From: *Environmental History of the Hudson River*. 2011. R.E. Henshaw (ed.), SUNY Press.

CHAPTER 12

Ecology in the Field of Time

Two Centuries of Interaction between Agriculture and Native Species in Columbia County, New York

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ABSTRACT

This chapter summarizes the history of agriculture's influence on the inland habitats of native plants and animals in an east bank Hudson Valley county. We follow agriculture in Columbia County, New York, since the early nineteenth century, highlighting the land covers created by farming and describing how these evolved as agriculture changed. Certain native species gained or lost habitat as land cover changed, and we use geospatial analysis of historical census data together with historical natural history accounts and our own recent fieldwork to depict the county's changing natural history. Understanding this interaction of agriculture with habitats for native species will be important if future efforts to meld agriculture and nature conservation are to be successful.

INTRODUCTION

This chapter traces the last two hundred years of agricultural history in Columbia County, New York, from the perspective of its implications for the ecology of native species. Farmland (both "improved" and "unimproved"; improved referred to land that was opened and actively used for farming) once covered nearly 90 percent of Columbia County's surface area; today, it accounts for less than 30 percent. The influence of that land cover change on native species, and on Hudson River sedimentation (Peteet et al., ch. 9 in this volume; Pederson et al. 2005), has been dramatic. Using geographically specific historical research and present-day observation, we describe the county's agricultural changes and their ecological consequences.

We use the concept of "ecological analogy" as a tool in our description. For our purposes, an ecological analogy occurs when human activities create habitat for a given species not by completely restoring that species' original habitat but by creating a new habitat that is sufficiently similar (i.e., offers enough analogies) so as to function. An example would be a mature, northeastern hayfield that, while sharing almost no plants with a Midwestern prairie, offers enough structural similarities so as to provide nesting habitat for certain birds whose demographic heartland was (and in some cases still is) the prairies. In this case, we would say such hayfields are "analogous" to prairies *from the perspective of these birds*. It is important to note that such analogies are almost never complete and that, while these new habitats may serve some native species, they likely exclude others.

After a brief introduction to the county, we explore three overlapping stages in the county's agricultural history and the associated consequences for its nature. We conclude with a brief consideration of the net effects and of the current forces influencing the ecology of native species. This chapter is not exhaustive. It focuses on changes in terrestrial cover types; additional factors such as exotic species (Teale, ch. 13 in this volume) and agrochemicals have also had pronounced ecological influences but are not considered here.

BACKGROUND AND CONTEXT

Columbia County borders the Hudson River to the west and Massachusetts and Connecticut to the east. Its elevation varies from less than 10 m along the Hudson to nearly 700 m in the Taconic Hills along its eastern edge (Fig. 12.1). The length of the growing season varies by about three weeks from the southwest corner of the county to the northeast corner. The county's 166,700 hectares can be roughly halved into a western Hudson Valley region and an eastern hill region. Limestones and dolomite formations that underlie parts of Ancram, Copake, Hillsdale, New Lebanon, Canaan, and Greenport substantially influence wild and cultivated plants. Biogeographically, Columbia County is in a "tension zone" (*sensu* Curtis 1959; Cogbill et al. 2002). This means that it harbors a mix of more boreal and more southerly species.

During the time frame covered here (ca. 1820–2009), Columbia County agricultural production evolved (Fig. 12.2), and its population grew from around thirty thousand to around sixty thousand, albeit with a dip in numbers between about 1870 and 1920. As has occurred throughout much of the Northeast, the extent of the county's farming has declined precipitously since the late 1800s. Currently, there is about one-quarter the farmland and one-sixth the number of farms of peak nineteenth-century levels. Ellis (1878) and Stotts (2007) are the classic references on the county's history, although these sources provide little information on overall landscape patterns or ecology. Litten (ch. 11 in this volume) provides an overview of agricultural history in the Hudson watershed.

Unless otherwise noted, population and agricultural statistics come from New York State and Federal censuses, the vast majority of these are available on line (New York State Library; U.S. Census Bureau; USDA-NASS). The Federal government began to collect agricultural data in 1820; New York State conducted its decennial censuses of agricultural production from 1845 to 1875. While these various censuses are imperfect and their methods

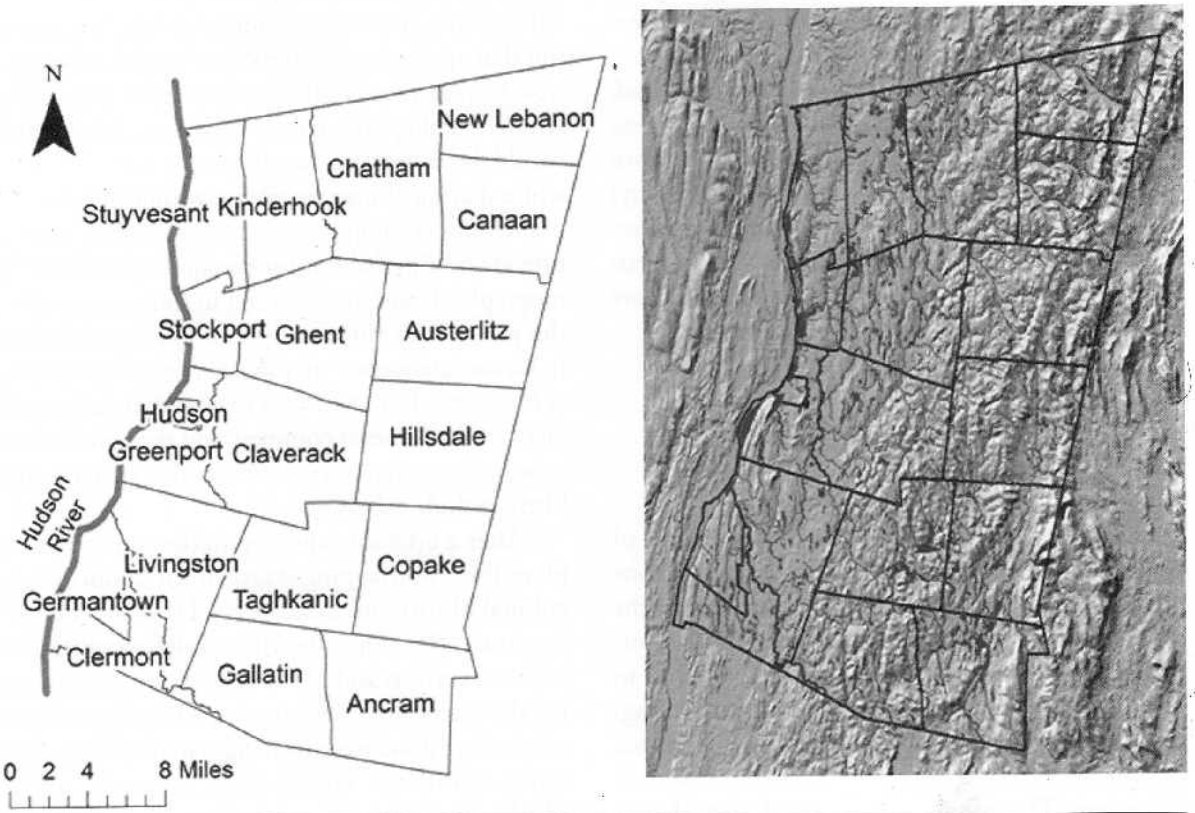

FIG. 12.1. The outline of Columbia County and the included towns (left) and the same outline superimposed on satellite image–derived topography. This study focuses on land-cover change associated with agriculture in Columbia County. Topography has had a major influence on the County's agriculture.

