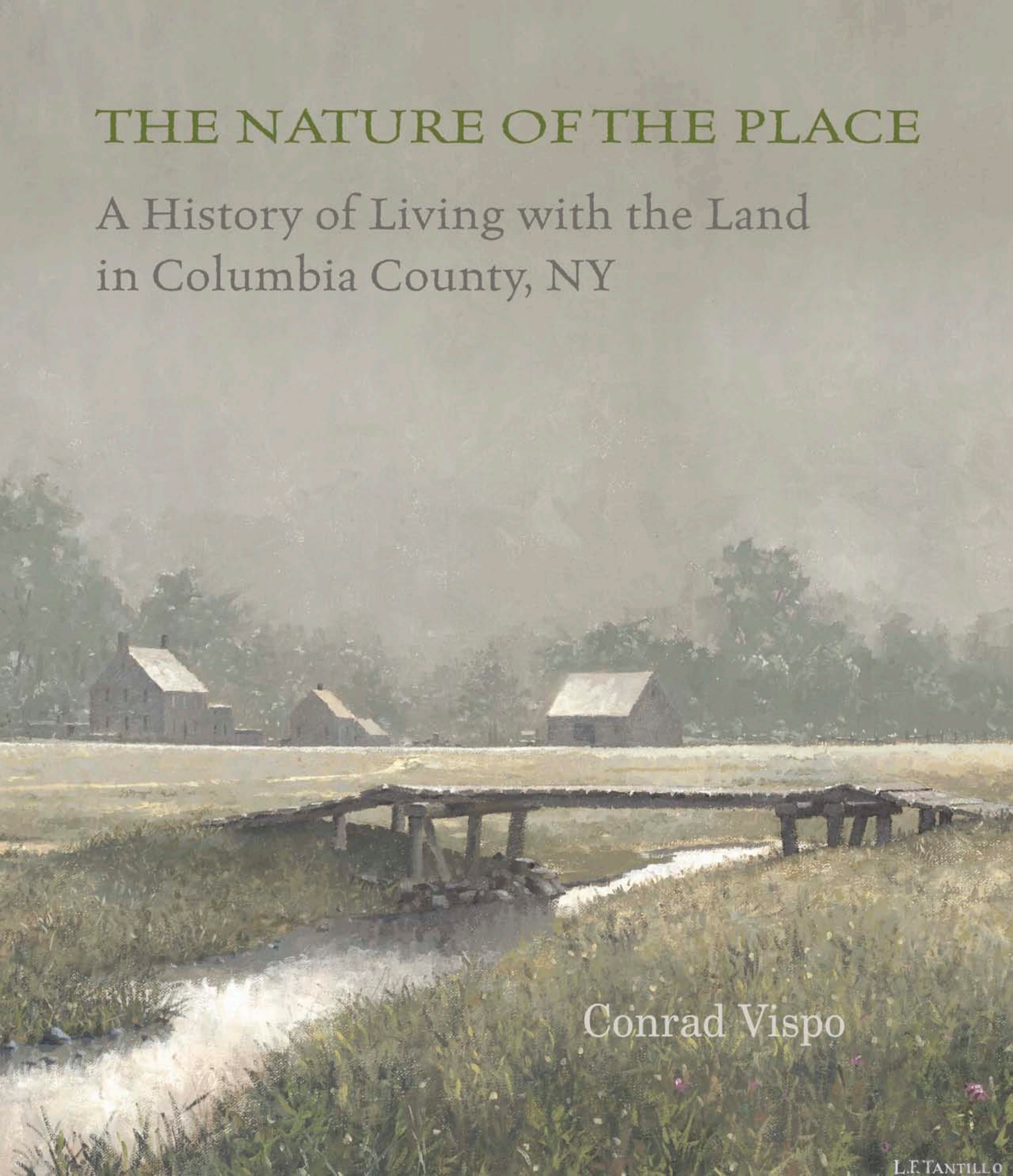
THE NATURE OF THE PLACE

A History of Living with the Land in Columbia County, NY

Conrad Vispo



Dedicated to my family

– my parents, wife and son –

for their support through the years,

and to the memory of the few

young biologists I've known

who never had a chance to

become old biologists.

CONRAD VISPO

The Nature of the Place

A HISTORY OF LIVING WITH THE LAND IN COLUMBIA COUNTY, NY

Conrad Vispo

Adonis Press

Published by Adonis Press

A branch of the Hawthorne Valley Association

321 Rodman Road, Hillsdale, NY 12529

www.adonispress.org

Furthermore:
a program of the J. M. Kaplan Fund

This publication was made possible through the generous support of Furthermore, a program of the J. M. Kaplan Fund, as well as the Rheinstrom Hill Foundation, the Bank of Greene County Charitable Foundation, the Novo Foundation, and institutional support from the Hawthorne Valley Association.

ISBN 978-0-932776-46-4
ISBN 978-0-932776-53-2 (ePub and Mobi)
ISBN 978-0-932776-54-9 (WebPDF)

Design and layout by Dale Hushbeck

Cover Painting: Len Tantillo, *The Bridge,* oil on canvas

The Nature of the Place

TABLE OF CONTENTS

Chapter One Meeting the Landscape.........11

Chapter Two Forests: Our Homeland.........33

Chapter Three Fields: Squares of the Landscape Quilt.........99

Chapter Four The Soil as Habitat with History.........155

Chapter Five Our Surface Waters: The Canary on the Iceberg.........227

Chapter Six The Crucial Patterns of Place.........295

Notes.........310

Index.........349

FOREWORD

The residents of Columbia County have much to be grateful for.

Rising in gently rolling hills from the Hudson River to the ridges of the Taconics in the east, Columbia County offers many beautiful views of the Catskills across the broad Hudson River Valley in the west. Located in the "gravitational center" between New York City to the south and the Capital District to the north and with a direct link to Boston via the Massachusetts Turnpike, the County has maintained much of its rural character while at the same time benefitting from its proximity to those urban centers.

Residents of the County will also be grateful for this book of Conrad Vispo's, which is probably one of the few in-depth ecological/historical studies devoted to an American county.

The author's perspective, reflected in this book, combines personal intimacy with professional rigor and objectivity. After putting down roots in the County during his childhood and youth, Vispo went on to study natural resources at Cornell (where he is now adjunct faculty) and earn his PhD in wildlife ecology in the Midwest, where he met his wife and fellow ecologist Dr. Claudia Knab-Vispo. The two of them then spent eight years studying the Caura River, a tributary to the Orinoco in Venezuela, before returning to the County where they, with the help of colleagues at Hawthorne Valley Farm, established the Farm-scape Ecology Program in 2003.

Beside drawing on the author's personal experience and the observations of predecessors and contemporaries, this book is also based on over ten years of extensive original research by the Farmscape Ecology Program. As its name indicates, the Program is especially devoted to researching the ecological interrelationship between farming and its natural environment, a recurring theme in the book.

At a time when we are growing increasingly aware of the reciprocal relationship between nature and human life, Vispo's lively descriptions remind us that how this interdependence plays itself out begins with how we think about our natural environment – its waters, forests, fields, and all their flora and fauna. Written out of love and appreciation both for the land and its human residents – with a contagious empathy that reveals itself not least through its subtle humor – this book is full of original observations as well as historical and factual information. Though based on past history and present conditions, it also seeks to uncover the future potential of Columbia County, and it calls upon its readers not only to appreciate its past and enjoy it in the present, but also to become active participants in forming its future.

- JOHN BARNES, *ADONIS PRESS*

PREFACE

Honest questions are, to my mind, one of the foremost demonstrations of love, and if this book can raise questions that prime the pump of intimacy with this land, then it will have served its purpose. This is a parochial book, it may have little continued relevance for passersby and those residents who eventually move on to other regions. That said, once one has felt the love of a place, it is not an emotion that easily goes unsatisfied elsewhere. I thus hope most of all that this book is an emotional journey that helps readers exercise the sinews of their reason and urge the currents of their heart in ways that bring them and their surroundings joy, wherever those surroundings may be.

This book has been embarrassingly long in coming, and it only made it this far because of the help of numerous people. My mother, Vivien Vispo; my late father, Raul Vispo; my wife, Claudia Knab-Vispo; and my son, Vincent Otter Vispo, all bore with me through the ups and downs of this project – this book no doubt ate up some of what should have been 'family time.' Thanks for not only tolerating this absence but even nurturing the book. Much of the work recounted reflects the doings of my colleagues here at the Farmscape Ecology Program – researchers Anna Duhon and, again, my wife Claudia (who read and corrected the whole thing several times and wrote small sections, but refused co-authorship), together with our technicians, past and present, Sara Powell and Kyle Bradford; they deserve much of the credit and none of the blame. Numerous interns, whom I will not try to list, also contributed to our findings and brought much-needed youthful enthusiasm to our ventures. My colleagues at Hawthorne Valley, including Martin Ping and Steffen and Rachel Schneider, tolerated, even encouraged, my obsession and somehow seemed to believe that something would, eventually, actually appear in print. Crucially, many farmers and other land owners around the County have tolerated our visits over the years; I hope this book is a small gift in return.

Many additional groups and individuals gave valuable input at various points and on various sections of this work and deserve heartfelt thanks. These include, in alphabetical order, Judy Anderson, early believer in and staunch encourager of our efforts; urban conservationist David Burg, who helped us think about the big picture; Tony and Gail Cashen, supporters of this work in many ways (including proof reading early versions); the helpful staff of the Columlbia County Historical Society; the welcoming people of the Columbia County Soil and Water Conservation District; our friends and colleagues at the Columbia Land Conservancy, who have long played an important role in the conservation of the County and have willingly shared their insights and connections; forest ecologist and historian Charlie Cogbill, who shares that landscape history ‘bug’; Bob Daniels, former NYS ichthyologist, who freely gave of his time to introduce us to the local fish; Bob Davidson, curator of Carnegie ground beetles, who helped us see the patterns in beetle morphology and ecology; the Alan Devoe Bird Club, which does an excellent job promoting study of our local birds, a group of organisms that has gotten somewhat short-shrift here; the late Nancy Dill, an early and long-time advocate for the value of knowing place; historian, ecologist, and farmer Brian Donahue who illustrated how those disciplines could be inter-woven; the gentle Ruth Dufault and late Peter Dufault for somehow believing in us; ant biologist and biostatistician Aaron Ellison, who kick-started our ant work; the late state paleontologist Don Fisher, who shared his detailed geological maps of the County; Georg Freese, who, as a fellow author, albeit of a somewhat different genre, helped convince us that this too will pass; David Foster, Director of the Harvard Forest, and his supportive colleagues, in addition to Aaron, who provided interesting discussion and technical support; former neighbors (we moved, not them) Tom Gerety and Adelia Moore for stimulating times at the Bog; Mike Gladstone, Furthermore manuscript reviewer and provider of crucial comments on an early version of this manuscript; archeologist Joel Grossman, who helped us appreciate the diverse possibilities of Native American history; the open and informative state historian John Hart; wildlife biologist Bob Henshaw, early inspiration and subsequent ‘promoter’ of our work; the family Holdrege, mainstay of the Nature Institute, whose older and younger generation have been just the sort of helping hand we’ve needed; Jerry Jenkins, inspirational and encouraging field botanist and landscape thinker; regional historian Stanley Joseph, sharer of local historical insights; Laura Manchester, former colleague at Hawthorne Valley, and early enthusiast of this work; that great promoter of all things aquatic, educator Fran Martino; Dale McDonald, whose effusive enthusiasm appeared at just the right moment; Rogers McVaugh, the county botanist who, in his 99th year, welcomed a visit from a couple of young biologists from his old stomping grounds; the helpful staff and associated researchers of the New Netherland Institute; pollen and pond-muck expert Dorothy Peteet, who helped us think about the land long past; Chatham librarian Fern Pellettieri, who seemed to take odd book requests as a pleasurable challenge; Columbia County historian extraordinaire Ruth Piwonka, who was always ready to field the out-of-the-blue question; Milo Richmond, my advisor when I was an undergraduate, whose stories of landscape change finally sunk in; Karen Ross, who has gotten us into, and out of, a great swamp; James Schamus and Nancy Kricorian, who have helped us brainstorm various aspects of the urban/rural conundrum; Bob Schindelbeck, Cornell soil guru; Cathy Stanton, who gave us new perspectives on the cultural landscape and provided an excuse for wearing a top hat; Caroline Stewart, one of our 'wise women' advisors, who's wonderfully piggy about the project; our colleagues at Hudsonia, the excellent regional biologists Gretchen Stevens and Erik Kiviat; the supportive Karen Strong and her compatriots at the DEC's Hudson River Estuary Program; and Harry Zirlin, eager ambassador for entomology. Many others have been great sources of encouragement, from our regular companions on our field outings – who have helped convince us that even when we're feeling low, the nature of this County really is neat – to fellow biologists and researchers who, by taking our small work seriously, have helped us believe in it. Thanks to all.

