streams are probably adequately buffered against acid rain. In sum, none of these values indicate obvious problems.

The aquatic insects and their kith which live in a creek can tell you about the health of those waters. However, rather than being a clear good/bad signal, the results are more often simply suggestive descriptions, especially when the waters are only slightly impacted. According to our two different indices based on macroinvertebrates, our streams ranged from non-impacted to slightly impacted. Our general conclusion would be that the aquatic invertebrates were reflecting waters that, as we have already seen, are somewhat nutrient enriched, but that may be without other major problems. A more rigorous, but geographically and temporally limited, assessment done by Kelly Nolan of Hudson Basin River Watch reached a similar conclusion for the waters behind Hawthorne Valley School. In general, we found ample examples of the relatively sensitive mayflies, stoneflies, and caddisflies, including especially sensitive families within those groups such as the "roach-like stoneflies" and the "giant stoneflies".

The relationship between stream salamanders and water quality has not been as thoroughly studied as that between water quality and invertebrates or fish. The vast majority of the salamanders which we encountered during our stream surveys were Two-lined Salamanders. These are considered to be relatively tolerant, widespread species, yet their number is thought to be useful in separating colder, headwater streams from other streams which, for natural or human-caused reasons, are warmer, slower moving and/or temporary. This species exists as an aquatic larvae for 2 or 3 years before becoming terrestrial, whereas the Dusky Salamander (the other species which we found) lays eggs on wet ground and develops quickly so that it does not need perennial flow. Aside from needing perennial flow, the Two-lined Salamander lays its eggs on the undersides of objects in the stream, such as rocks; high siltation might thus reduce available egg-laying sites. In our region, at least, the Dusky Salamander seems the rare species. Perhaps this is because it reportedly favours slightly lower streams, ones that may have been more radically altered by past human action. Hudsonia states that the Dusky Salamander is more sensitive to stream alteration, although it may be that the relative sensitivities vary depending upon the specific impacts being considered.[8]

In any case, our results, showing markedly higher numbers of salamanders along the Agawamuck, would suggest that at least in terms of water flow and habitat structure, this is perhaps closer to a natural headwater stream. The occasional presence of Dusky Salamanders along both the Farm Creek and the Agawamuck is taken as a positive sign. However, to build perspective, the exploration of other sites around the County is needed.

Fish

The results of our fish work are perhaps best understood by highlighting what the presence of each species implies about aquatic habitat quality. Quite a lot of work has been done to design aquatic health indices based upon fish; as a result, the relative sensitivity of each species has been determined. Table 9.1 lists the species we have found and summarizes their sensitivities based upon published studies. The photographic guide in Appendix 7 illustrates most of these species, along with maps of their known distribution in the County.[9]

Table 9.1. Classification of the fish caught during our preliminary surveys. In parentheses we give the literature-derived judgments of the sensitivity of each species to habitat alternations. "Tol." = tolerant; "semi-Sens"= semi sensitive; "Sens." = sensitive.

Order: Cypriniformes

Family: Cyprinidae

Golden Shiner – *Notemigonus crysoleucus* **(Tol.)**

Common Shiner – *Notropis cornutus* **(semi-Sens.)**

Spottail Shiner – *N. hudsonius* **(semi-Sens.)**

Fathead Minnow – *Pimephales promelas* **(Inroduced; Tol.)**

Bluntnose Minnow – *P. notatus* **(Tol.)**

Eastern Blacknose Dace – *Rhinichthys atratulus* **(Tol.)**

Longnose Dace – *R. cataractae* **(semi-Sens.)**

Creek Chub – *Semotilus atromaculatus* **(Tol.)**

Fallfish – *Semotilus corporalis* **(Sens.)**

Family: Catostomidae

Longnose Sucker – *Catostomus catostomus* **(semi-Sens.)**

White Sucker – *C. commersoni* **(Tol.)**

Order: Salmoniformes

Family: Salmonidae

Brook Trout – *Salvelinus fontinalis* **(Sens.)**

Brown Trout – *Salmo trutta* **(Introduced; Sens.)**

Order: Perciformes

Family: Centrarchidae

Pumpkinseed – *Lepomis gibbosus* **(Tol.)**

Bluegill – *L. macrochirus* **(Inroduced; Tol.)**

Largemouth Bass – *Micropterus salmoides* **(Introduced; Tol.)**

Family: Percidae

Tessellated Darter – *Etheostoma olmstedi* **(Tol.)**

Order: Scorpaeniformes

Family: Cottidae

Slimy Sculpin – *Cottus cognatus* **(Sens.)**

It would, of course, be exciting to follow the history of these species over the past, say, 300 years. However, in most cases we do not have the historical data to permit this. The earliest European accounts are often general, and certain determination of the species referred to is often difficult. Works of the 19th century, with some exception, focus on identification and give only a rudimentary idea of distribution and abundance. In both cases, the lion's share of the information is about prominent food fish; relatively little pertains to minnows and the like. The New York State biological surveys of the 1930s and 40s were the first attempt within the State to systematically describe the distributions of the more "obscure" stream fish. Additional sampling has occurred since then, although not in the systematic fashion of those early surveys.[10]

The county-wide distribution maps of these species suggest four general groupings of our stream fish: *Ubiquitous Species* – those basically found throughout the County; *Lowland Species* – those found most commonly in the western, Hudson-Valley half of the County and in the Harlem Valley; *Upland Species* – those found most commonly in the hillier, eastern portion of the County; and *Foothill Species* – those found where the larger valleys abut the hills, but not extending up into those hills. These are subjective, short-hand categorizations of the fish distributions; they describe occurrence patterns in the County, rather than widespread, ecological generalities. Examples of the four distribution patterns are illustrated in Figure 9.6.

In terms of judging the ecological effects of agriculture in the County, we can only speculate. The common lowland and ubiquitous species would, by implication, appear to have a relatively high tolerance for the agriculture which has influenced much of larger valley bottoms for the past three centuries. Upland species may be the ubiquitous species that were not tolerant of agriculture and/or species which require the headwater environmental conditions found in the higher hills. The Foothill species could, likewise, be sensitive lowland species which now only survive on the less-heavily worked margins of those lowlands or species which require environmental conditions specific to the "foothills". To explore this in more detail, we summarized our classification in Table 9.2, and then considered published information on the individual ecologies of each species.

Table 9.2. Species captured during our surveys categorized according to their distribution patterns. Species in green, bold type have been categorized as "sensitive" in the literature; species in green, regular type have been classified as "semi-sensitive", while those in standard black type were described as "tolerant".

Ubiquitous	Lowland	Upland	Foothill
Common Shiner	Bluegill	**Brook Trout**	Bluntnose Minnow
Creek Chub	**Fallfish**	**Brown Trout**	Fathead Minnow
Eastern Blacknose Dace	Golden Shiner	**Slimy Sculpin**	Longnose Dace
White Sucker	Largemouth Bass		Longnose Sucker
	Pumpkinseed		
	Spottail Shiner		
	Tessellated Darter		

The Upland Species are all sensitive coldwater sorts. Agriculture or other developments have no doubt affected them where the canopy has been opened, flow slowed, siltation increased or water quality impaired in some other way. However, they may never have been especially common in the larger, warmer river valleys.

In contrast, at least two of the "Foothill Species" (the Longnose Dace and Longnose Sucker) may have formerly been more widespread. These species are reportedly fond of slower, warmer waters, and yet are sensitive to deteriorations in these larger streams and rivers. Their peripheral distribution may illustrate the relicts of populations that were formerly more widely distributed across the lowlands. Bluntnose and

Fathead Minnows, on the other hand, seem to be hearty species, and their apparent "Foothills" distributions may be related to effects other than exclusion from bigger streams.

As we have already discussed, "Ubiquitous" and "Lowland" species would appear to be relatively little impacted by agriculture.

There are at least five species of stream fish which we have not yet caught in our surveys, but which others have caught in the County and whose regional statuses suggests they are suffering due to declining stream quality: Eastern Silvery Minnow, Creek Chubsucker, Northern Hog Sucker, Bridle Shiner and Satinfin Shiner. These are generally species of the larger, warmer, and slower valley streams. They have been reported to be declining in New York and/or adjacent areas, often due to siltation or water pollution.[11]

Several of the species discussed above have apparently declined due to reduction in stream quality. At least some of this deterioration may have been due to past and current agricultural impacts. Increased siltation, as can be caused by soil erosion, probably has reduced the habitats available to some of these species. Pesticide contamination and nutrient run-off may have also had impacts. The opening of stream banks and the straightening and clearing of stream channels has probably also reduced habitat quality. Housing and commercial development along streams has probably had some of the same effects, with the addition of stream and river damming for private ponds or power production. The 1930s DEC fish surveys make frequent mention of the impacts of raw sewage contamination of streams and of toxic industrial effluent. Runoff from road ways and acid rain may have also reduced water quality. In most cases, it may not be possible to isolate the impacts of these various effects. However, at the same time, it is apparent that there is reason to encourage any activity which reduces contamination of streams. On farms, perhaps the single most important management action would be to allow the revegetation of stream banks, this can not only restore in-stream habitat complexity (as streams are allowed to wander somewhat and as debris accumulates) but also such buffers can help intercept the run-off of soil, nutrients and agrochemicals before they reach the streams.[12]

Summary of Hawthorne Valley Conditions.
Our stream waters show definite evidence of agricultural influence. At least during some times of year, the main branch of the Agawamuck enters farm property with a substantial nutrient load. It does not improve during its travel through our property. However, because of the abundant forest cover and clear waters, aquatic habitat generally seems fairly good along this stretch. The Farm Creek showed more distinct impacts, perhaps because it travels partially through open fields and because we assessed it right where it left the core of the Farm. Nutrients, especially phosphate, and bacteria consistently increased across Hawthorne Valley property; aquatic invertebrate counts, low salamander levels, and reduced fish diversity suggest there may have been faunal consequences. While none of the measured nutrient or microbial levels is extreme, the measurements are elevated. The relatively high phosphate run-off would suggest that manure is being deposited directly into streams or is leaking in from above-ground sources. (Once in the soil, phosphate leakage is normally slight, and so compost that has been incorporated into fields is unlikely to be a major source).