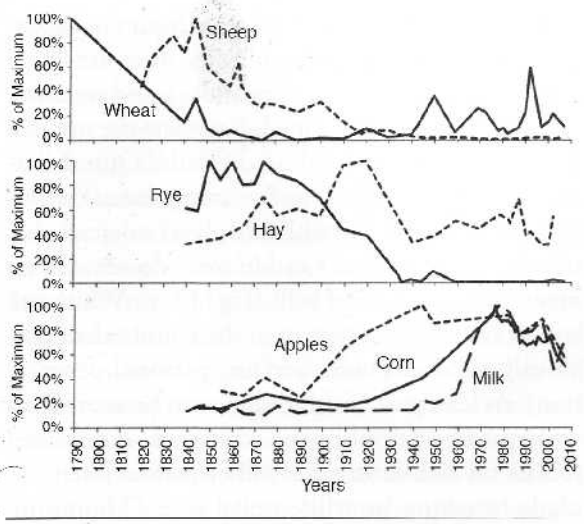

FIG. 12.2. The evolution of some important Columbia County agricultural commodities over the past 200 years. Values are represented as percent of observed maximum production (or density in the case of sheep). Data are from state and federal censuses, except for earliest wheat production estimate which is extrapolated from censused population size and estimated per capita needs (Bruegel 2002). During the past two centuries, the county has transitioned through periods of wheat, wool, rye, hay, fruit, and milk production, along with some additional products not illustrated here (e.g., potatoes, beef).

changed over time, they are probably suitable for outlining the general patterns discussed here. We use town-level statistics to describe the mode and spatial distribution of agriculture; we use regional historical literature together with our own fieldwork to hypothesize ecological effects.

Indigenous activity prior to European settlement (Lindner, ch. 7 in this volume) and European-spurred activity prior to 1820 (e.g., Henshaw, ch. 1 in this volume) no doubt affected the ecology of Columbia County. We selected our time period because of its immediate relevance to the current state of the land and the relative abundance of local information.

THE STARTING POINT: CREATING ANALOGIES

The typical farm of the 1820s was probably fairly diversified, providing many of the familial needs, but also creating some surplus for market (Bruegel 2002). By 1820, about 60 percent of the county was already in "improved acreage"; during subsequent years, that percentage did not exceed 75 percent (Fig. 12.3a). Thus, understanding our starting point helps explain much of what followed.

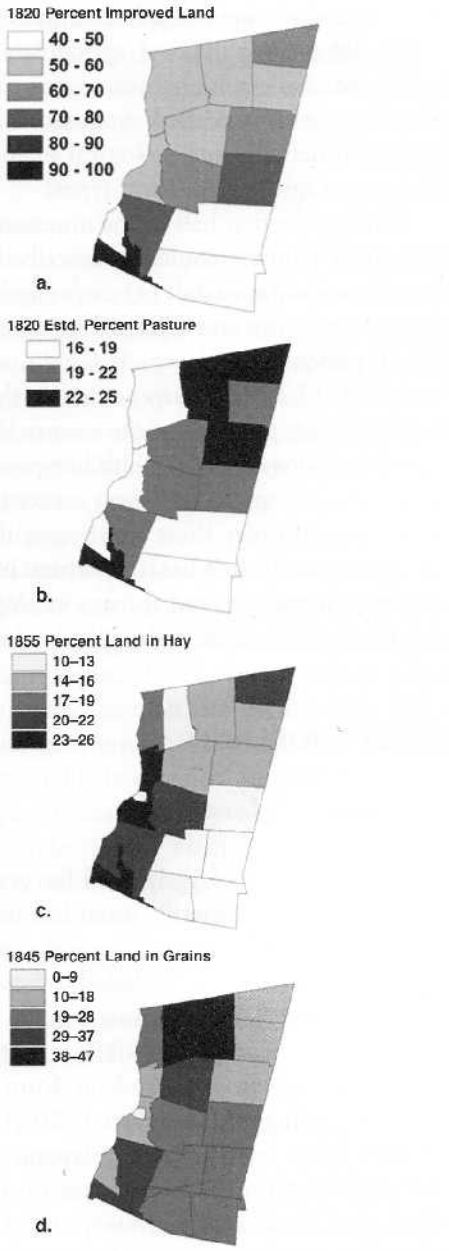

FIG. 12.3. The distribution of early Columbia County agriculture as derived from census data. Land uses were calculated as percent of a given town's total surface area. In 1820, improved land (a.) was defined as all land opened for agriculture. Estimated pasture (b.) is derived from census information on livestock multiplied by per animal land requirements from Lemon (1972); it is unlikely that these requirements derived from Lemon's Pennsylvania research are exactly true for us, but relative values might be more accurate. Grains (d.) included corn, wheat, oats, and rye. The earliest available agricultural census information is from 1820, however, hay and grain production were first censused in the later years indicated here. The number and extent of the towns within the county evolved between 1820 and 1845. Pasture, hay meadow, and grain land had distinct distributions, probably due in part to distinct soil types and climates within the county. These spatial differences helped lead to distinct ecological consequences for these land uses.

In this section, we will ask two questions: First, where did a given type of agriculture occur and hence which natural habitats were probably replaced or greatly modified? And, second, which organisms benefited from ecological analogies created by the new agricultural cover types?

During the first half of the nineteenth century, Columbia County could be described as having three forms of farmland: (1) *early cropland,* largely for grain growing and centered in the mid-county flats of present-day Claverack, Ghent, and Kinderhook (Fig. 12.3d); (2) *early pastures* in the northeast and southwest portions of the county (Fig. 12.3b); and (3) *early hay meadows* with hay production occurring mainly in the southwest corner (Fig. 12.3c). Below, we consider these three agricultural cover types in terms of their use, the natural habitats they may have impacted, and the new ecological analogies they may have created.