I also thank the array of authors who, although I have no personal connection to them, shared many valuable insights through their published works; they are cited individually in the notes.

Finally, the team that made this book a physical reality, editor/publisher John Barnes, the patient book designer Dale Hushbeck, and painter-historian Len Tantillo, all helped ensure that, whatever the shortcomings of my text, the book at least looks good.

This book has mistakes, of that I am sure. I am repeatedly surprised by how long and firmly I can inadvertently hold on to misconceptions. What I ask is that those noting such mistakes, big or small, take the time to write and improve my understanding. I would also be happy to hear from those who would like to add detail or nuance to what is written here.

I hope you have fun with this book, it's in your hands now.

- CONRAD VISPO

The Nature of the Place ~ One

MEETING THE LANDSCAPE

What This Book is About and Why It Was Written

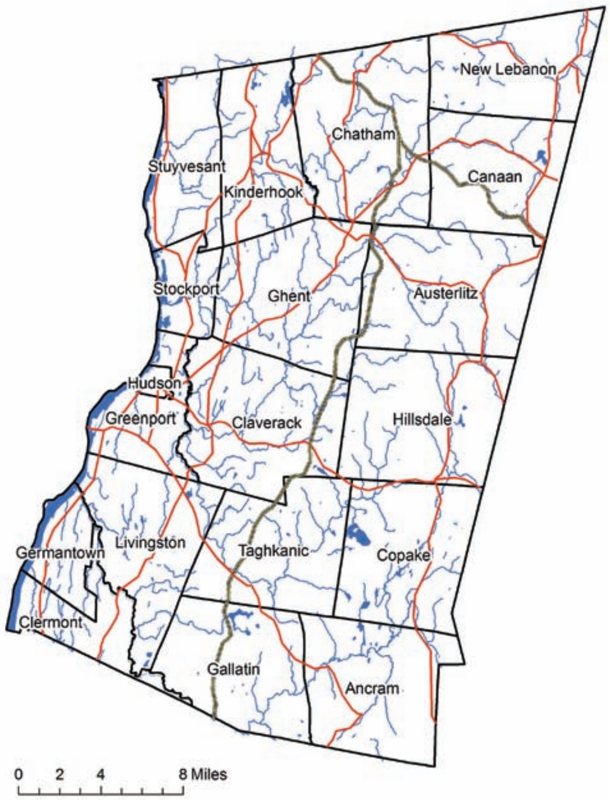
This book looks at the land cover of Columbia County, New York from the perspective of natural and human history. "Land cover" is a nuanced term: on the one hand, it can evoke comforting images of a forested bed cover; on the other, it can imply human alterations, as in "the land was covered with asphalt." This book hopes to encompass both such extremes and the range of relationships in between. We will try to describe forest, field, soil and waters both from the perspective of the diversity and beauty of their inherent nature and also in terms of the way the human head and hand has, for better or worse, left its mark. In some ways, this division is artificial, because humans are 'part and parcel' of this world. Yet, given our tremendous powers to change the land and the fact that we are responsible for our own hand, the dichotomy between wild nature and human influence makes pragmatic, if not philosophical, sense.

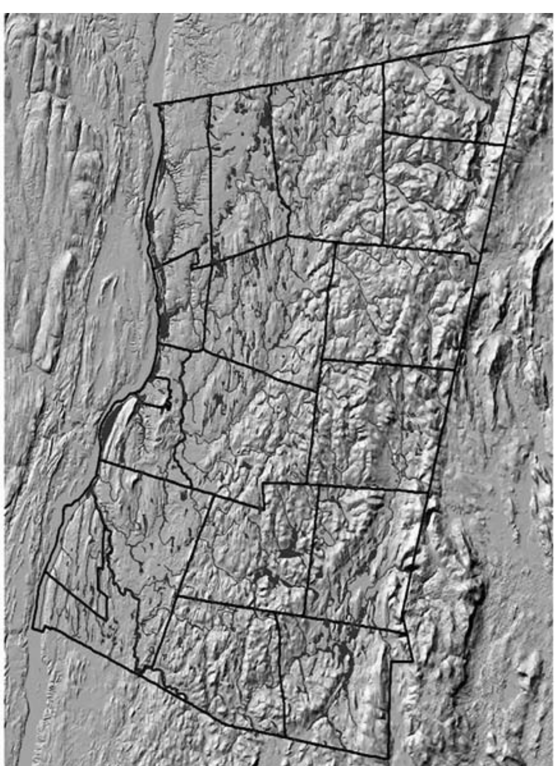
This book is intended neither as a field guide nor as a narrative for the rocking chair. It is meant as a resource and a spur. The descriptions in each of the following four habitat chapters contain an introduction to the relevant physical landscape, a survey of the history of human interaction with that landscape, a 'where-are-we-now' section, and an introduction to two select groups of organisms from the habitat under consideration. The general goal is to familiarize readers with their surroundings, so that they are inspired and facilitated in their explorations of nature and history. Ultimately, we hope that such explorations, together with the knowledge and compassion that they can bring, will help encourage well-informed land-use decisions. Place can be a limitation (Columbia County's big-wave surfing and alpine hiking communities, for example, are small), but understood and riffed on, it can help bring identity and satisfaction.

This book is not exhaustive. Instead, we have tried to give a broad-brush overview and then, as case studies of a sort, we have usually focused on a few particular aspects of the given habitat which are near and dear to us. Sometimes, the limits of our own experiences or the type of habitat dictate some divergence from our standard outline. This is, perhaps, most evident in the chapter on soils, a habitat that is so 'out of sight' that we revert to chronicling the history of human soil perceptions, rather than presuming to be able to describe in detail the history of the soil itself. Likewise, we do not aspire to describe the ecologies of all relevant species in each group we consider, be they wildflowers, butterflies, ground beetles or amphibians. Instead, we profile a subset of species that, in our experience, are relatively common in the County and whose natural histories illustrate an interesting range of ecologies and/or highlight aspects of the habitat we have discussed. We hope that making these acquaintances might prompt readers to pick up a field guide and begin their own explorations of these creatures; when relevant, we list our favorite resource books in the notes section. Much material, including old publications, is now found on the web. However, to save space, we've generally included web sites only when they are the sole source for the given material. Readers are encouraged to explore on-line archives for digital versions of historical works.

Finally, our societal understandings of natural and human history are ever changing. We encourage readers to pick up a camera, join a friend, subscribe to a journal, affiliate with a club… in short, to find a comfortable way of gathering their own knowledge and sharing it with the rest of us.

In what remains of this short chapter, we present some basic background information which will provide a foundation for most of the remaining chapters. This is information that, as we were first drafting the book, we found ourselves repeating at the beginnings of various chapters. We haven't rid the book of all repetition; but by placing this information here, we can not only be more efficient in our use of space, but also provide an initial overview that might get lost in the more detailed accounts of subsequent chapters.





Foundations

The face of the land is shaped by a variety of forces, which can be loosely grouped as physical, biological and historical. Various geological forces form the topography, bedrock and soils. Life creeps over and into that mantle, creating new worlds and modifying old ones. Finally, time results in aging and the accumulation of happenstance.

Columbia County is located in the Hudson Valley of New York State (see Fig. 1). Nestled on the east bank of the Hudson, the County is separated from Massachusetts by the rocky spine of the Taconics, a geological barrier that helped shape our human history (see Fig. 2). Due north is Rensselaer County and the Rensselaer Plateau, a rugged area reminiscent of the Adirondacks. To the northwest, there is urbanization in and around the Capital District; Albany's demographic influence extends into adjacent portions of Columbia County. Across the Hudson, Greene County reaches into the Catskills which, together with the Helderbergs, form the western horizon for the County. To the South is Dutchess County and the growing influence of New York City; Dutchess has more than three times the population density of Columbia County.

A Bit about Geology, Glaciers and Life

As the Earth's early surface cooled, a thin skin, like cream on milk, formed. However, the molten core continued and continues to flow, causing currents and collisions of the congealed surface plates that form our continents. These huge islands of rock were pushed around and into each other. Their collisions forced some plates up and sucked others down. Some 450 million years ago, one

Figure 1 *(above left). The towns, major roads, and waters of Columbia County. The Hudson River forms the western border.*

Figure 2 *(left). The Taconics occupy most of the eastern half of the County, while the land slopes off to the Hudson in the west.* Shaded relief by USGS.

***Figure 3**. The horizontal layering of the Catskills' sedimentary rocks. The Catskills were cut into the outwash plain formed by the erosion of what were once the towering Taconic Mountains.*

or more such plates began grinding into what is now northeastern North America, pushing part of the shoreline and continental shelf up and over and producing a rubble heap that, paradoxically, sometimes left older rocks atop younger ones. A second, somewhat later, collision resurrected that initial chain of mountains, and those mountains apparently reached Himalayan heights. The erosion of these various ranges created a huge washout plain that reached as far as the modern shores of Lake Huron and into which the primordial Catskills were subsequently carved. That etched basin was later uplifted, and the modern Catskills' horizontal, sedimentary layers are evident today when one views them from Columbia County (see Fig. 3). The remaining stubs of the great mountains that shed all those sediments are our Taconic Hills, which dominate, albeit relatively modestly, the eastern portion of the County. Taconic rocks probably underlie most of the County's western portion as well, but their low relief and subsequent burial by lake sediments have hidden them from view. The ultimate western margin of the Taconic heap seems to be marked more or less by the Hudson River.[1]

Today's Taconics reach some 2,000 feet in altitude and are a mishmash of compacted and reworked mud and sands (forming rocks such as shale, slate and schist) and of calcium-rich limestone and dolostone that derived from uncountable generations of now-fossilized sea organisms (see Fig. 4). These calcareous remains, including some limey shales, are scattered across the County, and have had a visible effect on the present-day ecology of wild and cultivated plants. The calcium carbonate of these rocks buffers the acids created by rotting organic matter, and so the overlaying soils tend to be less acidic than soils over other bedrocks. A few isolated bits of volcanic rock can also be found, apparent relicts of the previous tumultuous geological collisions.