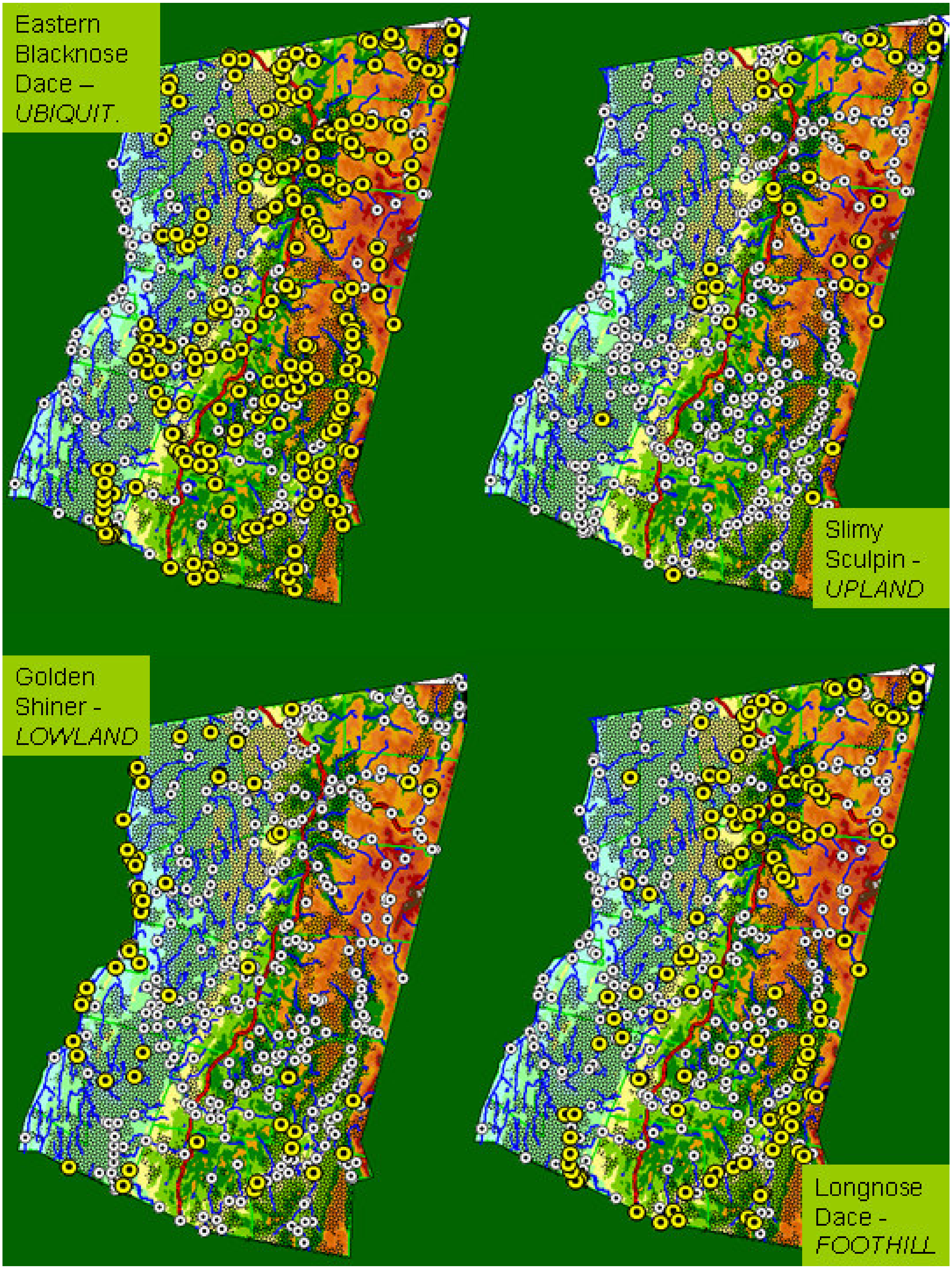


Figure 9.6. The distribution of fish in the County based upon DEC-supplied historic data and illustrating our four distribution categories. Background colors are elevation, the lowest land is to the west along the Hudson. Stippled areas are Agricultural Districts. Yellow dot-in-circles indicate sampling sites where the given species was found; smaller, white dot-in-circles show sampling sites where the fish was not caught. The Thruway and Taconic State Parkway are shown with red lines.

Management Ideas
Again, recommendations would focus on revegetating stream borders where possible and restricting the access of cattle to streams (mainly because the more available access there is, the more likely a cow will defecate in a stream). This restoration work has already begun, and a major portion of the exposed Farm Creek is already into its first year of regrowth. Any farming technique that reduces input of nutrients and agrochemicals would also be beneficial.

Both locally and at the County level, piecemeal efforts can go only so far. For example, improvement in Agawamuck water quality will depend, at least in part, on efforts made by farmers and other landowners upstream and downstream of Hawthorne Valley.

Part 10: Conclusions

Farms, as sources of grassland and shrubland habitat, can provide important land for certain native plants and animals. While these habitats were not necessarily historically common in our area, large-scale declines in natural prairie and wetland habitats, accompanied by efforts to control natural disasters such as flood and fire, mean that man-made grasslands and shrublands may now be crucial for certain species. In Columbia County, we found that farms provided habitat for at least 350 species of native plants, of which around 10% were openland plants of conservation concern. We tallied 150 species of birds found on Columbia County farms; these included 25-30 grassland and shrubland species, many of which are declining globally. Local farms also provided habitat for at least 49 species of butterflies, and we present a list of 18 butterfly species to watch if farmlands decline.

Farms also have their negative impacts, and aquatic habitats are often thought of as particularly sensitive to such effects. High levels of farmland nutrients appeared, in our data, to be associated with reduced diversity of stream invertebrates and vertebrates, although our evaluation was very localized, and we can hardly claim cause and effect. At the same time, certain species of vernal pool amphibians and invertebrates (the only fairy shrimp we found were in a pond surrounded by crop fields) appeared to be able tolerate at least some forms of agriculture. We are currently working to understand when the needs of these organisms and of farmers are compatible.

In this conclusion, we will first try to summarize our evidence regarding the value of farmland for nature conservation. We will then present some general considerations regarding the changes in agriculture and native species in the County and, finally, pass on to more specific recommendations primarily focused on Hawthorne Valley Farm.

Ecological and Historical Evidence on the Role of Farmland in Nature Conservation
To document that farmland has a value for nature conservation, we need to meet at least three conditions:

1. On-farm habitats contain significant numbers of species of conservation interest.

2. These on-farm habitats are declining (and hence worth highlighting).

3. Farms account for an appreciable proportion of these habitats in the County.

Below, we present an assessment of each of these points.

Do on-farm habitats contain significant numbers of species of conservation interest?
Certain native species are declining, rare or otherwise thought to be at risk. The status of some of these organisms is directly due to human-induced habitat loss; while others have long been rare, but the potential for habitat loss threatens to make their situation critical.

Here, we compare habitats based upon only plants, birds and butterflies. We have some data on amphibians and reptiles, but do not consider it sufficient to compare habitats

Table 10.1 outlines our results. While the criteria for evaluating species differs amongst groups (and is discussed further in the relevant section of this report) and while certain data need to be refined, it is apparent that the percentages of species of conservation interest found in wet meadows (or other open wetland), grassland, or shrubland are at least comparable to the proportions found in woodlots. In terms of absolute numbers of declining species, the non-forested habitats together hold at least as many as the forest itself. Our point is to document that agriculturally-created or preserved habitats have the potential to be of similar conservation value as wilder habitats (i.e., forests).

Cropland, while not evaluated rigorously for all species, appears to be consistently low in native diversity, although this will depend somewhat on what the planted crop is.

There are important caveats. First, we in no way mean to denigrate the value of natural woodlands, wetlands, alpine scrub or the like. There are very good reasons to preserve such habitats, and a more complete consideration of wild habitats (including more than simply second-growth forest) would doubtless boost their numbers. Our point, as stated, is simply to urge greater recognition of the value of agriculture in creating or maintaining other habitats that also have conservation value. Second, we have information only from the farms mentioned in this report. Because these farms are not a representative sample of all farms in the County, **these data are best taken to represent the documented potential for the given habitat to host such species, rather than proof that these species often or even usually are present on farms.** Finally, it is worth noting that the valid comparison is not always with "wilder" habitats: these days, when farms go out of production, development and landscaping are frequently the alternative. We are only beginning to study the conservation value of these land uses.

Table 10.1. The number of native plants, birds and butterflies found exclusively or predominantly in the given on-farm cover-type habitat and the % of those species which are declining or otherwise of conservation interest.

	PLANTS[1]		BIRDS[2]		BUTTERFLIES[3]		**Average % Decline**
	Species	% Decline	Species	% Decline	Species	% Decline	
Woodlots	114	21%	38	32%	5	40%	**31%**
Wet Meadows, etc.	48	40%	no data	37%	5	60%	**46%**
Shrubland	13	85%	18	61%	9	25%	**57%**
Grassland	15	45%	13	92%	26	20%	**52%**
Cropland	5	20%	few	?	?	low	**low**

[1] - "Species" refers to those plants found in our study to be exclusive to given habitat.
"% Decline" refers to % of those species that are of conservation interest.

[2] - "Species" refers to the number of county species primarily associated with given habitat.
"% Decline" refers to % county's species showing significant national decreases (BBS); wetland data refer to % of national species.

[3] - "Species" refers to the number of county species primarily associated with given habitat.
"% Decline" refers to % of county species with reported national/regional declines.

Are these on-farm habitats declining?

In parallel with the overall decline of land in farms, the extent of each of the on-farm habitats has declined in Columbia County over the past 150 years. Although, as we shall see later, this does not always mean that the habitat's *total* extent in the County has declined. Figure 10.1 illustrates the pattern of the decline, both in absolute and relative terms. On average, each cover type has declined by at least 2/3rd's since its maximum extent; woodland stands at 42% of its maximum on-farm extent, while permanent pasture is at only 6%. Permanent pasture has gone from being the largest single component of the farmland, to being the smallest. Pasture has declined more than other habitats because of its large extent during the sheep boom in the second quarter of the 19th century, and because of the advent of silage/haylage-based dairy herds. The timing of decline has also differed amongst habitats, with the old field/shrubland/wetland estimated to have risen to peak values in the early 1900s as farm fields began to grow back into forest.