EARLY CROPLAND

Definition and Location

Early cropland was largely used for grain production. This was primarily intended for the consumption of the farm families and their livestock (Bruegel 2002 and census-based estimates of early yields). However, in good years, grain was also an important cash crop. By 1680, wheat was being shipped south on the Hudson from Columbia County landings (Danckaerts 1680 [1913]). The Hudson River was the county's major agricultural thoroughfare into the late nineteenth century; indeed, the City of Hudson was founded largely as a safe hub for such commerce (Schram 2004). While grain was grown in all towns of the county by the time it was first censused in 1845, it was most common on the county's "prime agricultural soils" (USDA 1989), a north/south band of relatively flat and well-drained soils lying some 3–13 km inland from the Hudson.

Habitats Lost

Although Native American clearings formed the core of some early settlements in the County (Ellis 1878), European settlers felled substantial forest. On much of the best flatland soils, there are few if any pockets of old forest remaining, and much of the land is still being farmed. Knowing the original forest composition is thus difficult. Our reconstruction of early forests in the county based on witness trees (Vispo, unpublished data) suggests that oak (mostly white oak) and hickory dominated on many of these flatland soils (Fig. 12.4). White oak is now much less common in the county than previously (USDA Forest Service; personal observation). At least part of this decline can be ascribed to widespread removal of the white oak–dominated forests on rich farmlands (other factors likely include browsing by white-tailed deer [Thompson and Huth, ch. 10 in this volume] and the preferential use of white oak for construction).

We have no account of the native herbaceous plants that grew in these forests before clearing. However, Braun (1950) suggests that Hudson Valley white oak forests were similar to forests on the Harrisburg Peneplain in Pennsylvania. Her list of herbaceous plants in a white oak forest remnant on the Peneplain is our best approximation of the native plants that might have occurred in our white oak forests: wild geranium, perfoliated bellwort, false Solomon's seal, hogpeanut, blue-stem goldenrod, asters, and tick-trefoil. These species do not thrive on the dry, acidic soils typical of modern second-growth, oak-hickory forests. They are still found on some richer forest soils, but their numbers are probably significantly lower than during precolonial times.

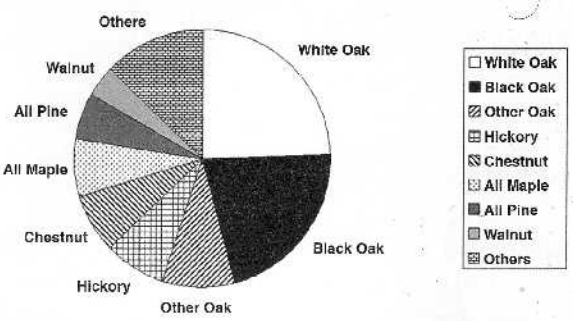

FIG. 12.4. The composition of early forests on Columbia County's central and western flatlands. White oak dominated these forests but is much rarer today, perhaps due in part to its occurrence on what proved to be agriculturally rich soils. These data (Vispo unpublished) were derived from witness tree information in late-eighteenth and earliest-nineteenth-century land deeds available in the county clerk's office in Hudson.

Analogies Created

Most cropland offers relatively few ecological analogies for animals because it is so heavily managed. Killdeer, a shorebird that strays inland, may have found some open cropland to be analogous to the beaches it had favored. More important than its role in providing structural habitat, however, was the fact that cropland provided food for wild animals. Woodchucks quickly arrived (Godman 1831), and a few butterflies, such as the black swallowtail (whose caterpillars feed on parsley and carrots) and our native whites (who feed on the brassicas) relished some crops (Fitch 1869; Harris 1862). A handful of native plants became cropland weeds. These included common ragweed in wheat, bur-cucumber and devil's beggar-ticks in gardens and corn fields, milk purslane and witch-grass in corn fields, and Pennsylvania smartweed in barnyards (Torrey 1843; Darlington 1859).

EARLY PASTURES

Definition and Location

Livestock played an early role in shaping the Columbia County landscape. Based on Lemon's (1972) estimates of the pasture requirements of colonial livestock (and roughly corroborated by correlational analysis of livestock and land use from later, more detailed Columbia County censuses), about one-third of all improved acreage in 1820 could be accounted for by the pasture needs of local sheep, horses, and cattle. Livestock (and hence estimated pastureland) were located primarily in the northeastern and, to a lesser degree, southwestern portions of the county (Fig. 12.3b). Early farmers used not only open pasture but also woodland pasture; however, we will not consider the latter.

In 1855 (when pasture was first tallied specifically), more than one-third the area of some eastern towns, but less than one-tenth that of some western towns, was in pasture. The nature of a pasture depends in part on who grazes it. The majority of pasture was probably accounted for by the needs of bovine cattle. At the peak of sheep populations around 1845, about one-fifth to one-quarter of the county's pastures were probably used by sheep; although this value averaged closer to one-third in some towns of the eastern hills (calculations based on livestock census information and estimates of per head land requirements from Lemon 1972).

Habitats Lost

Witness tree information (Vispo unpublished data) indicates that the county's forests on the steeper land where hill pasturing may have occurred were composed of chestnut and pine (mostly white pine) with lesser amounts of hemlock, beech, and maple, and interspersed oaks and hickories. Because these eastern forests were the main habitat for the county's more boreal organisms, such species probably decreased as forests were cleared for pasture (and for the production of tannins and charcoal, see Thompson and Huth, ch. 10 in this volume). Birds such as blackburnian, pine, black-throated-blue, and Canada warblers breed in the higher hills today (personal observation; McGowan and Corwin 2008) and were likely more common before forest clearing. More boreal plant species that may have declined include hobble bush, mountain maple, beaked hazel, yellow birch, paper birch, wood lily, painted trillium, bead-lily, trailing arbutus, poke milkweed, bunchberry, fly-honeysuckle, red-berried elderberry, and whorled aster, as well as some ferns, clubmosses, shade-tolerant grasses, and sedges (McVaugh 1958; personal observation).

Analogies Created

Scruffier pastures may have provided some analogies to prairie grasslands and savannahs. However, closely cropped pastures are too clean to provide many analogies to natural grasslands. Eaton (1910) provides a damning description of sheep pasture as bird habitat:

> [T]he principal harm of pasturing, to bird life, is found in the destruction of ground cover which inevitably results in woods and thickets. This is especially noticeable in sheep pastures where all the vegetation is destroyed to a height of three or four feet above the ground. In such pasture land the

> thickets and undergrowth, which usually support an abundant bird life, are eliminated and the birds must seek other coverts.

The lack of bushes and potential close-cropping of the pastures left room for few birds, although certain species (such as savannah and field sparrows, and kingbirds) may have used these lands, especially when there was scattered brush. Where vegetation crept in along fence rows, species such as bobwhite quail, yellow warbler, song sparrow, and catbird probably entered.

Intensively grazed pastures did not harbor many native plants. Few eastern North American plants tolerate intensive grazing. In eastern soils and climate, even prairie plants that had coexisted with grazing Buffalo did not compete well with the pasture grasses and forbs introduced from Europe. During the initial period of relatively good soil fertility (and sufficient topsoil), native plants likely composed very little of the pasture vegetation. As we'll describe below, this changed as some pasture soils became depleted.