While these gargantuan geological forces crudely shaped our landscape, glaciers were responsible for its texture. The last glaciation probably melted away from our region some 15,000 – 18,000 years ago (see Fig. 5), although some estimates have subtracted 4,000 years or so from those values. As will be discussed in more detail in our chapter on soils, an ice dam apparently backed up water in today's Hudson Valley, forming a long lake, similar to modern Lake Champlain but about twice the length and stretching from northwestern Putnam County to the northern end of Washington County. The shores of this Glacial Lake Albany extended roughly five miles into Columbia County. The valley of Kinderhook Creek seems to have formed another winding, elongate glacial lake.[2]

As glaciers and waters subsided, they left a more rounded, gently rolling landscape of hill and valley, clothed in glacial debris. This is the topography characteristic of much of the County and which gives the town of Hillsdale its name. In a self-reinforcing process, living organisms began to colonize the

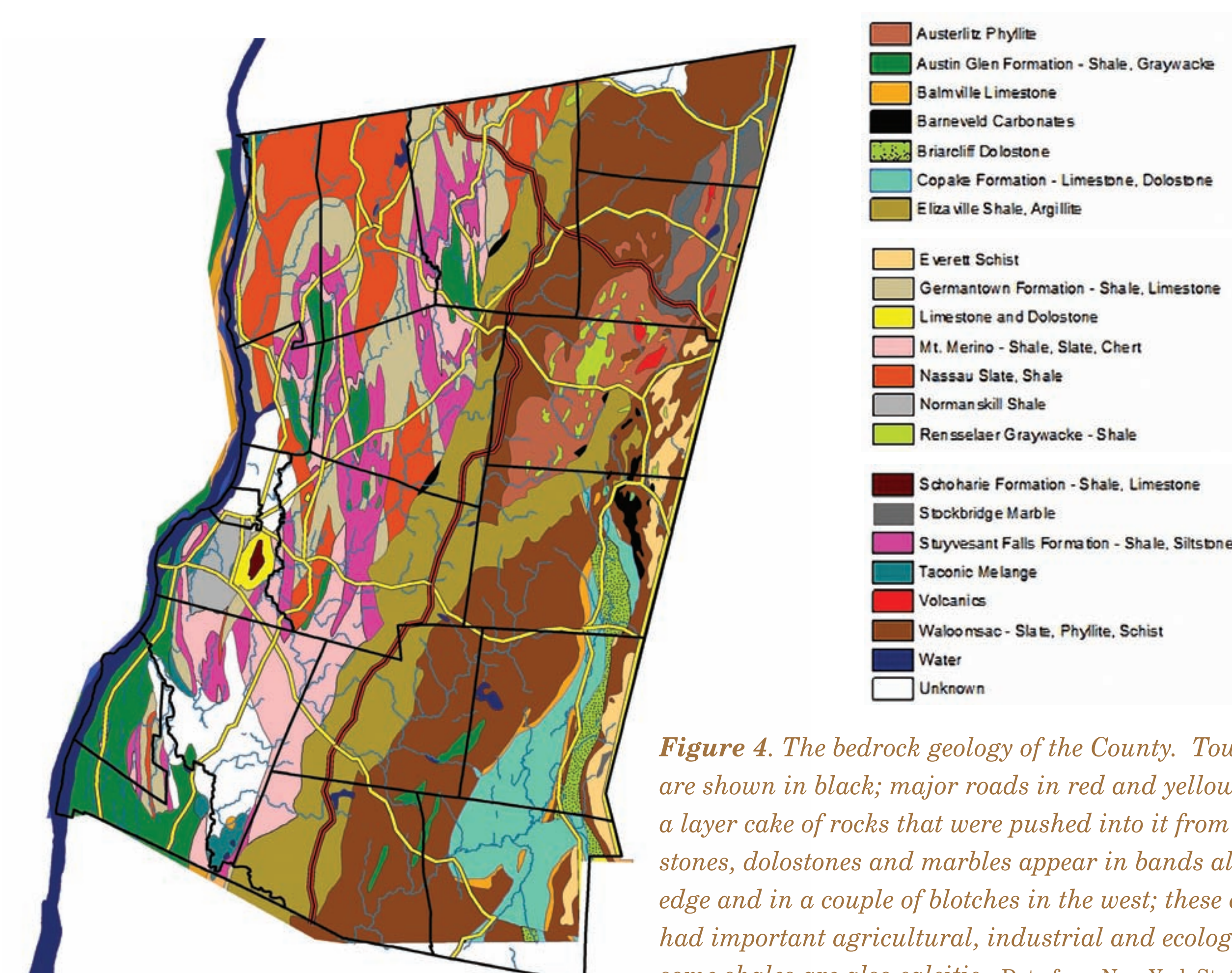


***Figure 4**. The bedrock geology of the County. Town boundaries are shown in black; major roads in red and yellow. The County is a layer cake of rocks that were pushed into it from the east. Limestones, dolostones and marbles appear in bands along the eastern edge and in a couple of blotches in the west; these calcitic rocks had important agricultural, industrial and ecological effects; some shales are also calcitic.* Data from New York State Museum.

post-glacial substrate, pulling nutrients from the air and out of the rocks and, with their own bodies, building a richer soil. As life spread across the former glacial terrain, it improved the conditions of its own existence by building soils and creating the basis for more and more complex ecological webs. Lichens first sent their tarnished-copper colored carpets inching across exposed rock, and, as they built soils, mosses and more complex plants such as grasses began to colonize the barren ground. Some biogeographers believe a vast strip of prairie bordered the southern margin of the receding glaciers, providing homes to grassland organisms from the size of tiny leaf hoppers to that of the tremendous mastodons. Gradually, as other plants colonized the area and the climate moderated, forest arose over much of the landscape, first evergreens and then, perhaps with a bit of help from Native Americans, deciduous forests.[3]

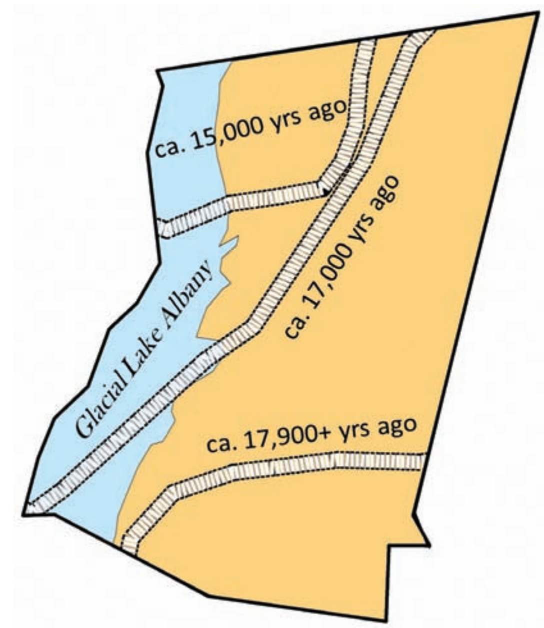


Figure 5. *The approximate location of the southern glacial edge during the last glacial retreat and the rough extent, in the County, of Glacial Lake Albany, formed in part from glacial meltwaters.*
Sources listed in note #2.

Taking this long view of the County helps our understanding in at least two ways: first, the distribution of life on our land is not static. Rebound after inevitable large and small scale disturbances means that species are constantly in motion at various scales. That such change sometimes occurs at scales much longer than our lifespan doesn't mean it isn't happening. Also, traces of that history help explain the patterns of life we see today. The pine plains, which originally stretched north from Kinderhook (see Fig. 6), formed on the beaches of a glacial lake and the outwash plateaus of glacial runoff. Small, relictual populations of northern plants or perhaps even prairie organisms still dot the landscape, fading traces of a distant, biogeographical memory. As they are removed by natural or human forces, they wink out and are unlikely to soon reappear. The Hudson Valley provides a relatively warm corridor for northward-probing southern organisms, while the Taconics, relatively higher and cooler, are home to more boreal life.[4]

As we detail in subsequent chapters, the geological patterns described above have had a large influence on human settlement. Much of the County's prime agricultural lands are on soils left by Glacial Lake Albany or in fertile valleys formed by erosion of calcareous rocks. Likewise, iron foundries, cement factories, and brick yards all depended upon the presence of their raw materials close at hand. Our topography also did much to determine the distribution of water power. A quick look at early 19th century industry, most of which was water-powered, shows that it was distributed primarily along two steps: first, where streams fall off different layers of the Taconics rubble pile and second, where those streams tumble down to the Hudson itself. As a last example, one needs only trace the Indian paths that evolved into colonial turnpikes, paved roads, and, in some cases, thruways and railroad beds; these followed the land's contours and took advantage of valleys and passes. Peaceful Valley in southeastern Canaan, for instance, was an early route of human travel which now funnels the New York State Thruway and the CSX Railway lines through the pass at State Line.

Largely as a result of topography and location relative to larger continental factors, climate varies across the County (see Fig. 7) with the northwest being driest and the southwest hottest. Precipitation increases eastward into the wetter hill country, and spots along the Taconics apparently receive nearly 20" more rain per year than certain Hudson Valley sites. The growing season (time between last and first frost in a given year) varies by almost three weeks from the shorter season of the hills to the longer valley season.

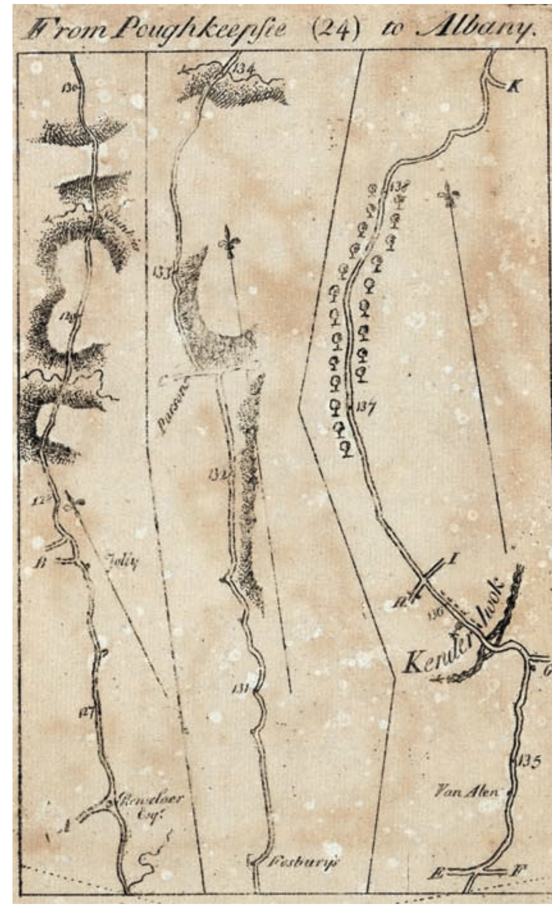


***Figure 6** (above right). A plate from Christopher Coles' 1789 work,* A Survey of the Roads of the United States of America*. The right frame shows the leg of the journey passing through Kinderhook and heading north. The tree-lined section indicates the pine forest that used to stand on glacial outwash sands along present-day Route 9 north of Kinderhook Village (see Chap. 2, p. 71).* Image courtesy of the Rumsey Map Collection.

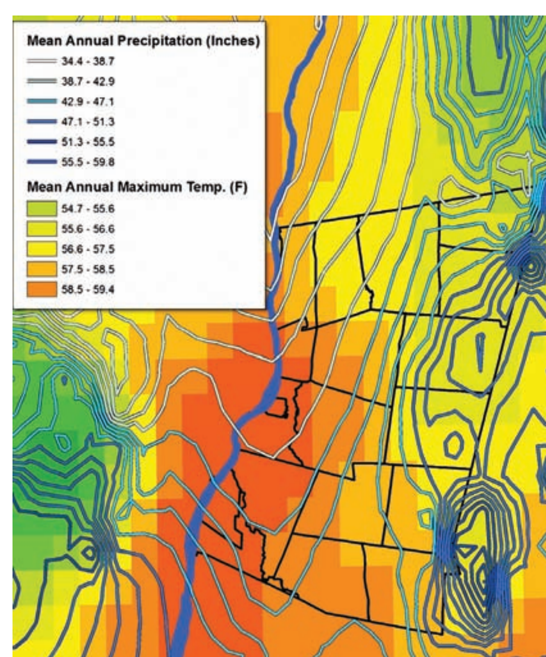


***Figure 7**. Average climatic conditions 1971-2000 in Columbia County. The green-to-red background tint reflects relative temperatures with green being cooler and red hotter. The 'contour' lines reflect precipitation with bluer lines indicating areas of greater precipitation. As remarked by early farmers, these climatic gradients result in marked differences in growing season with the difference from southwest to northeast approaching three weeks.* Map created based on national climatic data gathered by the PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu.