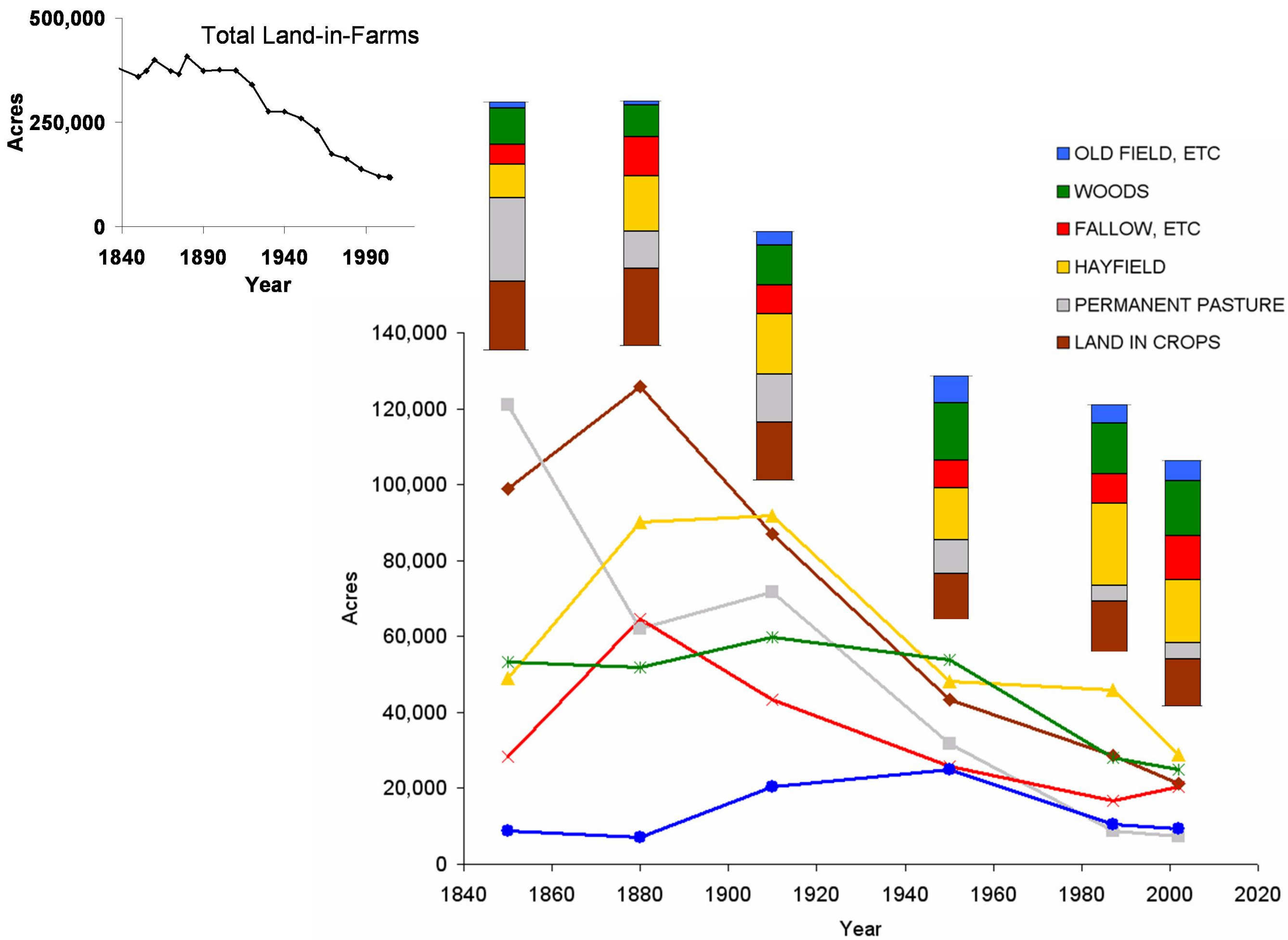


Figure 10.1. The historical fate of on-farm habitats. Connected dots indicate the absolute extent of the given habitat in the County. The values for each year sum to total 'land in farms', the trend of which is shown in the inset. The bar diagrams show the *percentage* of total Columbia County land-in-farms that is accounted for by each habitat type

The ecological effects of these declines in extent have probably been exacerbated by a trend towards increasing intensification of use. Depending upon the crop, yield has increased from 200-600% since 1910 (see Figure 10.2). As a consequence total agricultural production in the County did not begin to tail-off until around 1970 (Figure 10.3).

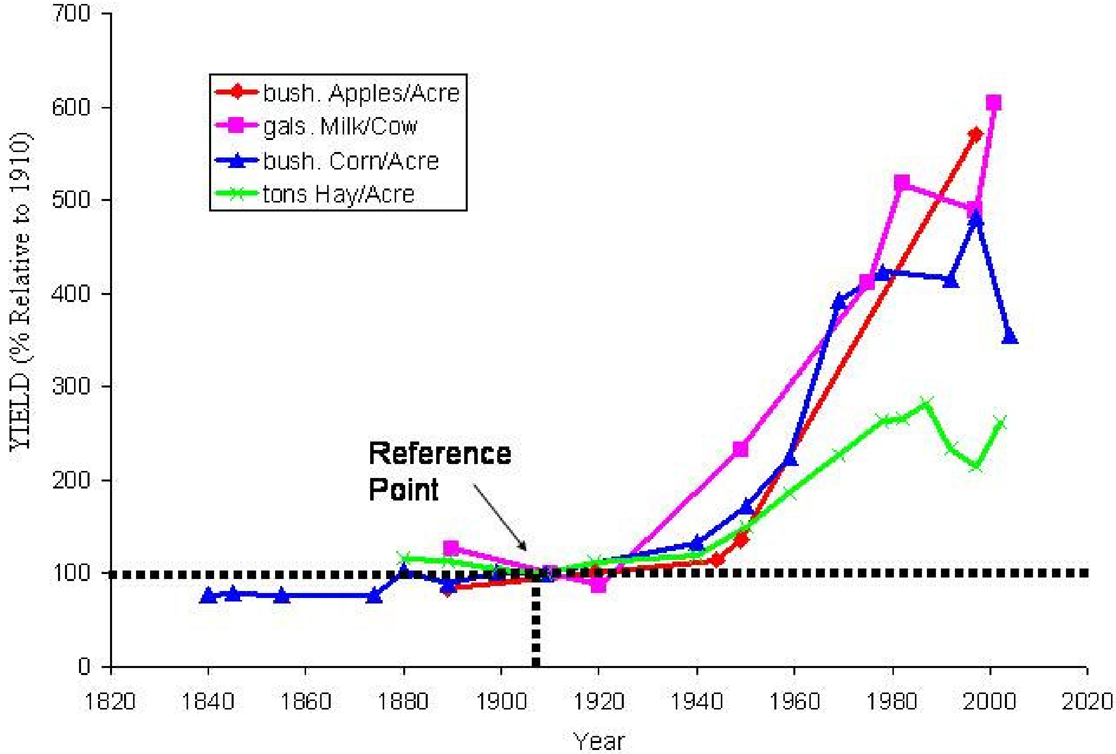


Figure 10.2. Yield of apples, milk, corn and hay relative to 1910. Yields have increased 200-600% over the past 100 years.

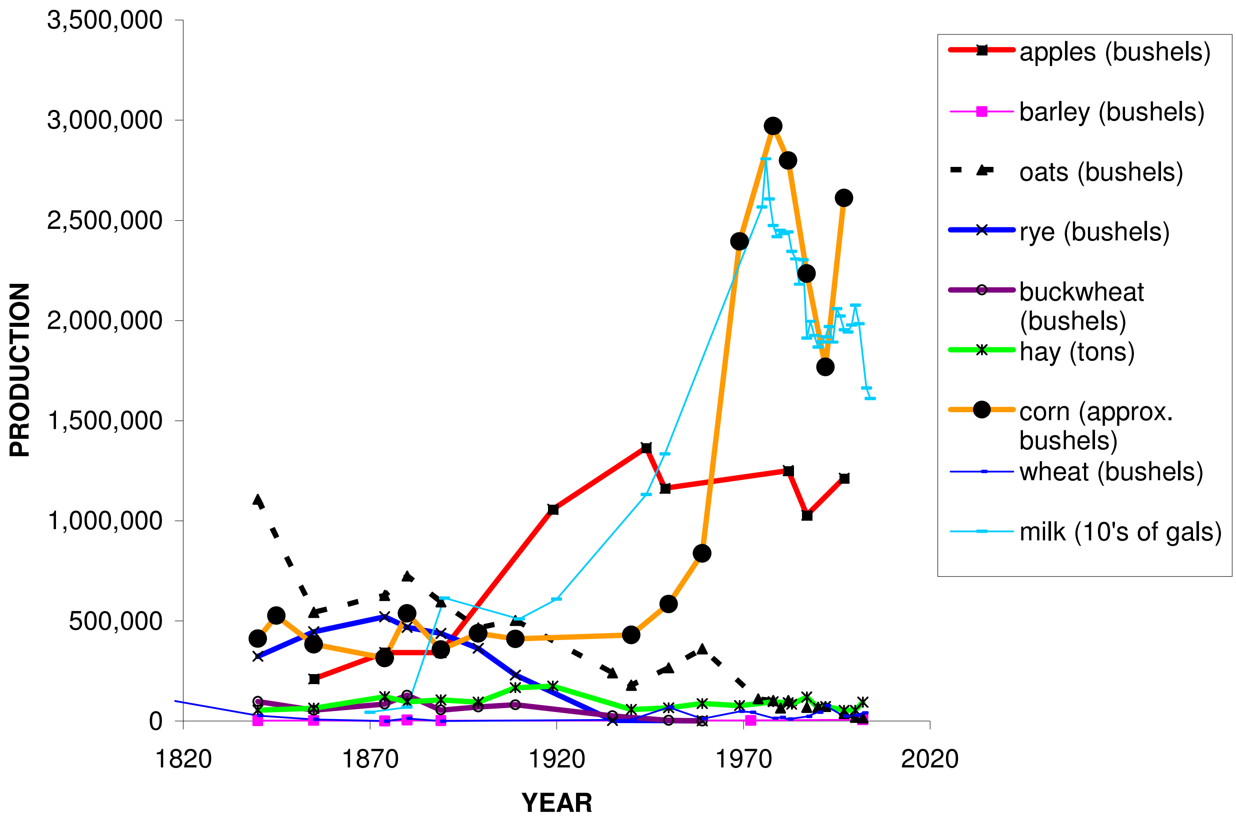


Figure 10.3. Farm production over the past 200 years. Production units are indicated in legend.

Do farms account for an appreciable proportion of these habitats in the County?
Having established that on-farm habitats can be important for the conservation of certain species, and that these habitats have declined substantially, it remains for us to demonstrate that farms are important sources of these habitats. For example, if, as we have pre-supposed, on-farm woodlots only account for a relatively small proportion of the forest in the County, then one could hardly argue that preserving farms helps conserve forests.

The figure below (Figure 10.4) shows our estimates of the evolution of different habitats at both the County and on-farm scale.