EARLY HAY MEADOWS

Definition and Location

In the Northeast, early hay meadows were primarily wet meadows. They produced reliable hay crops due to the regular input of nutrients from flooding (indeed, in some places early efforts were made to reroute floodwaters through fields in order to "fertilize them by flooding" (Donahue 2004). While we have found little direct evidence for such lowland hay meadows in Columbia County, mapping of adjacent Berkshire County, Massachusetts, done in the 1830s indicated that all hay meadows were in lowlands (Hall et al. 2002). Inspection of a 1762 property map from the Kinderhook area (in the collections of the Columbia County Historical Society) shows a long lot plot configuration with lots extending out from creeks; a configuration perhaps associated with assuring farmer access to a diversity of soils, including streamside meadows (Chelsea Teale, unpublished manuscript). There are reports of lowland haying by New Lebanon Shakers at least for the decade or so after 1790 (Anderson 1950).

Much of the early haying apparently occurred in the southwest corner of the County (Figure 12.3c). Some of this hay may have been cut from the Hudson River tidal floodplain, but some probably also came from inland swales. The topography of Germantown and Clermont is dominated by a series of north/south ridges with small wetland valleys in between. As Spafford (1824) put it, "The surface is but gently undulated, and the soil is good for grass." Haying also was common in New Lebanon in the northeastern corner of the county. Spafford (1824) describes that town as "good farming lands, dry and warm or *wet and grassy*" (emphasis added).

Habitats Lost

Some wet grasslands may have initially been floodplain or swamp forests. The clearing of *floodplain forest* would have removed habitat of plants such as silver maple, sycamore, cottonwood, bitternut, green ash, leatherwood, marsh pea, false mermaid weed, ostrich fern, green dragon, wild rye species, Canada brome, and certain sedges (e.g., *Carex davisii* and *C. spengelii*) and of animals such as wood turtles and select ground beetles, dragonflies, and damselflies (Knab-Vispo and Vispo 2009; Knab-Vispo and Vispo 2010; Thompson 1842). Through an examination of the early aerial photos (1940s), we estimate that, at the most, around 16 percent of the floodplain area maintained its forest cover over the last two hundred years. *Swamp forests* may have harbored red maple, winterberry, swamp white oak, buttonbush, black ash, and poison sumac (personal observation); we have no assessment of swamp forest extent in the county.

Analogies Created

Some of the new wet meadows were partial analogies for a habitat that humans had removed from the landscape some two hundred years prior: beaver meadows. Beavers were already "exceedingly scarce" in the Hudson Valley by the end of the seventeenth century (DeKay 1842; see too Müller-Schwarze and Sun 2003 and Henshaw, ch. 1 in this volume), and the ecosystems that they had created were largely

missing prior to the beaver's partial return in the late twentieth century. Today, beaver densities are probably 20–50 percent of precolonial levels (based on current beaver density estimates for Massachusetts [Massachusetts Division of Fisheries and Wildlife] and Connecticut [Wilson 2001] together with estimated maximum beaver densities in areas/eras with little or no harvesting of beaver [Wright et al. 2002; Seton 1929, see also Hill 1982 and references therein]). Numerous native species are found in wet meadows that were created or are maintained by agriculture. These include rare species such as bog and spotted turtles, ribbon snakes, leopard frogs, and harriers (personal observation; Kiviat and Stevens 2001). We have found wetland butterflies including bronze copper, eyed and Appalachian browns, black dash, mulberry wing, and Baltimore checkerspot around wet meadows on farms (Vispo 2011). Plants of historical (Torrey 1843) and modern wet meadows (personal observation) include iris, blue-eyed grass, common monkeyflower, common vervain, sweetflag, golden ragwort, green-headed coneflower, yellow avens, and meadowsweet, as well as native sedges and grasses. However, some plants previously associated with wet meadows now rarely occur there. These include Canada lily, ragged-fringed orchid, purple-fringed orchid, nodding lady's tresses, blood milkwort, swamp saxifrage, and the adder's tongue fern (Torrey 1843; personal observation). Their consumption by increased white-tailed deer populations may partially account for the modern rarity of these species (McVaugh personal communication; personal observation).

In sum, as continues to be the case with farming, the ecological ramifications of early-nineteenth-century agriculture were likely mixed. By removing forests, farming caused certain organisms to lose habitat; by creating new cover types, it provided certain organisms with new space. In the section that follows, we move on from this starting point and explore the evolving analogies associated with two agricultural cover types: pasture and hay meadow.

EVOLVING ECOLOGICAL ANALOGIES ON ACTIVE FARMLAND

The ecology of farmlands after 1820 evolved in at least two ways: first, modes of production changed as markets rose and fell. These changes produced major variation in the proportions of different agricultural cover types. Second, technological developments meant that the ecology of a cover type and the analogies that it offered changed as techniques and practices evolved.

We will focus on pastures and hayfields in this section. At their peaks, these lands together covered more than eighty thousand hectares or around half of the county. Our central question is: "How did the agricultural techniques associated with each mode of production vary over time, and how did these developments influence the value of these lands as ecological analogies?"

Pastures

"Pastures were New England's stepchild," states Whitney (1994), implying that they got only the attention and manure that was left for them after croplands and hayfields. The result, in New England at least, was a decline in pasture quality. Cooper et al. (1929) depict the plant succession on pastures undergoing progressive soil depletion. Most of the introduced agronomic grasses outcompete native ones when nutrients are high, but are then unable to maintain themselves as nutrients decline. Thus, as soil quality declines, native plants become *more* common.

Many of the native plants that came into these exhausted pastures found analogies to their original, thin-soiled habitats on ridge tops, steep hillsides, sand barrens, etc. Examples of native plants that were common on "dry hillsides" or "sterile fields" and which still occur on such lands today are: pussytoe, gray goldenrod, mountain-mint, sweet fern, poverty oatgrass, little bluestem, pasture rose, dewberry, and arrowhead violet (Torrey 1843; personal observation). The native grasses such as little bluestem are, in turn, followed by a set of grassland skipper butterflies, specifically Leonard's skipper, cobweb skipper and Indian skipper (Cech and Tudor 2007; Vispo 2011). Again, there is a group of native plants described as "not rare," "frequent," or "common" in these habitats by Torrey (1843), but which are now quite rare. These include whorled milkweed, upland boneset, Venus looking-glass, American pennyroyal, clammy cuphea, yellow wild

indigo, wild sensitive plant, rattlebox, downy trailing lespedeza, Virginia yellow flax, and little sundrops. It is not clear why these species are now rare; some of these may have always been relatively less common in our area (e.g., clammy cuphea) and so may have now become actually rare as the availability of their habitat declined.