A Brief Overview of Human History

Native Americans

Evidence of human settlement appears shortly after the glaciers retreated. Indeed, one cannot talk about our post-glacial ecology without accepting that humans have been a part of it almost since the start. While the earliest evidence of human settlements in the Hudson Valley comes from shortly after glaciation, around 10,000 – 13,000 years ago, Europeans have only been on the scene for 400 of those years. Nonetheless, it is the influence of human action during the past 200-300 years that is most currently evident on our landscape, and for which we have the most information. Although we will allude to Native American influences or uses, for the most part we will, for practical reasons, focus on those more recent centuries.[5]

When Henry Hudson sailed up the Hudson River in 1609, a Native American group that has, subsequently at least, been named the Mahicans (sometimes spelt Mohicans; however, the Mohegans and Mohawks were other peoples) apparently occupied much of Columbia County (Fig. 8). They spoke a language similar to certain other East Coast tribes and so have been included in what is called the Algonquin language group. The very southern edge of the County, south of the Roeliff Jansen Kill, may have touched upon lands of the Munsee people. At colonization, the Mahican homeland seemed to radiate out from southwestern Rensselaer County, reaching south along both sides of the Hudson to Dutchess County and north along the river to Washington County. In the east, their lands reached at least as far as the Housatonic, and in the west they abutted the Mohawks somewhere around Schenectady.[6]

Such distributions were hardly permanent. Even prior to European arrival, periods of social mixing and migration were probably common. Mahican oral history describes such movements. The Mahicans themselves may have been composed of distinct groups or units which formed and melded over time. There were said, for example, to be distinct eastern and western Mahican dialects within their homeland. Self-perceived cultural lines may have been fluid and fuzzy, with distinctions clearly perceived between tribes recently brought together, but less sharp amongst groups with similar languages and long periods of co-existence. Our current maps of Northeastern Indians are but an early 17th century snapshot of a long-term, dynamic process.

Pre-colonial indigenous population estimates are a controversial topic amongst anthropologists and archaeologists, perhaps because they influence our views of the relative wildness of the early landscape and of European impact on it. Was it, to use modern terms, wilderness or was it countryside? Were humans benign actors leaving little mark on the nature of the land, or did they already have a relatively large role in shaping the landscape? Because of these implications and the paucity of hard data, this is academic terrain ripe for debate. We have no direct censuses of total Mahican population at the time of European arrival or earlier. Tragically, fatal smallpox epidemics swept through the Connecticut and Hudson River Valleys in the early 1600s; and all later Native American population estimates are of much reduced populations.

***Figure 8**. A 1614 map of New Netherlands based on the explorations of Adrian Block showing modern Long Island at the bottom right, the Hudson River in the center and probably the Connecticut to the east. Note the location of the "Mahicans" and small images of their houses.*
Image from newnetherland-abhc.info of original map in The Hague.

To illustrate the complications of estimating these early populations, it is useful to consider our earliest written estimate of Mahican population size. It comes from the papers of Kiliaen van Rensselaer (ca. 1590–1640), first patroon of Rensselaerwyck. He was an absentee landlord and may never have visited his manor, however the details in his documents were presumably supplied by his employees working along the Hudson. In a 1634 report to the government in Amsterdam, he refers to lands located just north and northwest of Columbia County (see Fig. 9) and states, "So that the territory of the Mahikans, who in their time were over 1,600 strong, has all together over 1,200 morgens of cleared land and far more than 16,000 morgens of mountain and valley, forest and marsh..." Even such a quantitative statement leaves huge room for interpretation. Eighteen thousand morgens (or about 36,000 acres) is but a small portion of the total lands in which Mahicans resided, but was this the core of Mahican lands and so unrepresentative of densities elsewhere in their home range? What is meant by "1,600 strong" – was this total population or just, as some have suggested, warriors (hence indicative of a total population of about 8,000)? In any case, to what degree does this estimate reflect a Mahican population already cut down by those decimating diseases (the report came just as the first thoroughly-documented Hudson Valley smallpox epidemic was peaking)? Such are the uncertainties left by even a relatively detailed population estimate.[7]

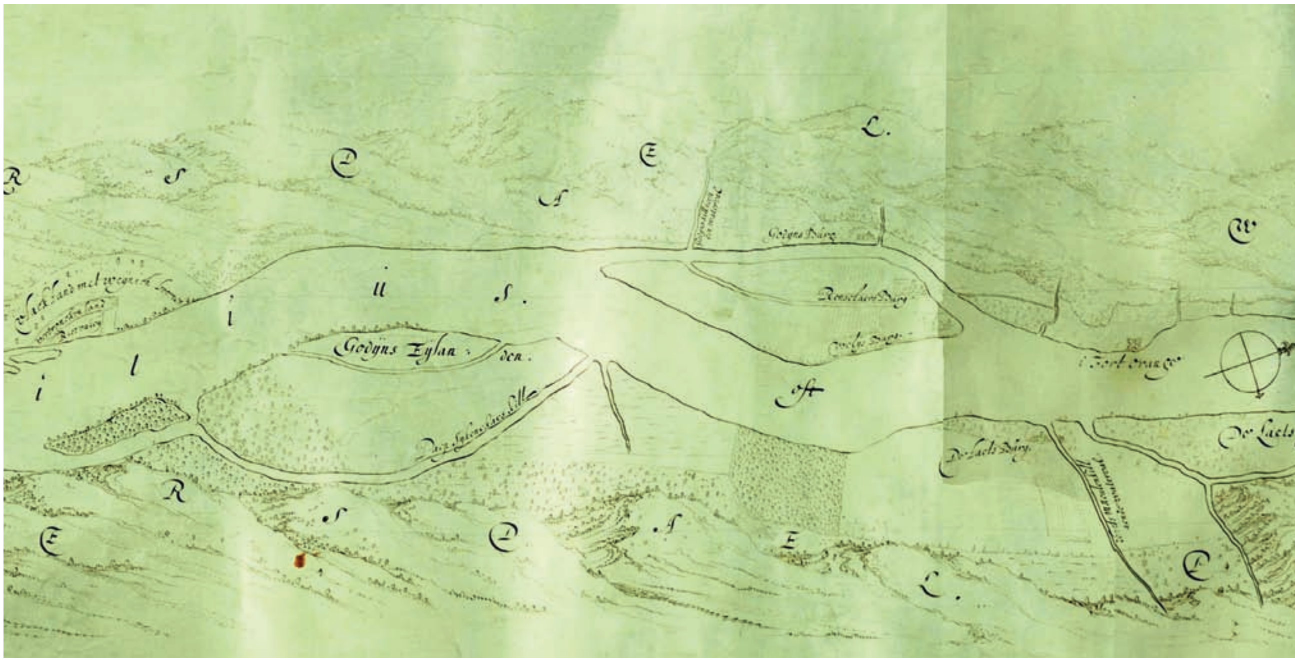


***Figure 9**. A ca. 1632 map showing a stretch of van Rensselaer's early holdings in the patroonship of Rensselaerwyck. North is to the right, and just left of the compass is the location of Fort Orange, close to modern-day Albany. Columbia County is off-map to the left. Much of the flat lands along the Hudson appear to be cultivated, and certainly at least part, if not nearly all, of that land was opened by the Native Americans whose cultivation preceded the Dutch in this region.* Image courtesy of the New York State Museum.

On this unsteady ground, Columbia County indigenous populations can be calculated in various ways. The estimates of 1,600 or 8,000 people on 36,000 acres cited above result in densities of about one person for every 25 acres or five acres, respectively. If one assumes that the western, banks-of-the-Hudson third of Columbia County (or about 137,000 acres) was the most analogous to the lands described by van Rensselaer, then a population of 6,000 to 30,000 in Columbia County could be calculated. The lack of archeological evidence of large or numerous settlements strongly argues for the lower population values, although some suggest that the nature and location of Mahican settlements meant their traces were quickly obliterated by subsequent settlements. Other estimates exist. A recent work proposed a total Mahican population of 2,000 to 3,000, based in part on the dearth of archeological evidence. Others have put the number around 6,400, and one 19th century Mahican speaker cited a population of 25,000. Given that Columbia County was a quarter or less of the total Mahican domain, these values would suggest an indigenous population of about 500 to 6,000 in the County. This has been a long, drawn-out aside on demographics, but it has perhaps served to illustrate the ample room for speculation: depending on our starting points, we can justify population estimates that vary by at least an order of magnitude.[8]

We will discuss indigenous land use (e.g., burning) and settlement patterns in more detail in subsequent chapters (Chap. 2, pp. 37-40; Chap. 4, pp. 162-166). In brief, at the time of European settlement, Mahicans were apparently farming, hunting, fishing and gathering, with at least some people making seasonal movements to meet these needs. The shores of the Hudson and the banks of our larger creeks seem to have been the primary settlement areas because of their proximity to fish, canoe travel lanes, and good agricultural soils. Villages were apparently small, and many may have been temporary.

The indigenous landscape was not immediately erased by European arrival; however it changed dramatically. As mentioned earlier, during the early 1600s, preceding much of the European settlement, widespread epidemics killed many indigenous people throughout the Northeast. Yet, relatively large Native American populations co-existed with European colonists for decades, albeit not always peacefully. Cultural interchange influenced both societies, and it influenced the land- and resource-use patterns of native and colonial cultures. Much fur trapping was done by indigenous people responding to the markets offered by European traders. Efforts to control fur trapping grounds formed a major theme in the power struggles of the French, Dutch and English in the Northeast, and various indigenous groups were drawn onto one side or another of these conflicts. In terms of agriculture, many early colonial settlements were founded at the sites of indigenous villages, partially because these groups shared certain goals (for example, both natives and settlers wanted easy access to water and good agricultural soils), and also because clearing shrubland or young forest, such as colonists might have found around former Native American villages, was notably easier than clearing mature forest. In addition, Native Americans and colonists exchanged medicinal knowledge, agricultural techniques, and technological know-how. As difficult as it is for us to imagine, given the eventual eradication of most aspects of Native American culture from everyday North American life, there was perhaps at least a century or so of more balanced, multicultural relationships.[9]

The Mahicans seem to have disappeared from the region more by attrition and a progressive whittling away of their lands than by pitched battles. For a variety of reasons, including a misunderstanding of European land ownership concepts, misleading land speculators, the social disruption of the epidemics and alcohol, and the consequences of incorporation into European fur-trade economics, Mahicans progressively sold off their lands during the 17th through early 19th century. The last regional Mahican population was around the Stockbridge Mission. Mahicans left Stockbridge by 1788 and moved progressively westward, reaching Wisconsin in the early 1800s. Many currently live on Wisconsin's Stockbridge-Munsee Indian Reservation, northwest of Green Bay.[10]

Initial Colonization

In Columbia County, the Dutch (and a few Swedes), who initially came in pursuit of the fur trade, first settled the area around Stuyvesant and Kinderhook. Kinderhook is one of the earliest, still-extant place names along the Hudson River. Colonial populations then spread north and south along the banks of the Hudson. Columbia County was established from part of Albany County in 1786.

Much of the written history of colonial and early federal human history in Columbia County is dominated by discussion of the patroon and manorial systems, and so it is worth describing them here. During 17th century Dutch settlement, the Dutch West Indies Company granted patents to certain wealthy individuals authorizing them to purchase land from the native Americans. These wealthy individuals, the so-called patroons, were obliged to establish and maintain working farmers on their lands. These were effectively business relationships; indeed, "patroon" apparently comes from the Dutch meaning 'head of a company.' Patroons, in turn, established contracts with would-be farmers whom they brought over from the 'old country.' They were responsible for providing these farmers with their land and means of farming and with establishing and maintaining the local judiciary. Tenants were governed by lease details and owed the patroon yearly rent, including labor, and a minimum fixed period of service. The fur trade dominated Dutch interests and relatively few patroonships were established; fewer still produced much agricultural profit. The subsequent British manorial system, modeled upon the by-then-abandoned English feudal manor system, had some similarities to the patroonships. However, the fur trade was waning, and, unlike the Dutch, the English were counting on an established population who, in good colonial fashion, could supply the Crown with raw materials. The majority of the Hudson Valley manors were created by the English after they gained control of New Netherlands in the late 1600s. Manors could, in some ways, be viewed as administrative colonization tools: the Lords were created as a landed aristocracy with political power but also civic responsibility for establishing social structures and maintaining order. As Ruth Piwonka put it, by supporting this local aristocracy, "the British authorities were spared expense and trouble in setting up new colonies—it was a good deal for them. And sort of hard work for both tenant and landlord."