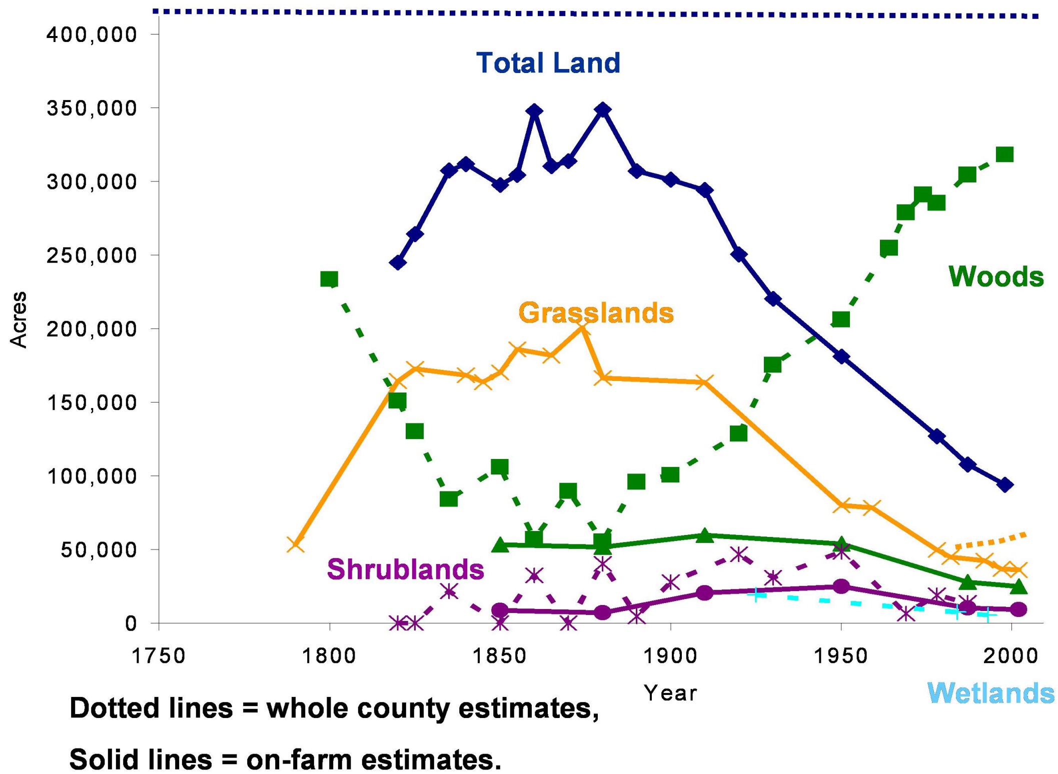


Figure 10.4. A graph illustrating the estimated contribution of farmland (solid lines) to habitat totals (dotted lines) in the County. We have no historical estimates of on-farm wetlands; the county line is derived from historical soil surveys and 1993 remote sensing.

Exploring our example of forestland, we can see that on-farm woodlots went from accounting for nearly 100% of the County's forests in the second half of the 1800s to less than 10% today. Indeed, total forest in Columbia County has increased markedly, while its on-farm component has actually declined. For grassland and shrubland/wetland however, farms apparently have contributed and continue to contribute a significant proportion. It is thus difficult to argue that farms play an important role in preserving woodland, whereas their role in grassland and grassland/shrubland conservation may be more important.

To explore this question further, we utilized a land cover map derived from remote sensing project done by Cornell's IRIS. They took a 1993 satellite image of the Hudson Valley and classified each 30 meter by 30 meter quadrate according to cover. By extracting the data for Columbia County from this image, we were able to use this source to estimate actual, total habitat composition for the County. We compared this to agricultural censuses taken around the same time. Our conclusions are summarized in Table 10.2.[1]

Table 10.2. A comparison of estimated on-farm extent of various habitats in comparison with county totals. The remote-sensing information was derived from a Hudson Valley 30m-resolution land cover map produced by IRIS at Cornell University. These data are compared with census estimates from the same period

	1993		
	County-wide remote sensing (acres)	On-Farm census data (acres)	% of Total on Farms
Woods	285,970	27,000	9%
Grassland (hayfield & pasture)	67,330[A]	42,511	63%
Shrubland	7,520	9,215[B]	70%
Wetland	5,620		

[A] - The remote sensing analysis appeared to include most hayfield in its "cropland" category. (i.e., remotely-sensed cropland ≈ on-farm census cropland + hayfield). Because we considered hayfields to be grasslands, we added the census estimate of hayfields to the remotely-sensed estimate of grasslands to derive our estimate total grasslands.

[B] - This is the category "unimproved, unwooded" agricultural land, i.e., all farmland that is left after cropland, pasture & woods are removed; wetlands and shrublands would be here, but so too would farmyards and roads.

We estimate that more than 60% of the County's grasslands were on found on farms in 1993 (this value was calculated by adding the estimated hayfield component of what Cornell called "cropland" to their "grassland" cover type). Shrubland and wetland were distinguished in the land cover map, but not in the agricultural censuses. We assume that these two habitats are the major component of the agricultural census category denoted as "unimproved, unwooded". We believe that farms probably account for at least 50%, and possibly as much as 70% of the combined shrubland/wetland cover type.

In Sum

Based upon the above considerations, we conclude the following:

- **Farm habitats can harbor numerous species of conservation interest.**
- **These on-farm habitats are all declining.**
- **While these habitats are not exclusive to farms, farms are a major source for them.**
- ***Thus, preservation of farms has the potential to assist regional nature conservation in important ways.***

The continuation of our work is focused on extending our analysis to other on-farm habitats and taxa; on looking at the ecological consequences of other extensive land uses; and on getting an appreciation of how much of agriculture's documented nature conservation potential is, in fact, realized.

Some Observations on the Future of Agriculture in Columbia County

In considering the future of agriculture-native species interactions in Columbia County, it seems best to first sketch the likely future evolution of farming in the region. It is the economic existence of agriculture that will shape the ground that nature conservation has to work with, not the reverse.

Columbia County farming is both blessed and damned by its proximity to New York City. Such a huge market, which contains some relatively well-to-do and "discerning" customers, provides substantial outlets for certain foods. While such marketing requires the investment of capital and time in transport, it usually pays off. Even without direct marketing in New York City, the numerous second home owners in Columbia County insure that, in summer at least, their money will flow into local markets. On the down side, land prices have jumped dramatically since 2000, and the sometimes marginal profits associated with the historically more common means of farming (e.g., apple and dairy) have made it ever more tempting to sell off land for development. It has also meant that it is more difficult for any farmer to find suitable and affordable land. Figure 10.5 illustrates the overlap between development pressure and agriculture in the County. [2]

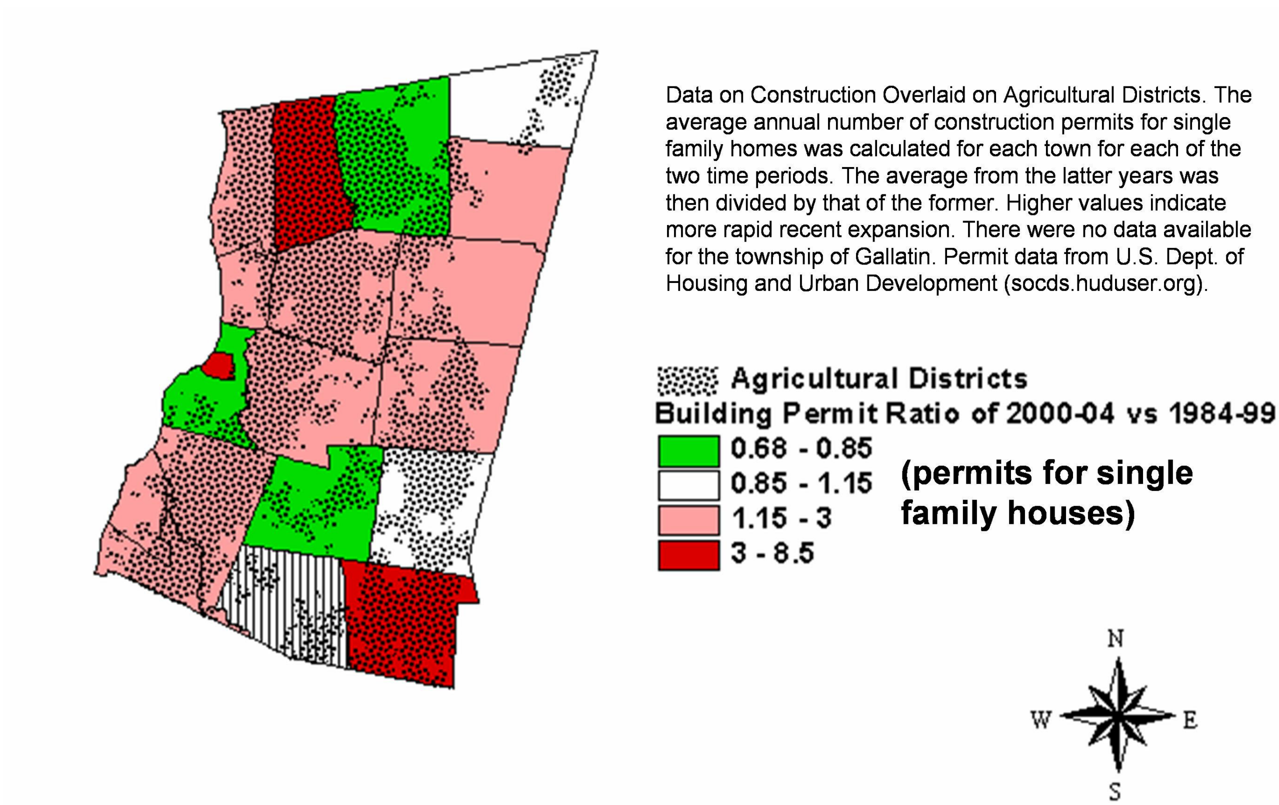


Figure 10.5. A map illustrating development pressure in relation to agricultural use. Methodological details are described in the figure.

While apple and dairy still top the agricultural sales charts for the County, regional trends indicate that market gardens, some of which are producing goods for the landscaping and flower business, are increasing. In addition, some of the formerly “conventional” farms are converting towards direct or niche marketing (e.g., home delivery of milk, organic fruits and vegetables, u-pick gardens, grass-fed beef, artisanal cheeses). In thinking about the future habitats that agriculture will be able to provide to native species, we should probably envision an expansion in the market garden sector, if any, and declines in most of the other sectors.[4]

The net nature effect of this evolution in commercial farming is not clear to us. The cultivated portions of market gardens are probably home to few native plants and vertebrate animals. However, an emphasis on organic production in this sector is generally a good sign, especially if it includes habitat management considerations as well as chemical ones. The decline in dairy farms threatens to remove some hay fields and pastures from the landscape, and yet grass-fed livestock and haying for horses may produce some counter currents.

At the same time, much of the former farmland is converting to rural estates, some of which, out of owner vocation or tax planning, are receiving at least passing agricultural use. Thus, some “agricultural habitat” is no longer on active farms. In contrast to the lands found on working farms, it is doubtful that these properties will move substantially towards market gardening. Rather, they may revert to forestland, undergo intensive landscaping or development, or perhaps be maintained as hay meadows.