Sheep pasture and cattle pasture are distinct ecological habitats. We have already quoted Eaton's damning description of sheep pastures as bird habitat. Sheep and bovines differ in their grazing behavior. Specifically, most cattle browse less intensively than most sheep. The result is that cattle pastures are more apt to fill-in with unpalatable shrubs. The net effect of both degradation of soil quality and of increases in cattle was the "shrubby pasture" that is still familiar to us today. We will discuss "shrublands" and their ecological analogies in greater detail in our section on abandonment; the point here is that pastures probably provided ecological analogies for the most native species when those pastures were agriculturally marginal—it was these conditions that allowed both native plant species and native shrubland birds to find homes.

Pastures imply fencing and hedgerows, and so we consider these technologies briefly here. The first fences in our county were likely of wood and were probably relatively rare. They fenced free-roaming livestock out of crops (Cronin 1983). Eventually, the containment of livestock became the main role of fencing. Around that time, rock walls sprang up as freeze-thaw cycles pushed more rocks to the surface and as timber scarcity led to moderation in wood use (Thorson 2002; Allport 1990). By the late 1800s, wire fencing was appearing. Strands of barbed wire and woven sheep fence still border many fields, even if their job has now been taken by high-tensile wire or other substitutes.

Different field margins provided different habitats. A variety of wild animals inhabited rock walls (e.g., snakes and rodents). Squirrels and chipmunks, in turn, helped disperse the nuts and acorns that have now grown up into towering oaks and hickories. Wire fences have proved excellent bird perches, and so tend to become neighbored by bird-dispersed plants such as cherries, viburnum, and shadbush (Whitney 1994; personal observation). Some suggest that the "cleaning up" of the fence line that followed the widespread acceptance of wire fencing was partially responsible for the sharp decline of bobwhite quail (Forbush 1912).

Unlike hedgerows in some other, more deforested regions, hedgerows in the forested Northeast do not currently appear to be important sanctuaries for woodland plants or animals, although they provide habitat for some and conduits for others (personal observation; Freemark et al. 2002). Their ecological role in our county may have been greater during the height of agriculture.

Hayfields

Hayfields reached their commercial zenith in the late 1800s when their area topped 42,000 hectares in the County. Much of this hay was sent via river to fuel New York City horse power.

Upland hay increased during the nineteenth century. We have no statistics for Columbia County, but Whitney (1994) describes the situation in Worcester, Massachusetts, where upland hayfields accounted for 49 percent of all hay meadows in 1780 and for around 75 percent by 1850. Between 1850 and 1875, all Columbia County towns reported increased hayfield area. The increase averaged over 800 hectares per town. At the same time, pasture and cropland *decreased* by an average of about 87 and 250 hectares respectively (presumably in part due to conversion to hayfield), and total improved acreage increased by roughly 230 hectares per town. Thus, although the pattern varied across towns, increased upland hayfields apparently came from a combination of pasture and cropland conversion and the opening up of new land. Additional hayfield apparently came from the shifting use of extant improved acreage (not all open agricultural land, i.e., "improved acreage," was apparently used in a given year).

To the degree that upland hayfields replaced former sheep pasture or cropland, the increase in hayfields may have signaled an overall increase in the ecological analogies provided by the agricultural landscape, at least for the grassland birds who found prairie-like structure in such fields. Early naturalists were quick to link farming, with its extensive hayfields, to the increased abundance of these avian species (Wilson 1829).

Upland hayfields provide ecological analogies for certain prairie species, especially some Tall Grass Prairie organisms. Many of the birds and some of the plants currently and/or historically found in hayfields originally had their demographic heartlands in the prairies of the Midwest. Bobolinks, meadowlarks, dicksissels, upland plovers, vesper sparrows, and grasshopper sparrows, for example, are all birds that occupy, or at least occupied, eastern hayfields but which probably had their largest precolonial populations on the prairies (Wells and Rosenberg 1999; note however that these species do not all necessarily co-occur in the same types of hayfield or prairie).

All else being equal, nesting habitat structure and extent seem to be the key parameters determining the occurrence of grassland birds (e.g., Swanson 1996). Such an emphasis on structure means that the structural analogies between hayfield and prairie are sufficient for these birds, even if the plants in the hayfields are nearly 100 percent European. Vegetation height, density, and herbaceous versus woody nature are among the parameters used to describe the habitats of grassland birds. This is in contrast to butterflies who, given their caterpillars' close links to food plants, are probably more strongly affected by the botanical composition of a field than by its structure. Hayfields—unless on thin soils—harbor few unique native butterflies (personal observation; Vispo and Knab-Vispo 2006).

The wet meadow hayfields probably favored the red-winged blackbird who seeks just such wet, grassy, reedy, or sedgy areas. Early accounts of bobolink also refer to them as being birds of wetter meadows (Macauley 1829; Thompson 1842). However, as ground nesters, they were probably most common not in true wet meadows but on moister upland fields where good watering made for a thick thatch. As drier upland hayfields expanded, so too did these species. In the mid-1800s, bobolinks were very common. Kent (1933, cited in DeOrsey and Butler 2006), for example, describes their "great flocks in migration" along the Hudson. However, as noted below, this boom was soon dampened by the changing calendar of mowing.

Upland hayfields may have changed little in plant composition throughout most of the nineteenth and twentieth centuries. They have been predominantly composed of nonnative grasses, especially timothy. Timothy or timothy and clover accounted for some 50–60 percent of haylands in the county at the beginning of the twentieth century. Earlier accounts suggest that the use of "English Grasses" was well established by the end of the eighteenth century. By the second half of the twentieth century, alfalfa hay was becoming more common. According to the Census of Agriculture, in 2007, it accounted for nearly one-quarter of all hayland, although "other tame hay," including timothy, still made up 55 percent. Torrey (1843) lists a number of plant species that occurred in "meadows" and which we still find in "wild" hayfields today. These include fleabanes, black-eyed Susan, spiked lobelia, evening primrose, and small-flowered crowfoot. However, he also lists slender lady's tresses (an orchid) as "common," common lousewort as "very common," and blue toadflax as "not rare" in meadows. None of these later species are now easily found in Columbia County (personal observation).

In the first half of the nineteenth century, hay cutting was with a scythe. It was slow and laborious. In Columbia County, it generally began in early or mid-July (Emmons 1846; Anderson 1950) and may have extended for several weeks. A practical, horse-drawn hay cutter was introduced before the Civil War. Prior to the end of the 1800s, mechanization and new ideas of progressive agriculture favored a cut in June, possibly followed by a second, later cut. Mechanization, for a variety of farm activities, continued apace in the twentieth century. Around 1944, the number of horses and mules on U.S. farms was surpassed by the number of tractors (White 2008). By 1950, for example, of 1,517 Columbia County farms censused, 19 percent used only horses, 32 percent used both tractors and horses, and 49 percent used only tractors. Early (i.e., May) haying became even more intense late in the twentieth century as the concept and technology for haylage stored in those blue "Harveststore" silos or, more recently, for plastic-wrapped baleage spread in the county. ("Haylage" and "baleage" are hays that are allowed to ferment, a process that, as with silage, results in greater nutrient availability in the feed.)