From the late 17th century through the early 19th century, the majority of the land that is now Columbia County was, at least on some books, part of the Livingston Manor in the south and the Rensselaer Manor (or Rensselaerwyck) in the north. The original patroonship of the Rensselaers was respected (as a manor) by the British, when they finalized control of the Hudson Valley in 1674. Robert Livingston, an active colonial administrator and power broker under both the Dutch and British, was granted his manor in 1686. In practice, while the Livingston Manor was largely realized, the situation in the northern two thirds of the County was less clear. The Columbia County portion of Rensselaerwyck was separated from the main Manor in the early 1700s. Although sometimes called "The Lower Manor," the validity of this portion of the manor was hotly contested. Areas such as Kinderhook were quickly acquired by independent land owners, and squatters on and claimants to the remaining lands were numerous, fed in part by borderland disputes between Massachusetts and New York. In effect, therefore, the "Lower Manor" of Rensselaerwyck never really existed on the ground. In 1808, less than 20% of farmers were reported to be tenants in certain northern portions of the County, while 50% or more were tenants in some of the Livingston tracts. Furthermore, in the North, the Rensselaers were hardly the only landlords. Relatively small scale landlords, such as Alexander

Coventry, whom we will meet later, frequently had tenant farmers on their lands, although these landlords shared neither the powers nor the stated civic responsibilities of the manor lords.[11]

For the most part, it seems that both lord and tenant felt the relationship worked well enough until roughly the late 18th century. Certainly, there were disgruntled tenants before that, but many of the earlier disputes were apparently fueled less by tenant demands and more by non-tenants trying to gain rights to lands claimed by lords of the manor. Individual landlords were, depending upon personality and circumstance, more or less demanding of their tenants in terms of their diligence in rent collection, the duration of leases, and the terms governing lease transfers. While details varied, lord and tenant relationships seemed relatively harmonious for about a century.

Rent and tenancy appeared to come more explicitly to the fore around the turn of the 18th century, and this tension erupted into the Anti-Rent wars of the mid-19th century. The build-up of tensions may have come from various sources, not least from the whims of demanding landlords, who, perhaps,

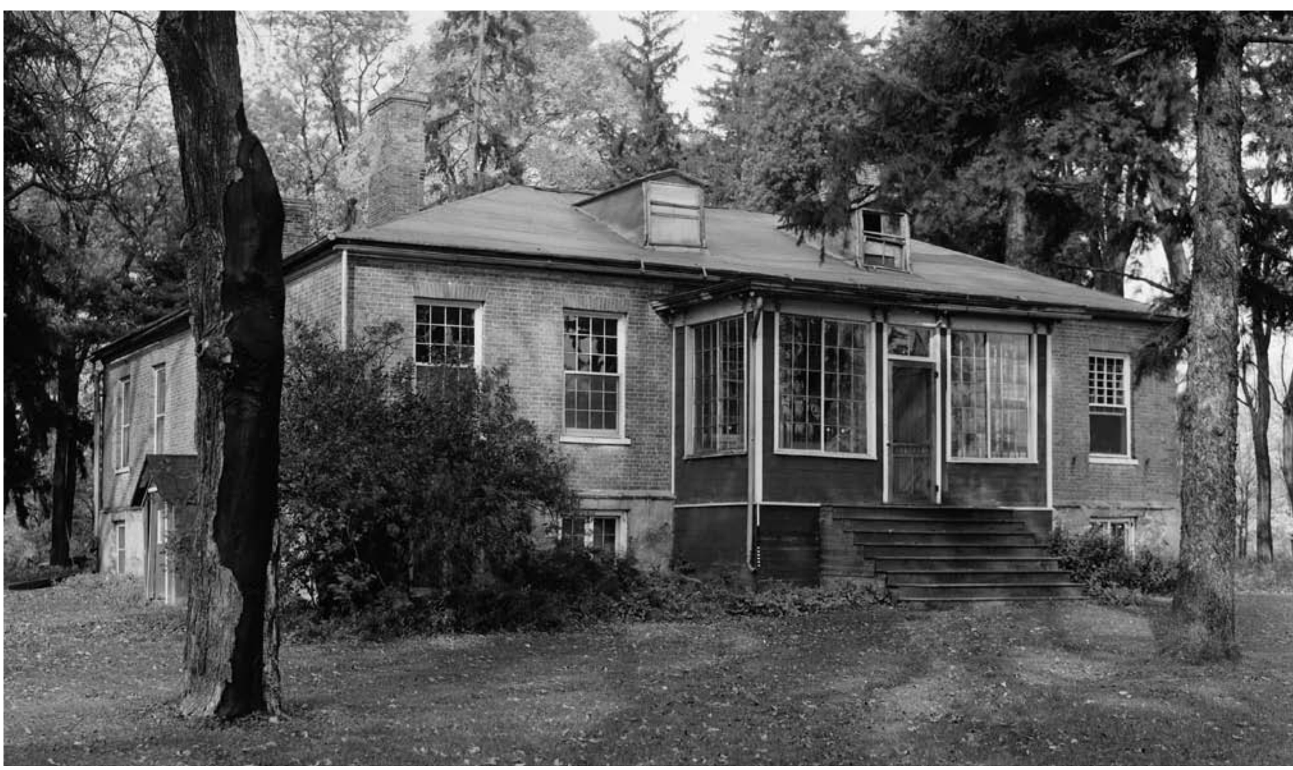


Figure 10. *The stunted house of Peter R. Livingston near Blue Stores. Reportedly something of a rake, Peter R. Livingston, the eldest surviving son of the last Lord of Livingston Manor, began construction of this house in anticipation of making it the manorial seat. The ground floor had been completed when work was halted by the Revolution. Construction never resumed. In 1790, his father passed him by and willed the majority of the manor lands to his four younger brothers. The manor lands were beginning to be dispersed, and most were sold off over the next decades.* 1937 image from NY-362 of the Historical American Building Survey (HABS).

were feeling particularly stretched as manorial lands were divvied up among heirs after the absolution of primogeniture in 1782. Tenants may also have looked at the opening of western lands and asked themselves ever more urgently why they were bound to a well-to-do landowner, rather than being freeholders themselves. The turmoil may have been enough to stunt the demographic growth of the County during this period.

The Livingston Manor began to be broken up in 1790 when the last lord of the manor distributed the property amongst five sons (see Fig. 10). They continued to supervise tenants on those lands, but parcels were progressively sold off, and the Manor slowly dissolved. The death of Stephen van Rensselaer III, then lord of Rensselaerwyck, in 1839 precipitated a tenant revolt as his heirs attempted to collect back rents. Civil disturbance led the governor of New York to declare, in 1845, that several counties, including Columbia, were 'in insurrection' and to send in the militia. The anti-rent cause became a focal point not only of state but also of national politics by the mid 1800s. However, the dance of popular and legal power between tenants and landlords continued with neither side clearly getting the upper hand. Rather than being completely anulled at any particular moment in time, the manor system seemed to fade away as a scattering of unfavorable laws and the dilution of manorial might through divided inheritance led many landlords to eventually sell their manor lands to private holders.[12]

Fueled in part by 20th century social debates, there has been discussion over whether or not the manor system in the Hudson Valley was in fact feudal. The discussion may revolve around one's definition of feudal as much as one's understanding of Hudson Valley land tenure. Certainly, the shape of Hudson Valley Manors was feudal in that a lord was given land and law-enforcing power by the Crown; the lord was allowed to establish the terms of tenant leases, including perpetual rent paid partially in terms of labor and little monetary recompense to tenants for their improvements. On the other hand, in practice, the proximity of open lands may have forced landlords into compromise. Unlike crowded Europe, most tenants could move on if they wanted to. (Although, if the patroon or lord had sponsored their trip across the Atlantic, they might be bound to work the land for a fixed period to repay the trip.) This did not insure what we might view as modern justice – landlord judicial power did not bode well for tenant rights – but the possibility for tenants to 'opt out' may have avoided some of the more egregious injustices we associate with serfdom in Europe. We will return to a consideration of the effect of the manor system on land use in Chapter 4 (pp. 182-183).

Agricultural History

Thus, despite the early Dutch disinterest in agriculture, they did establish farms. By 1680, there are records of wheat being sold down the Hudson from at least one Columbia County landing, heralding centuries of ag-economic relations with New York City. It seems likely that farms were scattered across the western portion of the County by the beginning of the 18th century and that much of the land within five to ten miles of the Hudson was substantially opened. The second half of the 18th century saw a huge demographic expansion as crowding in New England and the westward migration of hostilities with Native Americans unleashed a flood of Yankee settlers. Between 1750 and 1800, colonist population in the County is estimated to have increased about 12 fold or an average annual increase of nearly 650 people per year, the fastest recorded rate of human increase that the County has observed (see Fig. 11). An explosion of land clearing probably accompanied this population boom. We estimate that, by 1800, the majority of all farmland clearance that would occur prior to the present had already occurred. The peak of cleared land area was reached by 1835, although the maximum number of individual farms may have occurred around 1825 or earlier. Modern field shapes still partially reflect the Yankee and Dutch divisions of this time period: square, rigidly cardinal alignments in the eastern hill towns; more 'organic' field forms, mirroring stream courses, in the western Dutch-settled lands.[13]

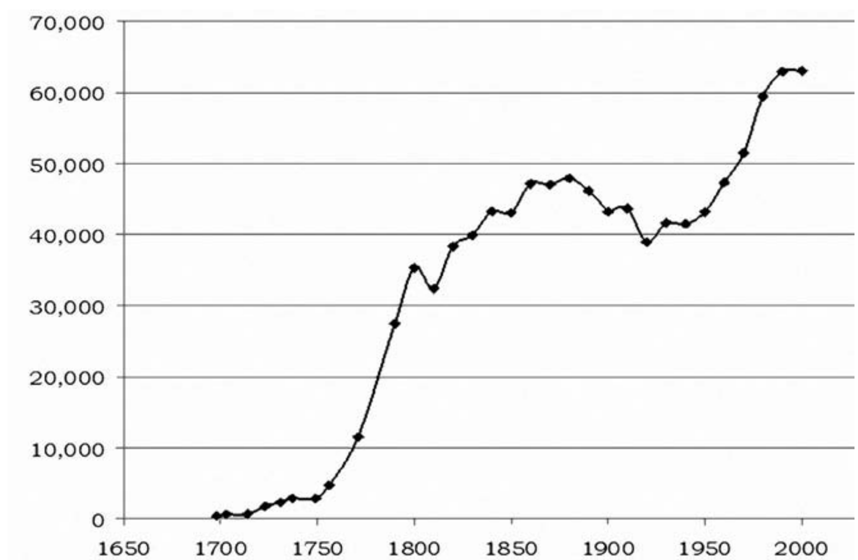


***Figure 11**. Population of Columbia County. Until 1786 the County was part of Albany County, and most early figures are area-based estimates derived from the records of the total Albany County population.*

Although there have been periods of stasis, the agricultural history of the past three centuries in Columbia County has been one of regular change (see Figs. 12 and 13). Early farms were relatively diversified because they provided most of the family's needs. Some early specialization is evident with the patterning determined partially by ethnic diversity and partially by landscape diversity. Wheat was an important early trade commodity and was demanded of manor tenants as rent; a 1769 account of travel up the Hudson is replete with mentions of wheat as both crop and currency. Residents of manors and those having access to points of commerce may have grown especially large amounts of this grain. By 1813, one gazetteer described the County's agriculture as "it now supplies a vast amount of surplus products, principally grain, beef, pork, and livestock, well adapted for West-India markets." Late 18th/early 19th century commerce between the West Indies and New York was brisk, and this market helped shape local agricultural production. As would later happen again, when New York City became a major hub of cotton commerce, New York was closely tied to the slave economy (see also Chapter 4, p. 175).[14]

By the early 1800s, wheat growing was waning for a variety of reasons including wheat pests and disease, exhausted soils, and increased competition facilitated by the Erie Canal and railroad expansion. Economically, wheat was replaced in part by the wool trade. The sheep increase was spurred by European disorder around the Napoleonic Wars and an import tariff on English wool. Robert Livingston was one local figure who, by importing Merino sheep and publishing a book on sheep raising, helped stimulate local interest. Some of our mills, which later produced cotton cloth,

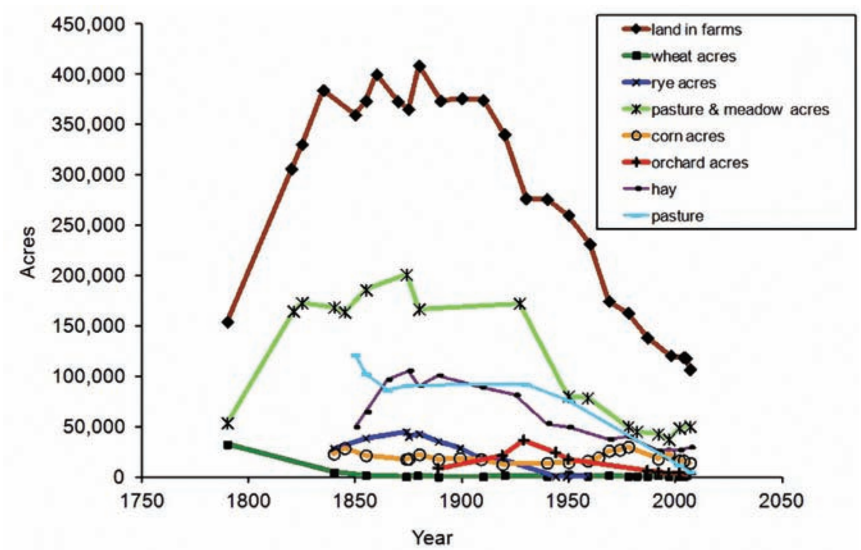


Figure 12. Acreage in select agricultural uses over time. There are approximately 412,000 acres in Columbia County. After peaking in the late 1800s, all agricultural land use has dwindled. While part of this land use decline does reflect an overall drop in farming activity, it also reflects changes in the land demands of agriculture.