The tendency for agricultural intensification, albeit in different regional contexts, is widespread. A Finnish set of studies, which in many ways parallels our own, bemoans the loss of meadows used for hay and pasture, citing them as the most important sources of on-farm biodiversity. The authors urge adequate funding in support of "traditional" farming (i.e., pasture- and meadow-based). Likewise, England has initiated a variety of steps directed at preserving species-rich agricultural habitats. These programs are greased by agricultural incentives. While such payments for seemingly non-productive services may be anathema to some farmers, in our minds, they simply recognize and reward additional, important "products" of farming, namely farming's contributions to nature conservation and to aesthetics. Possibilities for such incentives appear to be growing in Columbia County, and we hope they will serve to both encourage farming and aid nature conservation at the County scale.[3]

Of most concern perhaps is the overall intensification of general land use. As we have pointed out elsewhere in this report, the habitats most favorable to native plants and animals are rarely the most productive or even the most scenic – the dismissal of vernal pools as puddles and of shrubland as wasteland has already been mentioned. As the value of land increases, now regularly in excess of $20,000 per acre, the apparent space for such unappealing areas declines. It is important that, as farmers, as land owners, and as citizens, we recognize the nature conservation value of these seemingly "junky" habitats.

In considering the "farmscape" as a whole, we must think about the roles that both working farms and rural estates can play in nature conservation. Below, we present our thoughts relating to each.

Management Thoughts and Questions

In each of the preceding chapters, we have presented management ideas. We will not repeat them here. Rather, we try to first generalize, and then specify. (As this report was being proof read, we received a copy of The Wild Farm Alliance's *Biodiversity Conservation: An Organic Farmer's Guide*. While we have not integrated its recommendations into this report, it provides valuable, detailed suggestions. The Wild Farm Alliance's webpage is www.wildfarmalliance.org.)

In terms of working farmland, if maintaining native species on the farm is of interest, certain **general ideas** can be suggested:

> **Whenever compatible, integrate the life cycles of native plants and animals into the farm management.** *For example, the timing of pasture and hayfield use can strongly affect which native birds and warm-season grasses prosper.*
>
> **Leave tended 'eddies' in the flow of farmland use.** *That is, don't undervalue the role that relatively underutilized portions of the farm can have in maintaining native species if they are allowed to remain in wetlands, brush or grassland.*
>
> **Look for synergy, i.e., instances in which the promotion of native species can help farm production.** *This is easier said than done and requires getting down to specifics, but examples include native bees as pollinators, the potential benefits of hedgerows, and the possibility of improving the pasture quality of dry-hillside pastures through encouragement of a native warm-season grass.*

Because we have studied *Hawthorne Valley Farm* longer and in more detail, our recommendations for this farm are more specific and encompass our thoughts for future work. While specific to this farm, they illustrate measures that, with suitable modifications, might be taken elsewhere. They include the following:

Continue reforestation along the Farm Creek; avoid extensive deforestation around the Agawamuck. *Forested Riparian areas can serve as important filters for agricultural run-off, as creators of aquatic habitat, as corridors for terrestrial wildlife and as habitat for various native plants and animals. Monitoring the natural reforestation along the Farm Creek will reveal which wetland plants of conservation interest will continue to thrive as a more shaded riparian habitat develops.*

Explore ways of linking current and future watering ponds to wooded areas. *Our initial work suggested that, especially if linked to woodland habitats, farm ponds can provide useful habitat for native amphibians.*

Maintain light grazing of the wet meadows at the base of Atelier, Steephill, Westhill, in the Valley Field, and on the North Hill. *These wet meadows harbour a unique set of wetland plants, most of which would likely disappear if these wet meadows were allowed to become dominated by shrubs.*

Maintain brushy grassland/shrubland habitats on peripheral fields. *These peripheral fields are important habitat for grassland/shrubland plants and animals. If we were to identify one farm-created habitat as being the most important for native species, it would probably be this one. This task is not a passive one – it will require considering ways of maintaining the open nature of these fields. The already existing little bluestem populations on these dry hillside pastures might have a potential to play a more important role as forage and should be monitored and encouraged.*

Begin appealing research on farmland-relevant wildlife that serves to entice public participation (e.g., on bats and/or groundhogs). *The process of research is sometimes just as important as its results. If the public can better appreciate the ecological value of farming, they will have an additional reason for supporting its future in the County. Public interest is peaked by photos, images and stories as much as by facts; we need to seek useful research that also is charismatic.*

Monitor the results of above management and consider revisions as indicated by agricultural and biological information. *Our suggestions are pie-in-the-sky if their results are not monitored and management re-visited.*

Resist the concentration of agricultural activities. *As we have already outlined, native species tend to survive best in areas outside the constant focus of agricultural attention. If the farmscape evolves towards sharper lines between agricultural and non-agricultural space and if the land available for farm use dwindles, then the habitat for native species will likely be reduced.*

Our work with *farms outside of Hawthorne Valley* began only last year, and we have more **questions** than conclusions. These questions include the following:

- What might croplands with open ground (e.g., row crops) provide to certain grassland birds such as American Pipets and Vesper Sparrows? Both species are reported to use cropland for nesting, but we surveyed relatively few such plots.

- What role do cornfields play in maintaining regional wildlife populations, both during field growth and as post-harvest stubble and debris? Aside from being potential nesting grounds, cornfield leftovers probably provide important wildlife food in some areas.

- How important are hedgerows in providing habitat to brushland birds and corridors for forest wildlife? We need to work on better identifying which birds use hedgerows and in monitoring hedgerow use by wildlife.

- What effect, good and bad, do these farms have on the aquatic fauna? Our stream work at Hawthorne Valley was revealing, to what degree does it parallel the effects of other regional farms and what role do their ponds play?

- What habitats do larger conventional farms provide to native species? We have no experience with these farms, and so can't comment on their conservation value even though they often occupy many acres.

In relation to *rural estates*, our primary questions are as follows:

- Can the owners of these properties be involved in research and management designed to maintain or improve openland species habitat? Because the "shape" of these lands is often driven more by landowner aesthetics than economic necessities, involving these landowners in nature conservation may be one way of helping maintain native openland species in the County.

- To what degree are the desires of these owners, the needs of regional farmers and nature conservation compatible? Affordable, good farmland is in short supply. Despite the apparently strong market for local production, young farmers have difficulty becoming established because land is expensive. If we envision a socially and ecologically healthy future for the County, then we need to look for ways of bringing together landowners, farmers and conservation ethics.

As Aldo Leopold observed more than 70 years ago, "neat" farming aimed solely at extracting production from the land is rarely good for native species. Native plants and animals exist, for the most part, in the interstices of production, where the agricultural cycle allows them time and space to live. In comparison to, say, housing development, agriculture can be relatively good at providing such eddies for nature. Furthermore, in some cases, farming replicates the natural habitats which we have destroyed elsewhere. Current trends in our county are troubling not just for nature but also for agriculture. Land is being sucked out of agriculture by high land prices, and what remains is being trampled by the agriculturally-inimical tendencies that follow. It is perhaps a comment on our days that the time and space which have let other creatures co-exist with us is decreasing, while our connection to land as a source of needed food also declines. We can afford neither to ignore the plights of nature and of agriculture nor to blindly cater to them. It is our belief that, in the long term, a healthy landscape for our region will be a farmscape which strives to satisfy the desires of humanity and of the rest of nature. Such cohabitation will not come spontaneously, and it is our hope that this small work helps justify and inform the actions needed to create such a landscape.[5]

Acknowledgements

An activity like this requires the input, patience and work of many people.

We would like to thank the farmers who tolerated (heck, *even* encouraged!) our presence. At Hawthorne Valley Farm, Steffen and Rachel Schneider have been long and dedicated supporters, willing to openly share their perspectives and listen to ours. Katy Lince, the gardener at Hawthorne Valley, has maintained her support, even when we show some ecological interest in groundhogs. Judith and Abe Madey, part of the Hawthorne Valley dairy component, have let us muck around with their data and the cows; their support for research has helped encourage us. Dan Demaine, current herdmaster at HVF, has patiently handled the questions of us agro-science neophytes. A couple of farm apprentices, Laura Weiland and Theresa Peura, provided field support, and others contributed general enthusiasm. Laura Manchester has provided continual office support and had the patience to proof-read this document. Wayne Dunlop built our photography aquarium. Many additional people in the Hawthorne Valley community have encouraged us by their questions and interest.

Listing our collaborating farms from South to North, we have appreciated the hospitality of Barry Chase and his family on Chaseholm Farm; Barry's curiosity to hear about our latest findings made us feel like we might be doing something interesting after all. The Cashen families of Miller's Crossing Farm let us wander freely through their fields and backyards. Hugh Williams and Hanna Bail have, along with Emma and Christopher, been friends of our entire family, not to mention eager collaborators. Claudia, Willy, Otis and Mae of Little Seed Farm have long been thinking about on-farm education; they have been realistic assessors of our occasional forays into field courses. Their hospitality and openness have encouraged us from the start. Special thanks goes to Otis as Master Fish Seiner. Bill Gumaer of Gumaer Farm, not only tolerated us bungling about amongst the pasturizer and bottler to ask questions, but also took us out to see interesting sites. Finally, Mike Scannell and Joan Harris of Harrier Fields Farm have seamlessly discussed Orchard Orioles and Henry George, helping us better understand not only what birds are found on farms but why to farm in the first place.

We have received substantial field assistance. Various classes of Hawthorne Valley School and the Visiting Students Program counted weeds, butterflies, bugs and the like with us. Gary Shemroske has done much to help link our Program to the School, while the whole staff of the Visiting Students Program have been good friends and have helped us think about our shared interests in education. Jeanne Bergen and Malcolm Gardner helped with our early birding efforts. More recently, Sean Decker has brought his ample herpetological knowledge to the Program, and Martin Holdrege has been a dedicated fellow student of forest history and frog calls. Speaking of frog calls, Chris Schulat, Margaret Yurt, Matt Davis, and Sophia Sherman listened and reported. Mike Pewtherer has willingly shared his tracking expertise and natural history observations. Nancy Dill freely shared botanical literature; she and Craig Holdrege pointed us to several of the interesting plants mentioned in the report. Cameron Genter, Clementine Mallet, and Jaimie Poirier helped with plant inventories, while Ruth Default, Gretchen Stevens, Dan Frank, and Rick Rechell were always ready to answer botanical questions and help us put our findings into a larger context. Jean Gawalt was very helpful in digging up references, discussing local ecology, and reminding us of the beauty of it all.