The results of these changes in harvesting techniques were momentous for birds. A key consideration for grassland birds is the timing of the hay cut relative to when the young leave the nest. If the hay

cut occurs before fledging, then the hayfields become "ecological traps" that entice birds to nest but then foil reproduction. In Columbia County, bobolinks fledge around the first week of July (personal observation). When haying *began* at this time, most bobolink nestlings may have survived. When haying moved back into June and became more rapid, fewer clutches could survive to fledging. By the end of the nineteenth century, birders in the Northeast were noting steep declines of bobolink and meadowlark, and attributing this to changing farming methods (Eaton 1910). Bagg and Elliott (1937) put the beginning of this decline in the Connecticut Valley at as early as 1875.

The effect on the few native plants that were able to grow in hayfields may also have been substantial. In the 1930s, ragged-fringed orchid still was a common native plant in hay meadows, and McVaugh (personal communication) attributed its subsequent drastic decline at least in part to the change in haying schedule.

Butterflies also are affected by the timing of the hay cut. For those grassland species whose eggs and caterpillars are deposited in the fields, a cut that is made prior to when the adults take wing can destroy many individuals (Massachusetts Butterfly Club). While there is concern about the effects of early hay mowing (Massachusetts Butterfly Club), data from North America are sparse. Our observations suggest that intensively managed hayfields have host plants for the caterpillars of relatively few butterfly species (Vispo and Knab-Vispo 2006).

The trend toward early hay cuts in the county has been slowed somewhat by the modern spread of "estate" hayfields—hayfields cut once per year, often late, by contracted farmers who invest little in improvement and are thus sometimes satisfied by a late cut of relatively poor quality hay (personal observation). Landowners receive a property tax break for this "agricultural use" of their land. In 1910, around 1 percent of hay was "wild"; by 2007, nearly 20 percent was "wild" ("wild," in this context, refers to hay from a field that has not recently been seeded and thus tends to contain a higher diversity of plants). Yield has also begun to drop from 2.6 tons per acre in 1987 to less than 2 tons per acre in 2007.

Mechanization was also associated with drainage, because it both facilitated (through digging and tile-laying equipment) and required (wet ground could not support the heavier machinery) that practice. Large-scale drainage with clay tiling began in New York after 1850 (for example, New York State Agricultural Society 1858). Farmers could create cropland from areas that had been too wet to support more than occasional hay cuts. Once drained, many soils were rich in organic matter and offered high yields, at least initially. With the spread of subsurface drainage, the wet hay meadows were divided into those drained and used for crops and those left in hay and which, with the decline in the hay markets, eventually began to revert to floodplain or swamp forest.

This history of drainage has interacted closely with natural habitats in the county. Standing water or regular floods impose particular demands on native organisms and unique habitats result: red maple swamp forests, buttonbush swamps, sycamore floodplain forests, and sedge meadows are the names for unique communities that can occur on these lands. We estimate that some 40–60 percent of the plants, birds, and butterflies found in Columbia County wetlands are rare and/or experiencing declines (Vispo and Knab-Vispo 2006). For example, the New England cottontail, a species whose listing as an endangered species is pending, may have favored the shrubby cover associated with damper sites (Arbuthnot 2008). Statewide, wetlands are estimated to have decreased by 60 percent since 1790 (Dahl 1990). The 1923 soil survey of the county (Lewis and Kinsman 1929) lists 19,328 acres as being in muck and wetland while 1993 remote sensing by the IRIS program of Cornell put wetland area at 5,620 acres. A study of land change in the Hudson Valley (Amielle DeWan, unpublished data) estimated a 27 percent decline in Columbia County wetlands between 1986 and 2002. The techniques used in these studies differed but substantial wetland decrease is suggested.

Farms can be described as both the bane and the blessing of wetlands in Columbia County. Farmland drainage and clearing has resulted in significant loss or modification of wetlands, yet at the same time, because of the agricultural desirability of valley soils, the majority of wetlands do occur on farms. When managed in a compatible way, farms can help maintain important wetland habitats, such as the wet meadows that provide some ecological analogies to beaver meadows (Vispo and Knab-

Vispo 2007). Commercial and residential development is often less kind—few rules govern the use of small wetlands and their manipulation is frequent (personal observation).

The ecological changes we described above were all caused by farmers' efforts to improve their agriculture. In contrast, during the twentieth century, farmland abandonment and subsequent "rewilding" was one of the main causes of ecological change in Columbia County. In the section that follows, we describe the timing and distribution of abandonment, and sketch some of its ecological consequences.

FARMLAND ABANDONMENT: MAKING TRANSIENT, WILD-CRAFTED ANALOGIES

"Improved" farm acreage in the county began a steep decline around 1900 (Fig. 12.5). This drop probably reflected various, interacting factors including the spread of alternative, nonagricultural employment; the unprofitability of certain farms in the face of expanding Midwestern agriculture; and the shifts in regional styles of farming and, hence, changes in land requirements (see for example, Whitney 1901; Jones 1912; Vaughan 1929). This abandonment had two general ecological consequences: first, certain lands began to revert to conditions somewhat similar to pre-clearing and, second, in the process, large stretches of somewhat novel, highly transient shrubland and old field cover types were created. These habitats had not been completely absent from the county, however they now encompassed wider extents, and provided new opportunities for native organisms.

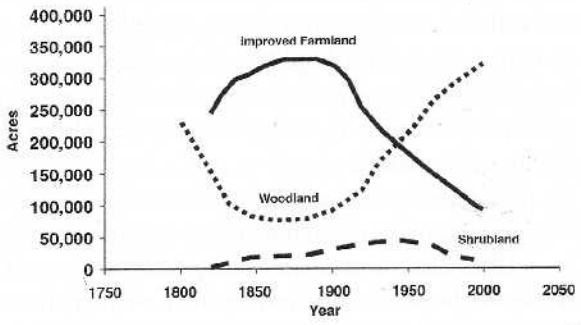

FIG. 12.5. Census data and extrapolations indicating the course of land use in Columbia County. Improved acreage is from census data; wooded acreage is partially extrapolation from land not in other uses and partially from forest cover estimates done by the state and federal agencies; shrubland extent is estimated based on change in forest extent and its recognition as a transitional state. The definition of "improved acreage" varied somewhat over time (in later years, emphasis was placed on ploughed lands); however, its general trend was probably more or less as indicated and can be corroborated by trends in total farmland.