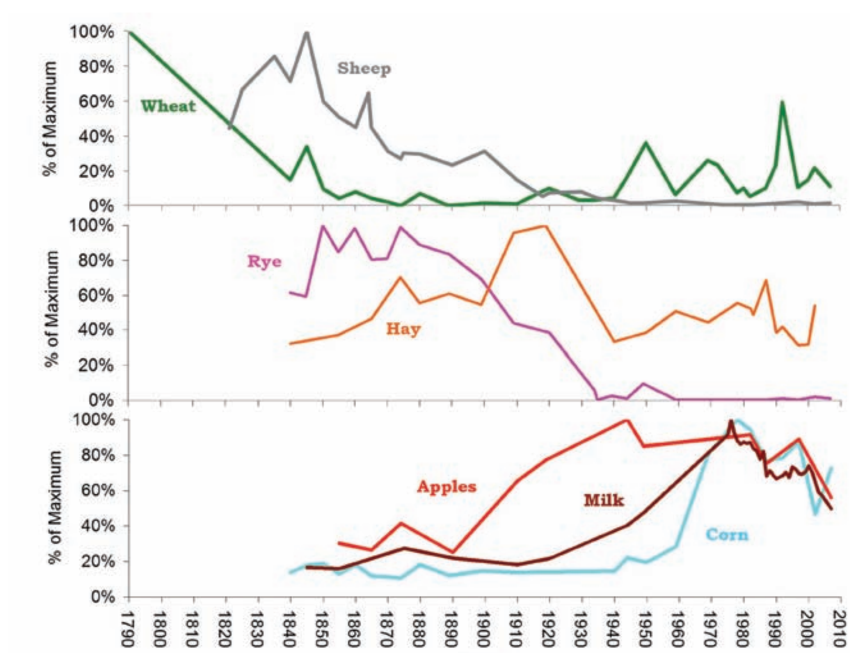


Figure 13. The course of select agricultural products in the County over time. Different waves of production defined the County's agricultural history during this period. The current decline of corn-based dairy and of orchards does not mean that agriculture itself is finished in the County.

Most data are from ag. censuses; 1790 wheat data from population and historical *per capita* consumption estimate; 1790 pasture and meadow data from estimate of number of cattle and stocking rate. It is likely an underestimate.

Figure 14. *Hillsdale in the late 19th century. The higher fields are probably pastures, perhaps originally opened to support sheep herds. Thin-soiled hill pastures were among the first fields to be abandoned. Charcoaling may also have contributed to the clearing of some slopes.*
Image courtesy of the Roeliff Jansen Community *Library.*

were initially established in order to process wool. By 1845, there were approximately 173,000 sheep in the County, or about four sheep for every human occupant. However, the boom collapsed as stability (and hence wool production) returned to Europe, as tariffs were removed, and as other regions of the Northeast developed strong sheep economies. There was a minor revival during the Civil War, apparently due to the need for woolen uniforms. The sheep boom helped shape the landscape, perhaps giving new purpose to thin-soiled hillsides or degraded lands which, nonetheless, could support extensively grazed sheep herds (see Fig. 14).[15]

The second quarter of the 19th century apparently saw the peak of County agriculture in terms of land opened for farming. (However, dramatic subsequent improvements in yield meant that peak production probably came later.) Farms continued to evolve from diversified subsistent ventures selling some surplus to businesses specializing in certain crops sold for cash. Rye growing, for stable straw and local paper production, gained in importance. In 1850, Columbia County led the State in rye production with a harvest of more than half a million bushels; its next closest competitor, Dutchess County, produced barely 60% as much. Hay production was also important; like the rye straw, much of it apparently went downriver to supply New York City horse power. Oats, although perhaps never an 'anchor crop,' were widely grown during the 19th century, and midway through that century the County ranked second in the State in terms of oat production. Much of this was probably destined for horse feed. In 1860, the County's agriculture was summarized as "Hay, (of which large quantities are pressed and sent to market), rye, oats, corn, potatoes, and buckwheat, are the staple productions." This was a bittersweet century agriculturally. Both the continuing westward migration of the 'Indian Frontier' and improved transport, first via canals and later via railroads, meant that local farmers suddenly had to compete with growers on the rich western New York grain lands and in the Midwest. At the same time, however, expanding and more rapid rail and road connections to New York and other cities facilitated agricultural markets for the County's fresh milk (spurring dairy farming in the southeastern part of the County) and fruits. By 1881, the County had one of the largest apple orchards in the country if not the world; and, by 1918, it exceeded all other New York counties in apple production.[16]

At the beginning of the 20th century, widespread abandonment of agricultural land was well underway (see Fig. 15). Not surprisingly, initial abandonment was most extensive on the higher, thinner soils of the hilly portion of the County. The reasons for this were probably diverse. Aside from the expanded transport networks, changes in agricultural markets and techniques meant that keeping marginal land in production was no longer as appealing. It became less costly to raise dairy cows on Midwestern grain, for example, than grow grain oneself (a situation which, as I write this, is now reversing). Late 19th century technological changes such as the advent of paper production from wood pulp and the rise of fossil fuels meant that some of the County's potential resources, such as rye straw and water power, lost relevance. Technologies developed around the Second World War spurred agricultural mechanization, prompting field enlargement, motorization, dairy farm consolidation, and increased reliance on pesticides and herbicides. Fruit and dairy remained the mainstay, albeit

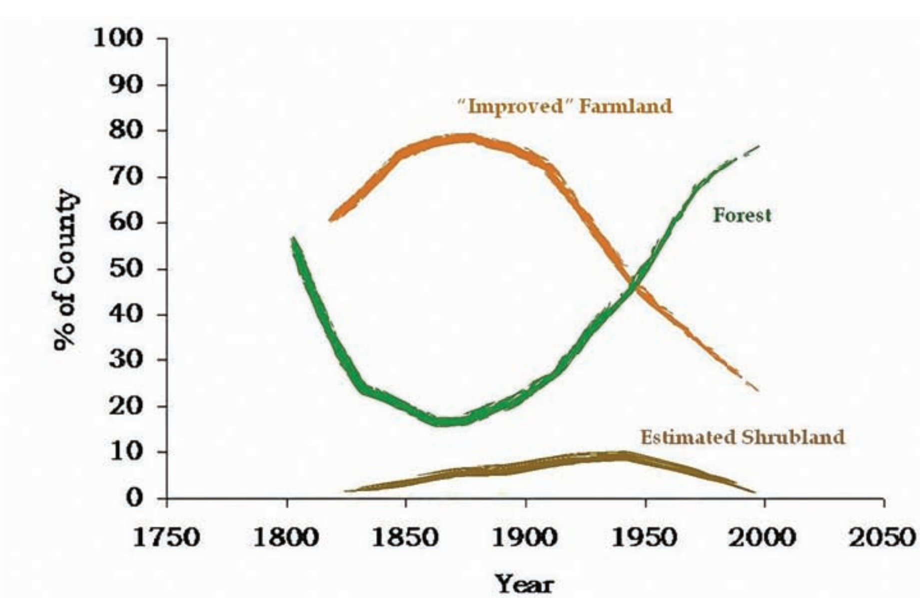


Figure 15. Trends in major cover types in the County, expressed as the percentage of the total County surface area covered by each. Notice the sharp decline in open farmland, the resurgence of forest, and the appearance of shrubland during that transition. Each of these cover types is associated with different kinds of wild plants and animals.

the shrinking mainstay, of Columbia County agriculture through the 20th century as refrigerated trucks and rail cars took away much of the advantage that the County had experienced in shipping dairy and fruits to New York City. Wars and recessions punctuated the general pattern.[17]

Industry

There has long been 'industry' in the County. Grist mills, saw mills, and blacksmiths arrived together with the earliest farmers. The County's first saw mill, for example, was reportedly established in 1665, and at least one grist mill was in place before the end of that century. The year 1743 saw the first iron forge in the County (and in New York). Shortly before the end of the 18th century, Chatham boasted 6 saw mills and 11 gristmills. In 1810, Columbia County led the State in pounds of wool carded and yards of wool fulled. In the same year, there were 34 tanneries, 8 distilleries, 2 paper mills, 1 ropewalk, and 1 gun powder mill (saw and grist mills weren't tallied). Yet, for the first two centuries after European settlement, these were probably accessories to a primarily agricultural way of life. However, during the 19th century, Columbia County's workforce went from being predominantly agricultural to one almost equally divided among farming, manufacturing and services/retail; a proportionality it held until after World War Two (see Fig. 16). During the second quarter of the 1800s, large paper and textile mills were established in towns such as Philmont, Chatham, Valatie and Stuyvesant Falls (see Fig. 17). Some of these larger mills employed more than 300 people, and by the end of the 1800s, employment in manufacturing exceeded that in agriculture (for more on mills, see Chapter 5, pp. 245-250).[18]

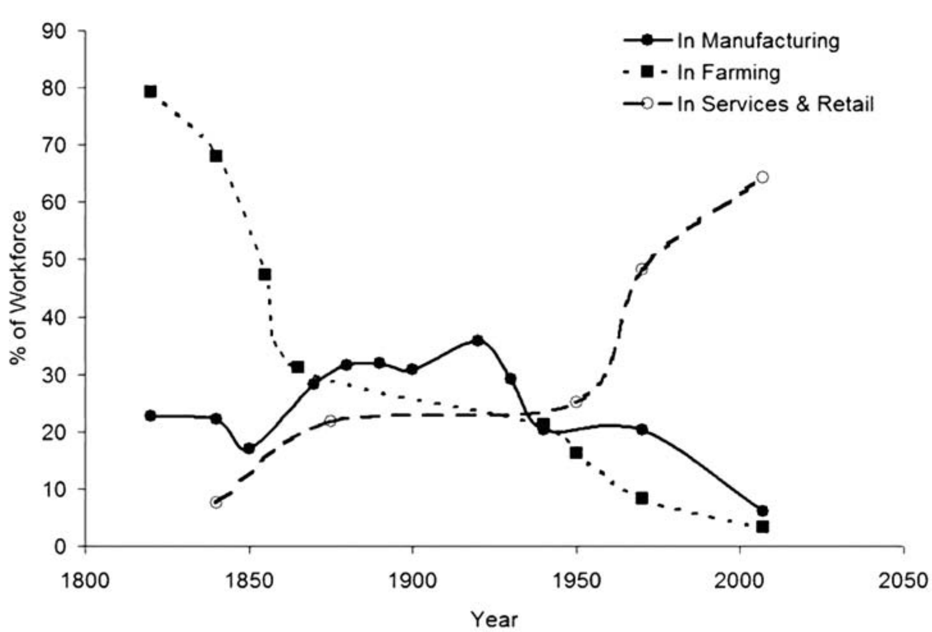


Figure 16. *The composition of the censused workforce in Columbia County. From a period of being mainly farmers, the County passed through a phase of more diversity in employment before arriving at its modern concentration on retail and services. These trends are approximate, and the definitions of 'workforce' and of each sector varied somewhat over time.*

Many of the County's larger industries disappeared during the Great Depression, and there is anecdotal evidence of a slight return to the farm during this period as city residents headed back to the country. Certain regional large industries did remain active well into the 20th century. Some of these, such as the GE plants in Rensselaer and Berkshire Counties, were located beyond our boundaries but employed County residents. In 1950, industries such as paper, cardboard, textile and clothing mills continued to operate in places like Philmont, Ancram, Chatham, Hudson, Valatie, Stottville, Stuyvesant Falls, and Chittenden Falls; Livingston retained a grist mill; New Lebanon still had a pharmaceutical company; Columbiaville had a furniture factory; and Hillsdale had a working foundry. By 2000, almost all these industries were gone.[19]

Where We Are Now

Today, the County workforce is primarily occupied in services such as healthcare, education, information technology, and landscaping, and in retail (including real estate), with few people working the land. The Capital District is an important source of government employment for area residents at least in the northwest portion of the County where the majority of residents work out-of-County (see Fig. 18a). Internet technology means that certain work can be done far from any formal office, facilitating at-home businesses and telecommuting. Servicing and retailing for second home owners is an important part of the economy. Most of the remaining farm activity, at least in terms of employment, seems to be concentrated in the southeast, southwest, and northcentral portions of the County. The future of farming is unclear. Certain types of agriculture are seeing a renaissance given the expanded interest in local foods and the proximity of city markets. Niche farms (such as those specializing in organic or grass-raised products) have increased, but conventional dairy continues its long decline.