We've needed lots of scientific help understanding techniques or identifying organisms. John Ascher, Craig Bruce, Douglas Carlson, Bob Daniels, Robin Jung, Kent McFarland, J. Kelly Nolan, Mike Richmond, Roz Renfrew, A.J. Smith, Gretchen Stevens, J.O. Whitaker, Jr. and Martha Zettel have all provided much needed input and consultation. We have fond memories of field time well spent with several of these folks

Our research will be trivial if it cannot be translated into meaningful benefits both to farmers and nature. The Columbia Land Conservancy, with interest in both areas, has been a crucial collaborator in seeking ways to keep our Program afloat and to utilize its results. Their willingness to take time and give advice has been greatly appreciated.

The Nature Institute, a Hawthorne Valley neighbor, has long encouraged our efforts to look at the Valley and has openly shared their thoughts with us. We look forward to working more together.

Columbia County Soil and Water Conservation has been generous in its time and materials, helping us print posters, measure water quality, scan aerial photos, dig soil samples, and present our case to the public.

The University of Wisconsin's Institute of Environmental Studies and Department of Wildlife Ecology provided important academic tools that have helped make doing academic research in a non-academic setting possible.

This Program, and this report, would not exist were it not for the funding it has received from various organizations and individuals. The Hudson River Estuary Program was crucial in providing us start-up funding and in continuing that support. They've not only been a source of funds, but also of professional networking. The Berkshire Taconic Community Foundation helped round-out our initial fiscal needs. The Hawthorne Valley Farm Board of Trustees, chaired by Joe Haley, has been key in helping us survive our own fund-raising ignorance.

Several individuals, while fitting in no particular category, have made major contributions to our efforts. Martin Ping, director of the Hawthorne Valley Association, has been a combination of support club, counsel, and accomplice; his interest in our activities has been very meaningful to us. Lea Iselin has not only let us wander the land of her and her husband, but also provided important financial advice. Finally, Tony and Gail Cashen have helped on many fronts, be it presenting our case to receptive circles, demonstrating early farm machinery, or strengthening ties to an alma mater. We have received numerous, generous donations of money from considerate individuals.

Our families have tolerated our lunacy with surprising nonchalance, only occasionally mentioning the existence of reality to us.

To all of the above and those we failed to mention specifically, we express our deep thanks and hope that, to some small degree, this report begins paying back the investments you have made in us.

Endnotes

Introduction

1- There are several good sources of information for understanding land use history. *Reading the Forested Landscape* by Tom Wessels is a good start. The various publications of David Foster and colleagues out of the Harvard Forest provide more information on historical ecology but are not as useful in the field. Their publications can be downloaded from http://harvardforest.fas.harvard.edu/ publications/pdfarticles.html.

2 – *Butterflies of the East Coast* by Rich Cech and Guy Tudor provides good information on the ecology of regional butterflies. *Butterflies of New Jersey* by Michael Gochfeld and Joanna Burger, while focusing on New Jersey, provides a valuable historical summary relating to some of our species. *Birds of North America*, edited by the American Society of Ornithologists and available in print or on-line format (http://bna.birds.cornell.edu) is perhaps the most up-to-date source for information on the ecology and distributions of our birds. *The Mammals of the Eastern United States* by John Whitaker and William Hamilton, now in its third edition, provides a good grounding on our mammal fauna; The first author and collaborators also have a *Mammals of New York* in press.

Part One. Primer.

1 – *The Passenger Pigeon: Its Natural History and Extinction* (1955) by A.W. Schroger is perhaps the classic summary. An update is provided by Blockstein's contribution (2002) "Passenger Pigeon (*Ectopistes migratorius*) in *The Birds of North America*, No. 611 (A. Poole and F. Gill, eds.). For information on the fate of the Allegheny Woodrat, see NatureServe Explorer website (http://www.natureserve.org/explorer) and LoGiudice's paper (2003) "Trophically transmitted parasites and the conservation of small populations: raccoon roundworm and the imperiled Allegheny woodrat". in *Conservation Biology* 17: 258-266.

2 – The classic work in this vein is R.H. MacArthur and E.O. Wilson's *Theory of Island Biogeography* originally published in 1967. However, these general ideas have subsequently been expanded and

formalized into the discipline of "Landscape Ecology" and incorporated into conservation biology. There are several texts available on these disciplines; one such recent publication is *The Principles of Conservation Biology* by Groom, Meffe, and Carroll; the third edition was published in 2005.

3 – *Hope is a Thing with Feathers,* by Christopher Cokinos provides a recent, popular account of the last days of the Heath Hen, Passenger Pigeon, and several other birds. David Foster and his colleagues at Harvard Forest (op cit.) have studied the fates of several New England old growth forests. Hurricane destruction has no doubt been a historical aspect of the New England landscape and, indeed, played an important role in forest regeneration. However, as less and less old growth forest remains, it is threatened by complete destruction due to such natural catastrophes.

4 - *Mineral Licks, Geophagy and Biogeochemistry of North American Ungulates*, published in 1985 by Robert Jones and Harold Hanson provides one in-depth study of this theme with familiar species.

5 – There are numerous discussions of the interaction of monarchs and other butterflies with their plants. The possibility that some birds incorporate toxins from their insect prey into protection for their own bodies is a more recent discovery. Two papers on this theme are Bartram and Boland's 2001 publication entitled "The chemistry and ecology of toxic birds", in the journal *Chembiochem* 2: 089-811, and the paper that got it all started, Dumbacher et al.'s (1992) "Homobatrachotoxin in the genus *Pitohui*: chemical defense in birds?" *Science* 258:799-801. The better known frog neurotoxins may also be derived by hijacking the protective chemistry of insect prey.

Part 2. History

1 – Various authors have tackled the question of the pre-settlement North American landscape. Some of these include Gordon Whitney's (1994) *From Coastal Wilderness to Fruited Plain*; Howard Russell's (1976) *Long, Deep Furrow*; Forster et al.'s paper, "The environmental and human history of New England" in Foster and Aber's book (2004) *Forests in Time*; Robert Askin's paper "History of grasslands in the Northeastern United States" in Vickery and Dunwiddie's (1997) *Grasslands of Northeastern North America;* and Motzkin's and Foster's paper (2002) entitled "Grasslands, heathlands and shrublands in coastal New England: historical interpretations and approaches to conservation." *J. of biogeography* 29: 1569-1590.

2 – Aside from the historical landuse information provided in the preceding references, information on regional Indians and their land use can be found in *The Handbook of North American Indians* (1978) vol. 15. The Northeast, edited by Sturtevan and Trigger; in Shirley Dunn's books on the Mohicans (*The Mohicans and their Land, The Mohican World*); in *Northeast Subsistence-Settlement Change* (2002) ed. by Hart and Rieth; and in Nabokov and Snow's chapter "Farmers of the Woodland" in *America in 1492* (1991) edited by Josephy.

3 – Preceding works, esp. Hart and Reith, provide some information on this. U. P. Hedrick's *A History of Agriculture in the State of New York* (1932) includes of summary of the plants grown by New York Indians.

4 – The cited early accounts of cleared land are found in *The Documentary History of the State of New York* (1851) edited by Morgan, specific examples are on pp 23 -24 of vol. 2. Initial settlement may have been slow, but the Dutch Patroon system, which encompassed most of Columbia County by the late 1600s, obviously spoke of more permanent intentions. However, the real boom in regional populations began after 1750 (see accounts of early populations, vol.1 *Documentary History of New York* (1849). Because early records of wildlife abundance were often tinted with boosterism and because almost from the moment of their arrival, Europeans began to affect wildlife, it is difficult to know what affect indigenous peoples were having. Nonetheless, it is apparent that many species declined during the initial years of European occupation. A scientific discussion may be found in Bernardos et al.'s paper (2004)

entitled "Wildlife dynamics in the changing New England landscape" on pages 142-168 of Foster and Abers' book *Forests in Time*. While modern–day game animals appeared to be relatively abundant when Europeans arrived, there is good evidence that Native Americans were responsible for the extinctions of such game animals as Mastodon, Mammoths and Ground Sloth (see for example, the paper by Robinson et al. (2005) "Landscape paleoecology and megafaunal extinction in southeastern New York State". *Ecological Monographs,* 75: 295–315). There is debate about the size of Native American populations in the Northeast (and elsewhere); a popular account of these discussions is found in the Atlantic Monthly (March 2002) article entitled "1491" by Charles Mann; for a more academic consideration, see, for example, Russell Thorton's 1997 article, "Aboriginal North American populations and rate of decline, ca. 1500-1900" in *Current Anthroplogy* 38: 310-315.

5- Much of the data presented in this section comes from early state and federal censi. A good on-line sources for such information is the Historical Census browser at the University of Virginia (http://fisher.lib.virginia.edu/collections/stats/histcensus/) and the federal census (http://www.census.gov /prod/www/abs/decennial/). Additional census information, especially that contained in the detailed New York State censi, was garnered from reading old census reports and old gazetteers and similar publications which quoted those statistics. Recent statistics on agricultural production came from various publications of the New York State Department of Agriculture and Markets and of NASS (National Agricultural Statistics Service). Digital copies of historical maps were inspected in order to better understand the geography of settlement; two excellent on-line sources for such maps are the U.S. Library of Congress (http://lcweb2.loc.gov/ammem/gmdhtml/gmdhome.html) and the David Rumsey map collection (http://www.davidrumsey.com/). General background historical information comes, in part, from various historical gazettes, but mainly from reviews such as Ellis' *History of Columbia County* (1878) and Piwonka and Blackburn's (2002) *A Visible Heritage: Columbia County, New York.*

6- The figures on an evolving county agriculture come from the state and federal censi. Unfortunately, there is a hole in our data from the late 1800s through the mid 1900s. The simplified agricultural scenario is largely speculation based upon these figures and peripheral reading. The story of sheep farming and tariffs is briefly told in Russell's *A Long, Deep Furrow*.

Part 4: Plants

1) The benefits of certain weeds in pastures are discussed, for example, in "Benefits of biodiverse forage" by Jerry Brunetti in *Acres U.S.A.*, October 2003.

2) Federally and state protected plants are posted on http://www.plants.usda.gov. Hudsonia, in its *Biodiversity Assessment Manual* (Kiviat and Stevens 2001), lists species considered regionally rare (less than 20 known occurrences in the Hudson River Valley) and regionally scarce (less than 100 known occurrences in the Hudson River Valley). McVaugh's (1958) state publication, *Flora of the Columbia County Area, New York* is an invaluable resource.

3,4) Tallgrass Prairie species are listed in *The Tallgrass Restoration Handbook for Prairies, Savannas and Woodlands* (1997) edited by Stephen Packerd and Cornelia F. Mutel.

5) Invasive species for our region can be gleaned from the Invasive Plants Atlas of New England, posted on http://invasives.eeb.uconn.edu/ipane/.

6) The information about spotted knapweed was taken from *Weeds of Canada and the Northern United States* (1998) by France Royer & Richard Dickinson.