Figure 12.5 shows the general pattern of rapid reforestation and the shrubland "peak" that occurred in the county during the first half of the twentieth century. A botanical glimpse of this period comes from pollen core data from nearby Stockbridge Bowl in Berkshire County, Massachusetts (Patterson 2000). From the late 1700s through the early 1900s, those data show that forest trees declined and grasses, native field weeds, and native wetland plants increased. Sharp changes occurred between 1900 and 1950, when most field plants dropped precipitously, and pioneer forest trees and then mature forest trees began to increase, along with a slight increase in shrubland vegetation. Somewhat similar patterns are reported in cores taken from Hudson marshes (Peteet et al., ch. 9 in this volume).

To understand the resulting ecological consequences, one needs to understand the patterns of abandonment. Table 12.1 shows how, at least in one eastern town, the steeper, higher terrain was the first abandoned. Abandoned tracts also had poorer soils and were more likely to have a northerly exposure. Flinn et al. (2005) found similar patterns in central New York. The 1923 soil survey of the County (Lewis and Kinsman 1929) noted abandoned farms on the eastern hills; this is confirmed by census data (Fig. 12.6). The hilltops and ridgelines, rarely used for agriculture or abandoned much earlier, were soon covered by extensive forests where forest-interior animals experienced a relatively sheltered existence until fashion, affluence, and engineering combined to now make the hills and ridgetops favored housing locations (personal observation).

The ecological succession that followed abandonment meant that many of the open pastures and hay meadows of the early and middle nineteenth century initially grew into old fields filled with weeds and native herbaceous plants. These were largely new cover types: in 1843 Torrey reported goldenrod as a weed of roadsides and edges; he did not mention our now-common, goldenrod-dominated "old fields."

TABLE 12.1. A comparison of certain landscape characteristics on abandoned and active farmland in the town of Hillsdale.

Timing of Agriculture	Soil Quality Rank (from 0 to 6 with 6 being best)	Elevation (meters)	Incline (ratio of drop to run)	Exposure (ratio of southern to northern)
None Evident	1.6 ± .7	338 ± 28	0.24 ± .06	1.36
Pre-1940s, not 2006	1.0 ± .4	314 ± 20	0.13 ± .04	1.09
1940s, but not 2006	2.7 ± .8	269 ± 23	0.13 ± .04	4
1940 & 2006	3.9 ± .8	262 ± 25	0.13 ± .04	2

Soil quality rank is based on USDA agricultural production data (USDA 1989). Data are based on a GIS analysis of randomly placed points. Each category was represented by 25 points, and the values represent the averages (± 2SE) for each set of 25 points. Modern and historical (1942) aerial photographs were used in these calculations; pre-1940s agriculture was deduced from evidence (e.g., obvious traces of field margins) in the early photographs. Pre-1940s abandonment tended to occur on lands that were of poorer soil quality, higher elevation, and more southerly exposure. Lands with no evidence of agriculture tended to be steeper.

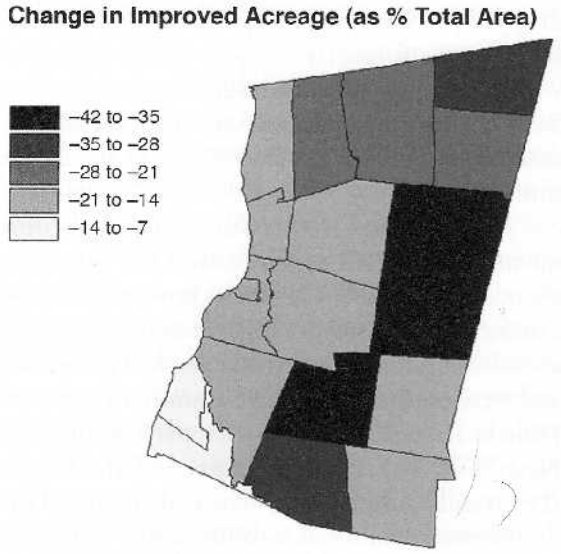

FIG. 12.6. Change in improved acreage between nineteenth-century maximum and 1930, expressed as percentage of total surface area of each town, as derived from census data. Eastern hill towns experienced noticeably higher rates of abandonment. While all towns experienced substantial abandonment during the remainder of the twentieth century (not shown), the hill towns still have the highest total farmland loss since nineteenth-century maxima.

Later in succession, shrubs (for example, dogwood) arrived and, finally, came forest (with "pioneer trees" such as birch, white pine, or ash often leading the way). However, succession is not a deterministic process, but rather a tendency colored by history, local particularities, and chance (see Wessels 1999). For example, gradually abandoned pastures often pass through a thorny shrub stage with hawthorn, raspberries, buckthorn, multiflora rose (after its mid-twentieth-century introduction), and red cedar. In contrast, suddenly abandoned plowlands might transition rapidly to a forest of whatever wind-dispersed tree species happens to be nearby and having a good masting year. White pine is a common colonizer. Alternatively, hayfield succession might be retarded somewhat as tall herbaceous growth delays the advance of woody plants.

From the perspective of animal ecology, shrubland, not old field, is perhaps the most interesting early stage of succession. The grassland birds of maintained but mature hayfields (e.g., bobolinks and meadowlarks) are not particularly common in old fields with rougher native "weeds" like goldenrod and ragweed and the beginnings of shrubby vegetation (personal observation). The ecological analogies to these birds' native prairies seem to break down as grasses become less common and broad-leaved plants become dominant. Even the butterfly community of old fields seems unspecialized and dominated by species typical of field/forest edges and hayfields (personal observation). Perhaps natural upland fields were rare in the original landscape, and few species are "pre-adapted" to them.

The arrival of shrublands, on the other hand, ushered in new plants and animals (see Litvaitis 2003 and accompanying articles). Some of these were species that had previously been found around beaver ponds and other wetlands. In the Northeast, rufous-sided towhees, chestnut-sided warblers, and catbirds, for example, may have originally occurred in such habitats (Birds of North America). Mockingbirds, field sparrows, brown thrashers, prairie warblers (a misnomer), and yellow warblers also settled into the shrublands.

The shrublands that develop from our old fields do not contain unique plants that are important for butterflies and moths; the ecologically important shrubs for butterflies and moths are those that are or simulate blueberry and scrub-oak dominated barrens (Wagner et al. 2003). Nonetheless, as noted in relationship to pastures, when old fields are on dry, poor soil then they support native plants and, in turn, native butterflies.

Wet old fields and shrubland host a variety of plant species, which may find these areas analogous to the beaver meadows and stream edges where they

existed prior to the expansion of agriculture. In addition to the wet meadow herbs listed earlier, native shrubs such as dogwood species, arrow-wood, nannyberry, willow species, swamp rose, meadowsweet, and steeplebush colonize wet old fields.

Abandonment of farmland not only meant direct changes in surface cover but also abandonment of the maintenance of drainage. Many fields that were wet meadows in the 1820s were likely drained by the end of that century. They stayed relatively dry until lack of drainage maintenance or intentional release from management saw them return to wetland in the last quarter of the twentieth century. Many of the organisms already mentioned in relationship to wet meadows benefited from such reversion.