As the new century begins, population in Columbia County is more or less level at slightly above 60,000 people, giving the County a density of less than half that of Rensselaer County to the north and less than a third that of Dutchess County to the south. This is, as shall be chronicled in Chapter 2, a largely reforested county (see Fig. 18d), with more than 60% of its surface area wooded, especially in the higher terrain. Ridge lines with a view are sought-after home sites and draw second-home owners and wealthier residents (see Figs. 18b,c). The recession of 2008 has dampened housing markets and housing construction, although the fear of fracking in the Catskills is pushing development eastward, and the housing market now (2014) might be rebounding. Transportation changes, such as the introduction of high speed rail along the Amtrak lines, are on the horizon and could produce dramatic demographic shifts as connections to larger cities become more rapid. Less tangible but not less important are human relations with the land. Figure 18 might be read to suggest that fewer people are in daily contact with the County's landscape and that the more forested parts of the County are the domain of second homes and the more wealthy and urban. That such people appreciate and care about nature is important and beneficial, but exclusivity in such enjoyment (for example, if only certain parts of society had convenient access to natural areas) would not bode well for many full-time residents nor for nature.

In the chapters that follow, we will delve into our landscape in more detail: where it is now, how it got there, and where it may go. Primarily, we will discuss ecology and land use: how native plants and animals have adapted to the terrain and human use of it. Yet, as we do so, please consider the people who have, over time, appreciated, used and enjoyed these natural resources and who do so today. Then ask yourself what that shifting constituency might mean for future nature conservation and land use in our County. It is not a question with an easy answer, but sociology more than ecology will likely determine the future lay of the land.

Figure 17. *Cottonmill constructed (1827) and subsequently expanded at Stuyvesant Falls. The Falls were used first as a source of mechanical water power and, since about 1900, hydroelectric power. The generators, upstream of the mill, were refurbished in 2012, and are currently producing power.*

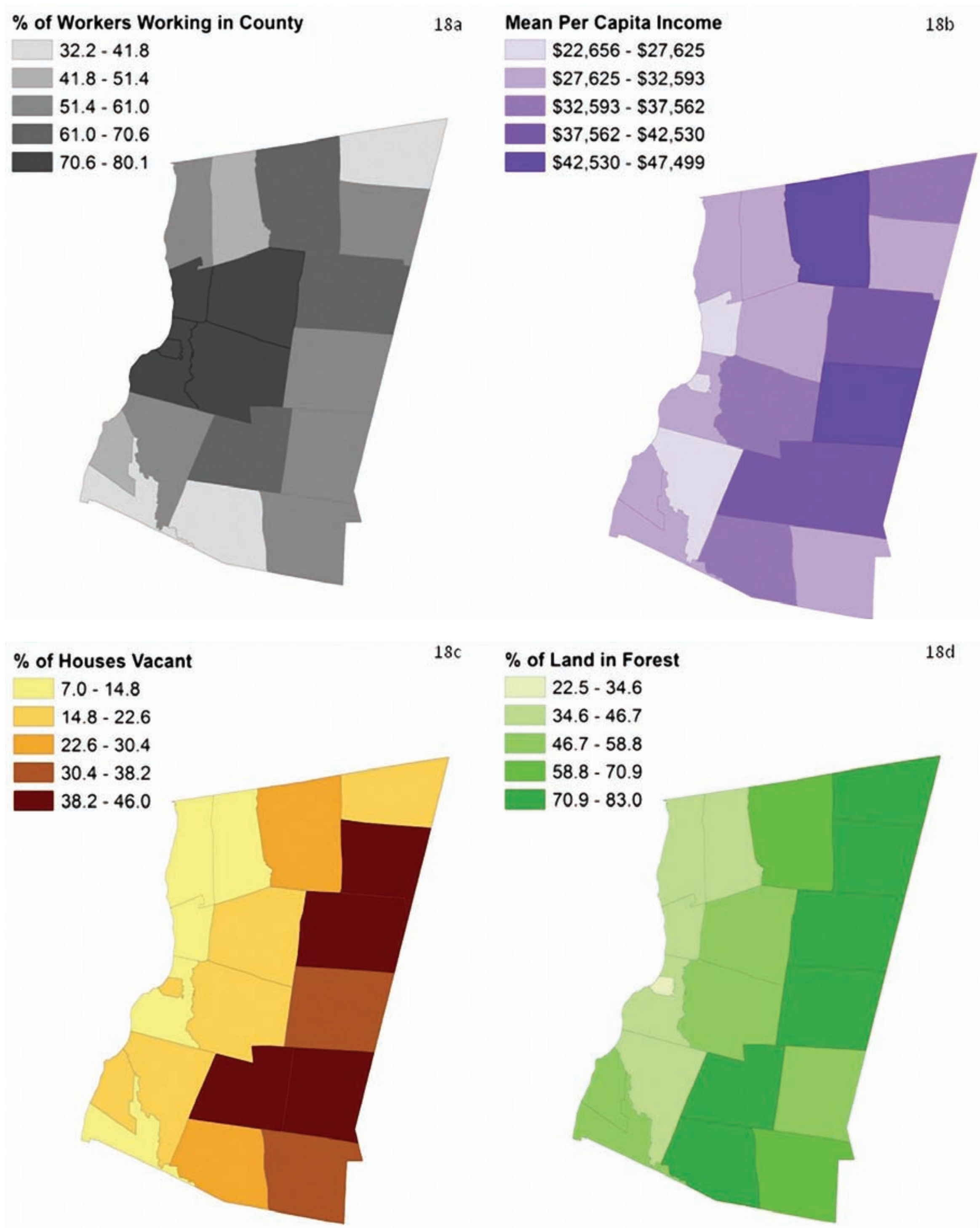


Figure 18a-d. *2010 social and housing characteristics (18a-c). 2002 remote sensing data on forest cover (18d, gathered by Amielle Dewan). Forest, wealth, and second homes are highest to the east; local (and less well-paying) employment dominates the west-central portion of the County.*

The Nature of the Place ~ Two

FORESTS: OUR HOMELAND

The woods are a good place to start our walk through the landscape. At present, forests probably cover about 60% of Columbia County, and trees may be one of the most familiar components of our natural surroundings. The stone walls that lace our forests testify that this was not always the case, but because forests have dominated our landscape for at least the past 12,000 years, many species in our current pool of native plants and animals depend upon forests for their survival.

The Effects of Glaciation

When glaciers retreated from the County around 15-18,000 years ago, they left a clean slate (or clean schist, or bare gravel). Slowly, successively, life re-invaded the land. This post-glacial ecological succession was somewhat slower than the modern succession we see occurring on farm fields, because it took a while for plants to actually arrive at a given spot after the glacier receded (imagine the difference in succession between two ploughed fields, one nestled in the middle of a forest, and another in the middle of a vast gravel beach). Using observations of the plants themselves and collections of fossilized pollen, researchers have been able to estimate when various trees returned to the Northeast after the last glaciation.

Plants varied in their speed of return. In part, the 'rate of return' was associated with seed dispersal strategies. The wind-blown seeds of pine, birch, ash, aspen or maple, for example, are likely faster travelers than the nuts of oaks, hickories or chestnut, although these latter species get a boost from animals including, it has been suggested, humans eager to have chestnuts or hickory nuts for the larder. (A recent example of human-assisted dispersal would be the Black Locust, a tree that settlers brought in from the Southern Appalachians because of its sturdy wood.) And yet tree species' colonization history is not as closely determined by its dispersal technique as one might expect (see Table 1). For example, acorn-bearing oak established itself here roughly 2,000 years before light-seeded maple. In part, these differences might reflect where a given species began its return trip from – was it poised just off the glacial periphery or had it been pushed 100s or 1,000s of miles further south? When a tree's seed did arrive, its survival was affected by the prevailing environmental conditions. For example, even if maples had have arrived here 12,000 years ago, the thin-soiled, post-glacial landscape probably wouldn't have welcomed them; Oaks may have been better able to establish themselves as part of a savannah on the edges of a glacially-induced prairie. Our forest composition is probably still rebounding from glaciation, although that recovery is being overshadowed by human forest alteration and climate change.[1]

To get a more detailed picture of what happened in our area, we can look at data from regional pollen maps (see Fig. 1). Some 10,000 years ago, our forests were mostly conifers such as fir, spruce and pine with birch and oak also present (along

Tree	Arrival in Our Area (Thousands of Years Ago)
Chestnut	2,000
Hickory	5,500
Beech	8,500
Maple	9,000
Oak	10,000
Elm	11,000
Hemlock	11,000
White Pine	12,000
Red/Jack Pine	12,000
Tamarack	12,000
Spruce	12,000
Fir	13,000

Table 1. *A table showing the approximate post-glacial arrival times of select trees to our region. The timing of a tree's return depends on various factors including how far it retreated from the ice front, its seeds' dispersal mechanisms, and its habitat requirements.* See note 1 for data sources.

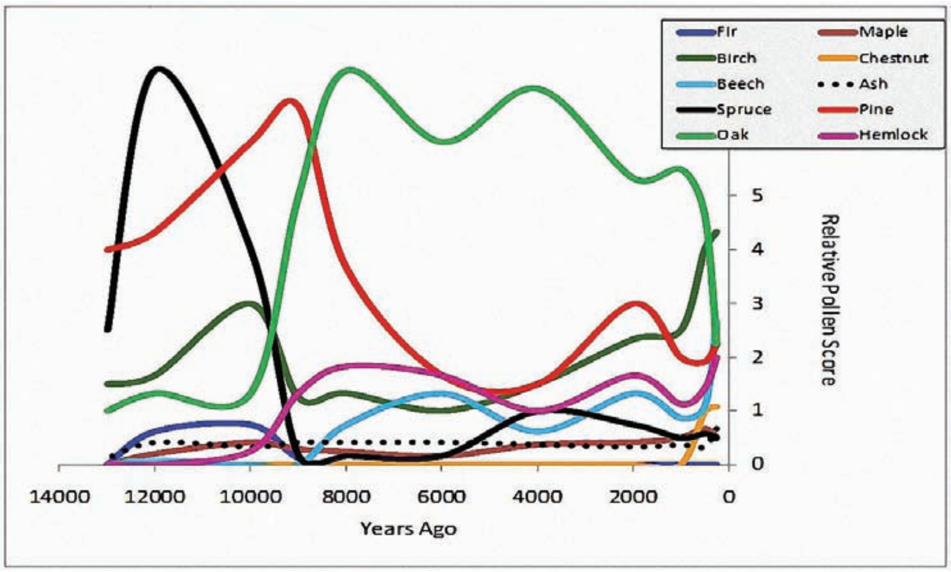


Figure 1. *A graphic summary of relative pollen densities as reflected in cores taken from the sediments of various waterbodies in our region. Note the transition from a spruce/birch/pine forest to one dominated, until recently, by oaks.*

Data summarized from information such as available on the Neotoma paleoecological database (http://www.neotomadb.org).