Part 5: Hedgerows

1- See for example the UK biodiversity action plan section on hedgerows (http://www.ukbap.org.uk/UKPlans.aspx?ID=7). For a Midwest perspective, see Sample and Mossman's (1997) *Managing Habitat for Grassland Birds - a Guide for Wisconsin* (available at http://www.npwrc.usgs.gov/resource/2002/wiscbird/ wiscbird.htm).

2- Oliver Rackham, a British landscape historian, outlined these ideas in his book (1986) *The History of the Countryside.*

3- The Quebec work mentioned has been carried out by Céline Boutin, Benoît Jobin and their colleagues. Three of their most relevant papers are the following: Jobin et al. (2001) "Bird use of three types of field margins in relation to intensive agriculture in Québec, Canada." in *Agriculture, Ecosystems and Environment* 84: 131–143; Boutin et al. (2001) "Comparing weed composition in natural and planted hedgerows and in herbaceous field margins adjacent to crop fields" in *Can. J. Plant Sci.* 81: 313–324; and Boutin et al. (2002) "Plant diversity in three types of hedgerows adjacent to cropfields." in *Biodiversity and Conservation* 11: 1–25, 2002.

4- Regarding microclimatic effects: from Australia, see for example, Cleugh et al. (2002) "The Australian National Windbreaks Program: overview and summary of results" in the *Australian Journal of Experimental Agriculture* 42: 649-664. A nice summary of a North American perspective can be found in the Pacific Northwest Extension publication (2002; pub number PNW005) "Trees against the Wind". It is available on-line at www.wsu.edu/pmc_nrcs/Docs/PNW005.pdf.

Part 6. Birds

1- There are numerous publications on grassland birds; one of particular regional relevance, although not dealing just with birds, is *Grasslands of Northeastern North America* (1997), edited by Vickery and Dunwiddie. Shrubland animals, including -but again not limited to- birds, received special attention at a New Hampshire conference. The proceedings of that meeting are available as papers in a 2003 issue of *Forest Ecology and Management*; they can be conveniently downloaded at http://www.unh.edu/natural-resources/litvaitis-papers.html. A recent general review of the status of birds of different habitats is the Audubon Society's 2004 "State of the birds" report (http://www.audubon.org/bird/stateofthebirds/).

2- The Wells and Rosenbereg paper referred to is "Grassland bird conservation in northeastern North America"; it was published (1999) in *Studies in Avian Biology* 19:72-80. Rigorous statistics on North American grassland decline are hard to come by. There are scattered references to less than 2% of original tallgrass prairie (the prairie which has the most biological affinities to our grasslands) remaining, but we could not find a good publication confirming these estimates. The value cited is for all current North American grassland (be it native prairie or not) relative to pre-European extent. It comes from the WRI (2000) publication *Pilot Analysis of Global Ecosystems: Grassland Ecosystems* by White, Murray and Rohweder; it is available on the internet at http://forests.wri.org/pubs_pdf.cfm?PubID=3057.

3- Wetland area figures come from Thomas Dahl (1990) "Wetlands losses in the United States 1780s to 1980s". U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. (http://www.npwrc.usgs.gov/resource/othrdata/wetloss /wetloss.htm).(Version 16JUL97).

4- Hudsonia's report is Dickert et al.'s "Biological Surveys at the Martin Van Buren National Historic Site, Columbia County, New York" (2004).

5- The breeding bird survey data, despite debate over their statistical intricacies, have been crucial for understanding trends in bird populations. The full reference is Sauer, J. R., J. E. Hines, and J. Fallon.

2005. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2004. Version 2005.2. USGS Patuxent Wildlife Research Center, Laurel, MD*, and the data are readily accessible at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. The New York State breeding bird atlas was organized by the New York State DEC; it has been directed by Kimberly Corwin; data are available at http://wwwapps.dec.state.ny.us/apps/bba/results/.

6- *Birds of New York State* by John Bull was published in 1974. De Kay published his bird information in 1844 as part 2 of the *Zoology of New York*, a volume in the series *Natural History of New York*; Eaton's *Birds of New York* was published in two parts, one in 1910 and the second in 1914.

7- In addition to the publication mentioned in the first footnote of this section, there are numerous publications and websites which consider the habitat needs of North American grassland birds. Some accessible and relevant summaries can be found in the "New York State Comprehensive Wildlife Conservation Strategy, Appendix A1: Birds" available at http://www.dec.state.ny.us/website/ dfwmr/swg/cwcs2005.html; and *Studies in Avian Biology* vol. 19, which is a collection of papers entitled *Ecology and Conservation of Grassland Birds in the Western Hemisphere* edited by Vickery and Heckert, The latter is the proceedings of a 1995 conference on this topic. It is available at http://elibrary.unm.edu/sora/ search.php (search for Vickery). Among websites the Massachusetts Audubon (http://www.massaudubon.org/Birds_&_Beyond/grassland/index.php) and Partners in Flight (http://www.blm.gov/ wildlife/pifplans.htm; this is the access page to their set of regional bird conservation plans) have particularly detailed accounts.

8- Most of these data come from the statistical sources previously cited (part 2, endnote 5). Perspective on current forest extent also comes from the U.S. Forest Services Forest Inventory data, the most recent of which are available at http://www.ncrs2.fs.fed.us/ 4801/FIADB/.

9- We are very lucky in having Amos Eaton's detailed reports in his 1910/1914 publication *Birds of New York*; this work includes county and regional evaluations of bird abundance. Given the delay between data collection and publication, these data come essentially from the end of the New York agricultural hey-day.

10- See Motzkin and Foster (op cit, part 2, endnote 1) for discussion of shrubland origins.

11- The majority of the data used here come from Birds of North America on-line (op cit. part 1, endnote 2).

12 – Aside from the sources listed above, David Sample and Mike Mossman's publication (op. cit. part 5, endnote 1) provides a rich source of habitat information and numerous references.

13- Sample and Mossman's work cited above has been supplemented by more regional information from Bull's *Birds of New York State* (op cit.).

14- David Swanson's (1996) publication "Nesting ecology and nesting habitat requirements of Ohio's grassland-nesting birds: A literature review" (Ohio Department of Natural Resources, Division of Wildlife, Ohio Fish and Wildlife Report 13; available at http://www.npwrc.usgs.gov/resource/othrdata /ohionest/ohionest.htm) provides a good summary of the literature relating to the size of habitat patches favored by various grassland birds.

15- The historic information on haying date comes from Mather and Brockett's (1848) *A Geographical History of New York*. For an in-state consideration of this issue see Eric Bollinger's (1995) "Successional changes and habitat selection in hayfield bird communities." published in *The Auk* 112: 720-730.

16 – The Audubon web page cited above, and Sample and Mossman's publication discuss some of the particular management techniques such mowing from the center out.

17- Herkert et al., in the paper "Management of Midwestern grassland landscapes for the conservation of migratory birds" pp. 89-116 in (1996) *Management of Midwestern Landscapes for the Conservation of Neotropical Migratory Birds.* edited by Frank Thompson III, review the interaction of different grassland management strategies and nesting grassland birds. Temple et al's paper "Nesting birds and grazing cattle: accommodating both on Midwestern patures", pages 196-202 in Vickery and Herkert (op. cit note 7 above) discusses rotational grazing and nesting birds in more detail. Survival was reportedly quite low on rotationally grazed pastures.

18- Sample and Mossman (op cit.) discuss conservation tillage and nesting grassland birds. The primary reference on this appears to be Best's 1986 paper, "Conservation tillage: ecological traps for nesting birds?" *Wildlife Society Bulletin* 14:308-17; however, we have not been able to consult this directly.

19- DeGraaf and Yamasaki's (2003) paper, "Options for managing early-successional forest and shrubland bird habitats in the northeastern United States" in *Forest Ecology and Management* 185: 179–191, provides some suggestions for managing for shrublands, including ideas on rotation length.

20- For discussion of nesting birds and organic farming, see Lokemoen and Beiser (1997) "Bird use and nesting in conventional, minimum-tillage, and organic cropland." *Journal of Wildlife Management* 61:644-655 (available at http://www.npwrc.usgs.gov/resource/birds/birduse /birduse.htm) and also Beecher et al's (2002) "Agroecology of birds in organic and nonorganic farmland." in *Conservation Biology* 16: 1620–1631. The bird poisoning information comes from the American Bird Conservancy's database at http://www.abcbirds.org/pesticides/.

Part 7: Butterflies

1- Our central reference, because it does provide a good, up-to-date review of eastern butterfly ecology, has been Cech and Tudor's book (2005) *Butterflies of the East Coast*. While we acquired it too late to incorporate into this work, David Wagner's book (2005) *Caterpillars of Eastern North America* seems to provide a great introduction to this life stage. We supplemented Cech and Tudor's publication with information from the USGS's on-line guide assembled by Opler et al. (*Butterflies of North America* at http://www.npwrc.usgs.gov/resource/distr/lepid/bflyusa/bflyusa.htm).

2- The TWINSPAN program is available in two, free online versions: TWINSPAN for Windows (http://www.ceh.ac.uk/products/software/CEHSoftware-DECORANATWINSPAN.htm) and as a component of the vegetation classification package called JUICE (http://www.sci.muni.cz/botany /juice.htm). We found JUICE output confusing, but TWINSPAN for Windows input format awkward. Our final solution was to import data into JUICE, save them from that program to Cornell Compact format and then analyze it with TWINSPAN for Windows. These sites also provide some background information on the mathematical technique.

3- Hudsonia's *Biodiversity Assessment Manual for the Hudson River Corridor* by Kiviat and Stevens (2001) provides information on regional butterfly abundances mainly, it appears, based on the fieldwork of their collaborator Spider Barbour.

4- Discussion of butterflies and grazing can be found in Pöyry et als. (2005) paper "Responses of butterfly and moth species to restored cattle grazing in semi-natural grasslands" in *Biological Conservation* 122: 465–478; a 2004 companion paper was published in *Ecological Applications,* 14: 1656–1670. Information from England can be found on the website http://www.butterfly-conservation.org/conbio/ butterflies_farmland/grassland.html. There are also papers relating to managing North American prairies for butterflies of North American, although it is not clear that is as applicable to our landscape. An example is Swengel and Swengel's 2001 paper, "Effects of prairie and barrens management on butterfly faunal composition" in *Biodiversity and Conservation* 10: 1757–1785.

5- For management of regional shrubland butterflies, see Wagner et al. (2003) "Shrubland Lepidoptera of southern New England and southeastern New York: ecology, conservation, and management" in *Forest Ecology and Management* 185: 95–112. For a European plea for shrubland conservation based upon butterfly needs, see Balmer and Erhardt (2000) "Consequences of succesion on extensively grazed grasslands for Central European butterfly communities: rethinking conservation priorities." *Conservation Biology* 14: 746-757.

Part 8: Amphibians.