Old field and shrubland were succeeded by forest. The reforestation of the Northeast has had a huge effect on its wildlife (Foster et al. 2002). Many native animal species that had disappeared prior to 1800 have returned; moose, fisher, bobcat, black bear, and wild turkey have become substantially more common in Columbia County during the past thirty years (personal observation). Whitetailed deer were among the first to return, in part because the old fields and shrublands that followed agriculture provided ideal habitat (Mattfield 1984). Historically, northeastern deer probably had survived in large part by utilizing openings created by fire, wind-throw, flooding, ice-scouring, or other disturbance (McCabe and McCabe 1984). The shrublands that followed farming, while probably somewhat different from the original shrublands, provided functional analogies, at least in terms of the food plants deer favored. The result of this increased habitat and of decreased predation/hunting has been a swelling of deer numbers to the point where forest succession is likely being affected today (e.g., Thompson and Huth, ch. 10 in this volume; Rooney and Waller 2003; personal observation).

These secondary forests are not botanical restorations of pre-European settlement forests (e.g., Singleton et al. 2001). Disease, logging, deer, and natural succession have all contributed to this change. Furthermore, McVaugh (1958) described the soils of the secondary forests as usually thinner, drier, and poorer than those of pre-settlement forests. We have few data on the ground flora of our pre-settlement forests, but poor soil species such as Pennsylvania sedge, wild sarsaparilla, Canada mayflower, and starflower may have now increased at the expense of rich soil species such as blue cohosh, bloodroot, wild ginger, Jack-in-the-pulpit, red trillium, and wild leek.

CONCLUSIONS

As a way of summary, we can take the changing landscape described above for which we have more or less firm statistics and hypothesize, based on some of the relationships we have mentioned, the resulting demographic chronology for select groups of wild plants and animals (Figure 12.7). Modern trends, which may only be beginning to show themselves, are especially hard to identify and so are particularly speculative.

Today, the county (and probably much of the Hudson Valley) is at a stage when relatively little habitat for native species is being created and existing habitat is being eroded. Most lands that will revert to forest have reverted and forest area, at least regionally, has begun declining; land in agriculture is shrinking and the farming on existing farmland is intensifying; and, compared to earlier levels, relatively little open land is succeeding to brush.

Specifically, for probably the first time since the mid-nineteenth century, forest area has begun to decline in the Northeast including the Hudson Valley (Tyrrell et al. 2004; DeWan and Zucker unpublished data; Foster et al. 2010). This "second

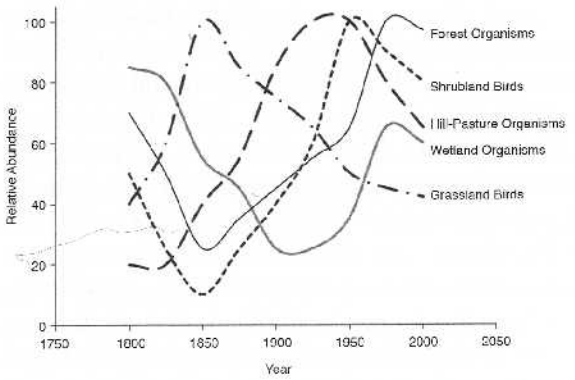

FIG. 12.7. An approximation of the county-wide relative abundance of select ecological groupings of organisms. Inspired by and compare with Foster et al.'s (2002) work in Massachusetts. The patterns seen here are hypothetical chronologies derived from the ecological relationships and changing agricultural landscape described in the text.

clearing" is due to development pressure, rather than agricultural expansion. The ecological effects reflect both absolute loss of forest area and the effective fragmentation of the remaining forest (e.g., Glennon and Kretser 2005). Much of this impact is due to regional changes in human population distribution and lifestyle, rather than absolute increases in population (Pendall 2003).

At the same time, land in farms continues to decline in the county. Part of this reflects a decline in the former "staples" of Columbia County agriculture: dairy farming and fruit production. It also reflects the growth of "niche farms." While some of these specialize in grass-fed livestock and dairy, most are intensive vegetable operations that use relatively small amounts of land compared to former modes of production. Average farm size has declined from nearly one hundred hectares in 2002 to fewer than eighty in 2007. From a nature conservation perspective, these patterns are especially troubling for those organisms that depend upon grasslands, shrublands, or open wetlands. We have estimated (Vispo and Knab-Vispo 2006) that 60 percent of the county's grasslands and perhaps 70 percent of its wetlands and shrublands (these categories are combined in agricultural statistics) occurred on farms in 1993.

Major landscape change in Columbia County is incipient. Rates of urbanization in Columbia County itself have been relatively modest, and forest loss, if any has occurred in the county, has been low. However, increase in developed lands and forest loss have been more marked in adjacent areas such as the Capital District, more southerly Hudson Valley counties, and the lands of Massachusetts and Connecticut (Tyrrell et al. 2004; DeWan and Zucker unpublished data; Foster et al. 2010; Loveland and Acevedo 2010). The current status can perhaps be best described as a slow or impending increase in the human domination of habitats. If trends evident in adjacent areas spread into the county, then this conversion would be expected to increase. Some of the habitats that largely avoided agricultural influences (such as ridgelines) are now being impacted (personal observation), and, due to fragmentation and other influences, the spread of human ecological impacts is advancing faster than the absolute rate of clearing (e.g., Glennon and Kretzer 2005).

While this chapter has not expressly linked upland land changes to impacts on the Hudson River itself, it is well documented that such land use changes within a watershed can result in direct impacts on the main waterways (e.g., Limburg et al. 2005; Cunningham et al. 2009). Many of the chapters in this volume have focused on the Hudson River itself, but this chapter has followed some of its tributaries upward and explored historical land use patterns which, while likely having water quality impacts, also had immediate, on-the-ground consequences for terrestrial ecology.

The changes in land cover and consequent ecological effects described in this chapter have been incidental insofar as they were driven by a variety of forces other than conscious conservation considerations. Despite increased public discussion of nature conservation, most nature conservation or habitat destruction continues to be "accidental." As human impacts in the Hudson Valley increase and as global stresses mount, a more conscious approach to landscape-level conservation will be needed if the trends highlighted by future historians are to reflect enhanced ecological analogies or actual habitat restoration.

ACKNOWLEDGMENTS

Much of our early fieldwork was funded by the DEC's Hudson River Estuary Program. Substantial additional funding came from private donors. Numerous volunteers, interns, and landowners were crucial in this work. Our colleague, Anna Duhon, helped with some analyses and stimulated others. Joel Grossman and Bob Henshaw provided helpful suggestions on drafts of this paper. David Foster and colleagues at the Harvard Forest provided useful critique of some of these ideas. We thank them all. Any errors of fact and concept here are ours alone.

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