1- The 2005 book entitled *Amphibian Declines: The Conservation Status of North American Species* by Michael Lannoo is probably the best single reference, although, admittedly, we had access only to excerpts or to other works by this author. There are other, earlier, briefer summaries such as Reaser's (2000) "Amphibian declines: an issue overview" prepared for the Federal Taskforce on Amphibian Declines and Deformities.

2 – Hudsonia's report is Dickert et al. "Biological surveys at the Martin Van Buren National Historic Site, Columbia County, New York" (2004).

3 – Occurrence records for amphibians we did not observe ourselves come from the New York State Amphibian and Reptile Atlas (http://www.dec.state.ny.us/ website/dfwmr/wildlife/herp/). Our basic natural history references were Hulse et al's book (2001) *Amphibians and Reptiles of Pennsylvania and the Northeast* and Degraaf and Rudis's (1983) *New England Wildlife: Habitat, Natural History and Distribution*, US Forest Service General Technical Report NE-108; the latter is available on-line at http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/scanned/OCR/gtr108index.htm.

4 – We used two main historic documents to assess past abundances of herps: James De Kay's 1842 Vol. 3: *Reptiles and Amphibians* in the series *Natural History of New York*, and Eckel and Paulmier's 1902 *Catalogue of New York Reptiles and Amphibians*, bulletin #51 of the New York State Museum. The licensed electronic resource *Early Encounters in North America: Peoples, Cultures and the Environment* (available to us through the University of Wisconsin) provided us access to early anecdotal accounts of wildlife. Peter Kalm's (1770) *Travels in North America* provided additional observations.

5 – Information on movement distances came from *Vernal Pools: Natural History and Conservation* by Elizabeth Colburn (2004) and from "Habitat management guidelines for vernal pool wildlife". WCS/MCA Technical Paper No. 6 by Calhoun and deMaynadier.

6 – Our two main references on current status for amphibians and other vertebrates was the New York State Comprehensive Wildlife Conservation Strategy (2005; http://www.dec.state.ny.us/website/dfwmr/swg/cwcs2005.html) and Hudsonia's *Biodiversity Assessment Manual for the Hudson River Corridor* (op cit.).

7 – Russells' *Long, Deep Furrow* (op cit.) and Hedrick's *A History of Agriculture in the State of New York* (op cit) both mention drainage history in the Northeast. The agricultural report citation is from *Transactions of the N.Y. State Agricultural Society* vol. XVIII (1858). Estimates of historic wetland loss come from Dahl (op cit., Part 6, endnote 3).

8- Ellis' *History of Columbia County* (op cit.) provides early engravings of the Columbia County landscape; early aerial photos from the 1940s were available to us through the gracious assistance of the Columbia County Soil and Water Conservation District.

9 – For a similar conclusion regarding amphibians and agriculture from elsewhere in New York State, see the results of Gibbs et al. (2005) in the paper "Changes in frog and toad populations over 30 Years in New York State" in *Ecological Applications* 15: 1148–1157; they reference additional, corroborating works.

10- The paper mentioned is Guerry and Hunter's (2002) "Amphibian distributions in a landscape of forests and agriculture: an examination of landscape composition and configuration" in *Conservation Biology* 16: 745-754.

11- The general literature on amphibian declines cited above makes clear the potential importance of pesticides and herbicides. Of regional importance is atrazine, a herbicide of corn fields; a recent paper discussing its effects is Rohr and Crumrine's (2005) "Effects of an herbicide and an insecticide on pond community structure and processes" in *Ecological Applications,* 15: 1135–1147. Of especial concern lately, not just for amphibians, are the pseudohormonal effects of some pesticides. Various studies have shown a detrimental effect of nitrate on amphibians (for example, Hatch and Blaustein's 2001 paper "Combined effects of UV-B radiation and nitrate fertilizer on larval amphibians" in *Ecological Applications* 13: 1083–1093 and Hecnar's (1995) "Acute and chronic toxicity of ammonium nitrate fertilizer to amphibians from southern Ontario" in *Environ. Toxicol. Chem.* 14: 2131-2137.).

Part 9: Water Chemistry and Biology

1- There are numerous publications considering the details of the interaction between farming and water quality. A general overview is available in the National Academy of Science's book (1993) *Soil and Water Quality: An Agenda for Agriculture* by the Committee on Long-Range Soil and Water Conservation Policy, National Research Council. This publication is available for on-line viewing at (http://www.nap.edu/books/ 0309049334/html/). The best source for more specialized regional information appears to come from USGS's National Water Quality Assessment Program. The various reports available for the Hudson River watershed can be downloaded at http://ny.water.usgs.gov/htmls/pub/nawqaweb/report.html.

2- A good survey of the issue in relation to nitrogen and phosphorus enrichment in the United States can be had in Carpenter et al's 1998 paper entitled "Nonpoint pollution of surface waters with phosphorus and nitrogen" in *Ecological Applications* 8: 559–568.

3- There are two main sources for information on aquatic macroinvertebrate biomonitoring in New York. One is New York State DEC's Stream Biomonitoring Unit (http://www.dec.state.ny.us/website/dow/bwam/sbu.html); they have published numerous regional reports, hard copies of which are available upon request. The other is Hudson Basin River Watch, a network of volunteers who are using macroinvertebrate biomonitoring to evaluate Hudson River conditions. Their guidance document provides detailed instructions on field and analysis techniques and is available at www.hudsonbasin.org/HBRWGD04.pdf.

4- Analyses are described in the *Hudson Basin River Watch Guidance Document* by Behar and Cheo (2004), available at the website cited above.

5- The most regionally relevant (from Pennsylvania) attempt to do this appears to be the SPAR program (Stream Plethodontid Assemblage Response); the final report (2004) by Rocco et al. is entitled "Stream plethodontid assemblage response (SPAR) index: development, application, and verification in the MAHA". It was published by the Penn State Cooperative Wetlands Center and can be downloaded at http://www.geog.psu.edu/ wetlands/people/grad_students/gian_exsum.html. The Ohio EPA undertook an integrated biomonitoring approach somewhat similar to our own and including salamanders. Their manual (2002) is entitled *Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams;* along with results summaries, it is available at http://www.epa.state.oh.us/dsw/wqs/headwaters/ #Project%20Reports. The USGS transect approach, which was introduced and explained to us by Robin Jung, is described in Campbell et al's (2005) "Stream salamander species richness and abundance in relation to environmental factors in Shenandoah National Park, Virginia" in *American Midland Naturalist* 153: 348–356.

6- One of Karr's seminal papers was (1981). "Assessment of biotic integrity using fish communities." *Fisheries* 6: 21–27. The paper referred to from Vermont is Robert Langdon's (2001) "A rreliminary idex of biological integrity for fish assemblages of small coldwater streams in Vermont" in *Northeastern Naturalist* 8: 819-232. Bob Daniels has done something similar for Mid-Atlantic States, Daniels et al. (2002) "An index of biological integrity for northern Mid-Atlantic slope drainages" in *Transactions of the American Fisheries Society* 131:1044–1060.

7- Reference values from elsewhere in the Hudson Valley were gathered from the USGS's on-line water data repository (http://nwis.waterdata.usgs.gov/usa/nwis/qwdata).

8- Our basic natural history references were Hulse et al's book (2001) *Amphibians and Reptiles of Pennsylvania and the Northeast* and Degraaf and Rudis's (1983) *New England Wildlife: Habitat, Natural History and Distribution* (op cit.). The Hudsonia document alluded to is their *Biodiversity Assessment Manual* (op cit.).

9- Aside from the works already mentioned in endnote 6 of this section, we also consulted Frank McCormick's (2001) "Development of an index of biotic integrity for the Mid-Atlantic highlands region" *Transactions of the American Fisheries Society* 130:857–877, 2001; and the Maryland DNR publication (2000) by Roth et al. entitled "Refinement and validation of a fish index of biotic integrity for Maryland streams" and available at www.dnr.state.md.us/streams/pubs/ea00-2_fibi.pdf.

10- The work from the 1930s and '40s that is referred to is that of the New York State Biological Survey. The two geographically-relevant reports are *A Biological Survey of the Mowhawk–Hudson Watershed* (1935) and *A Biological Survey of the Lower Hudson Watershed* (1937). Aside from fish, these reports also discussed water chemistry and macroinvertebrates.

11- The two works used for understanding regional fish ecology were the book (1985) *The Inland Fishes of New York State* by C. Lavett Smith and the website "An Annotated Working List of the Inland Fishes of Massachusetts"by Hartel et al. (1996) which can be viewed at http://collections.oeb.harvard.edu/Fish/ ma_fish/ma_fam.htm. These authors have also published the book *Inland Fishes of Massachusetts*, but we have not had a chance to read it. We also consulted the Nature Serve website (http://www. natureserve.org/explorer/) for additional information.

12- A good review of water-affecting factors in the Hudson River watershed is "Water quality in the Hudson River Basin, New York and adjacent states,1992–95", USGS Cirucular 1165 by Wall et al. (1998), available at http://ny.water.usgs.gov/htmls/pub/nawqaweb/report.html.

Conclusions

1- The Cornell report cited is "Hudson River Valley Land Cover Map Accuracy Assessment" (2005) by DeGloria et al. at Cornell's Institute for Resource Information Sciences (IRIS).

2- For an up-to-date economic consideration of agriculture in our region, see "Agricultural economic development for the Hudson Valley: technical report and recommendations", published (2004) by the

American Farmland Trust, written primarily by Gottwals and Mennitto, available on-line at http://www.farmland.org/northeast/ newyork.htm. For a report outlining the nature of development pressures in the Hudson Valley, see Pendall's 2003 Brookings Institute report entitled "Sprawl without growth: the Upstate paradox", available on-line at http://www.brookings.edu/es/urban/publications /200310_pendall.htm.

3- A summary of recent agricultural statistics is available in the New York State Department of Agriculture and Market's annual bulletin available at http://www.nass.usda.gov/Statistics_by_State/ New_York/Publications/Annual_Statistical_Bulletin/index.asp.

4- The set of Finnish studies was published in 2001 by Birdlife Finland, it was edited by Pitkänen and Tiainen and is entitled *Biodiversity of Agricultural Landscapes in Finland.* It is available on-line at http://www.lintuvaruste.fi/julkaisut/julkaisusarja/index.shtml#no3. In the United Kingdom, DEFRA (the Department for Environment, Food and Rural Affairs) appears to coordinate much agricultural activity. It is interesting that their very title implies the varied roles of agriculture. Their website, from which one can download of a variety of management guidelines, is http://www.defra.gov.uk/.

5- Aldo Leopold is best known for his *Sand County Almanac*. However, prior to that he published, amongst other things, the book *Game Survey of the North Central States* in 1931. This book chronicles his surveys of game in an industrializing agricultural setting.