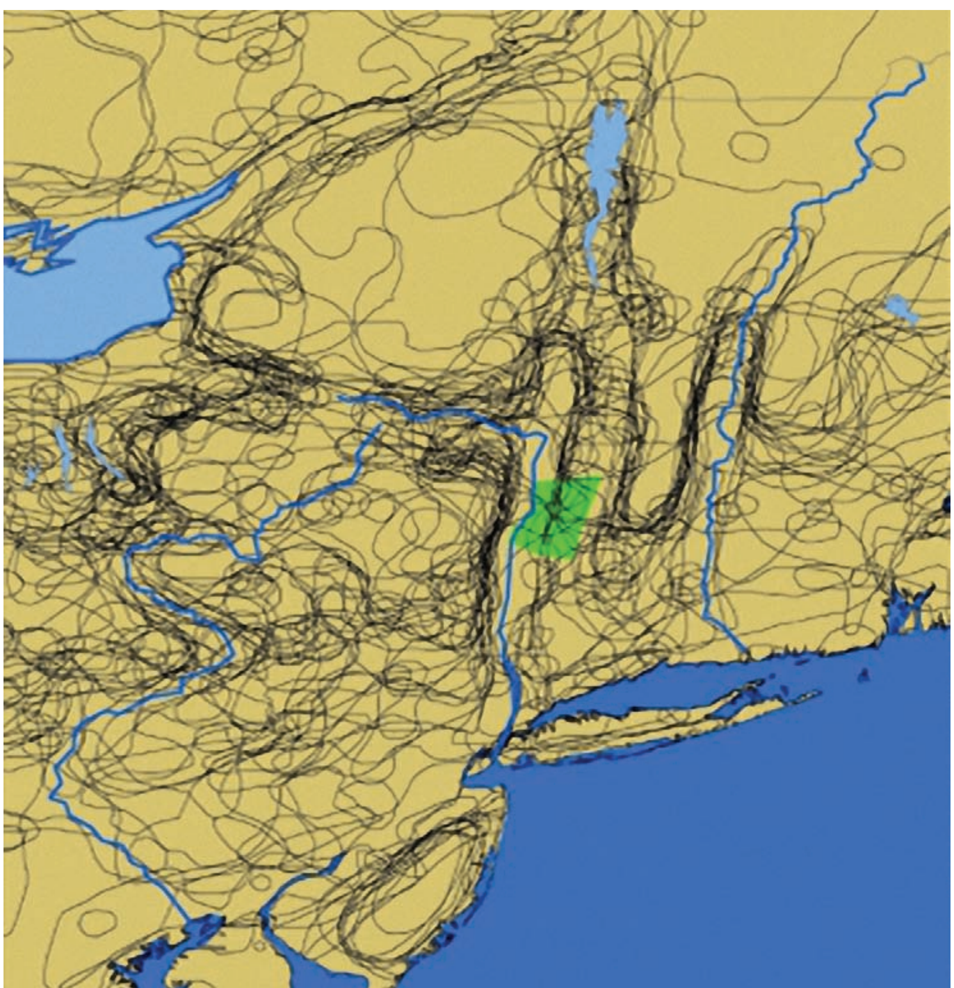


Figure 2. *The black 'strings' on this map are the distribution boundaries of the various tree species that occur in the area. One need not worry whether a given line is a north, south, east or west boundary: the point is that in some places, the boundaries of several species coincide, forming dark clusters of lines. The Hudson Valley, including Columbia County (in green), is one such area. This means that we tend to have both northern and southern tree species within our borders.*

Data from US Forest Service digitization of tree ranges (see note 3).

with several other species). By about 6,000 years ago, oaks and American Beech had become more common, although pines and Eastern Hemlock were still important. American Chestnut only appeared within the last 2,000 years, and now is largely gone again (although that recent change is not evident in the graph). More recent changes might largely reflect the widespread forest clearing, fire control and subsequent reforestation that marked the arrival of Europeans.[2]

Tension Zones and Biogeography

After the glaciers receded, these plants were not returning to a flat, uniform ploughed field. Despite the abrasive efforts of the glaciers, substantial topography remained, and surficial geology varied across the land. As a result, our forests became a patchwork with, for example, some more boreal trees persisting on colder, north-facing slopes at higher elevations and more southerly trees sneaking along lower, warmer valleys. As this description suggests, our County lies along the intersection of different types of forest. We are far enough north that some cold-loving plants can find nooks and crannies where they can survive, while we are far enough south that other warm-favoring species enter our area. Ecologists have called such zones of overlap "tension zones" alluding to the ecological tension between the various groups of plants.

The spaghetti bowl of lines shown in Fig. 2 is an attempt to illustrate the location of this tension zone in our region. To create this figure, we plotted the distributions of numerous woody plants. The lines indicate the approximate boundaries of the various distributions, be they northern, southern, eastern or western boundaries. Where lines tend to cluster, a zone of vegetation change (that is, a 'tension zone') is indicated. Notice how Columbia County lies in one such area where southerly trees that stretch up the Hudson River abut more northerly trees that creep down the Green Mountains and Taconics. The result for us is that we have relatively diverse forests, and botanical explorations around the County reveal pockets of more boreal and more austral forests.[3]

These were not uniform, slug-like mats of "northern" and "southern" forests that pushed and shoved at each other along the tension zone. Instead, the pattern was more like what one sees, at a smaller scale, when one views the distribution of trees on a forested hillside (patterns that are especially visible when autumn colors accentuate the differences): hemlocks, for example, may bunch together on the steeper slopes, but here and there a maple or hickory has found a foothold; and, amidst the maple/beech forest along the hill base, every so often a hemlock has been able to insert itself. There are few hard lines; instead there are tendencies. Fig. 3 shows the distribution pattern of some northern and southern species in the County. A good part of this irregularity is due to local differences in soil, moisture and sunlight. Part of the pattern's irregularity is also due to the pock-marking of natural disturbance. Such disturbances – caused by the likes of wind, fire, ice, and flood – result in scars in the forest, pockets of early succession and, overall, a variegated carpet. It is disturbance's constant re-setting of the clock that has led many forest ecologists to question whether any stable-state, "climax" forest ever exists.

Different forest researchers have classified forests in different ways. For example, one study of historical forest ecology in the Northeast characterized Columbia County Forests as "Central Hardwoods" (extreme southwest), "Transition Hardwoods" (most of the southwest half of the County), and "Northern Hardwoods" (throughout most of the northeast half of the County). Others describe the predominant forest as "Beech-Maple" or "Eastern Hardwoods." Whatever the names, the basic pattern is that of drier-forest trees such as oaks and hickories in the lower, southerly and westerly portions of the County, while trees typical of somewhat cooler and moister forests (e.g., American Beech, Eastern Hemlock and Sugar Maple) are more common in the higher, northerly and easterly portions. While White Pine is found throughout the County, it seems most common in the northeast, and may be joined by Red Spruce and Hobblebush. Tulip Tree, American Hackberry, and Flowering Dogwood are among the woody plants that creep in from the South and along the lower, warmer banks of the Hudson.[4]

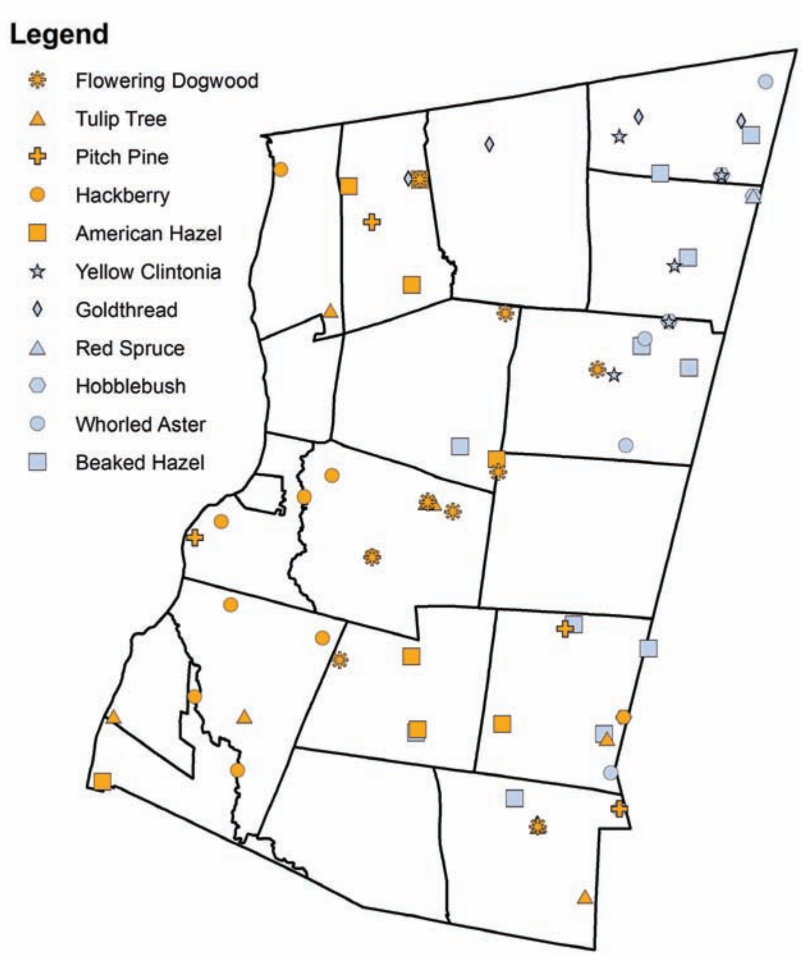


Figure 3. *The recorded distribution of select plants in Columbia County. Notice how plants partition themselves with some species occurring in the warmer southern and western portions of the County, and others confined more to the higher, colder eastern parts.* Data from McVaugh's flora of Columbia County and our own data.

Pre-European Settlement Forests

To the ever-present natural disturbances are added human impacts, impacts that probably began shortly after glaciation, hence blurring the distinction between natural and human-made. Our picture of the County's forests at the time of European arrival is clouded for a variety of reasons. Native Americans in our region left no written language, and the majority of their oral records have been lost. The descriptions written by the first colonists were often hobbled by a lack of biological knowledge and tainted by an urge to sell the new land to potential investors back in Europe. Furthermore, even if we can trust those early writings, what many of the explorers first saw was not representative of the landscape prior to European impact. As mentioned in the introduction, indigenous populations were probably decimated by disease before the physical arrival of most colonists. Thus, although the land of most colonial descriptions may have been widely dotted with the traces of former human habitation, given the contemporaneous low densities of Native Americans and the newcomers' unfamiliarity with the forests, those traces may not have been recognized as human evidence at all. Finally, more recent conceptions of these earliest forests were misled by 19th and 20th century observations of forest change. For example, the fields that Northeastern farmers abandoned during those later centuries were often invaded by White Pine, and, logically enough, some 19th and 20th century observers watched this happen, read early accounts of White Pine harvests, and drew the conclusion that, therefore, White Pine had dominated many of the early forests. We now believe that, while White Pine stands certainly did exist prior to colonization, in many parts of southern New England they were not extensive. Rather, White Pine is, given its growth habits and dispersal ability, an excellent colonizer of old fields. Eventually, succession usually weeds out most of it, because White Pine seedlings are not good at growing in the shade of deep forest. White Pine was definitely part of our early forests, but perhaps not as dominant as early speculation suggested.

Even at the local height of their population, there is debate over Native American influence on the forests. Most of this revolves around the extent to which indigenously managed fires were frequent and extensive and hence had major ecological effects. We may never know for sure how big an agent indigenous peoples were in the ecology of our forests in the period just preceding European contact. Evidence of burning comes from sediment cores ,which (see Fig. 4) show a peak of charcoal accumulation during a

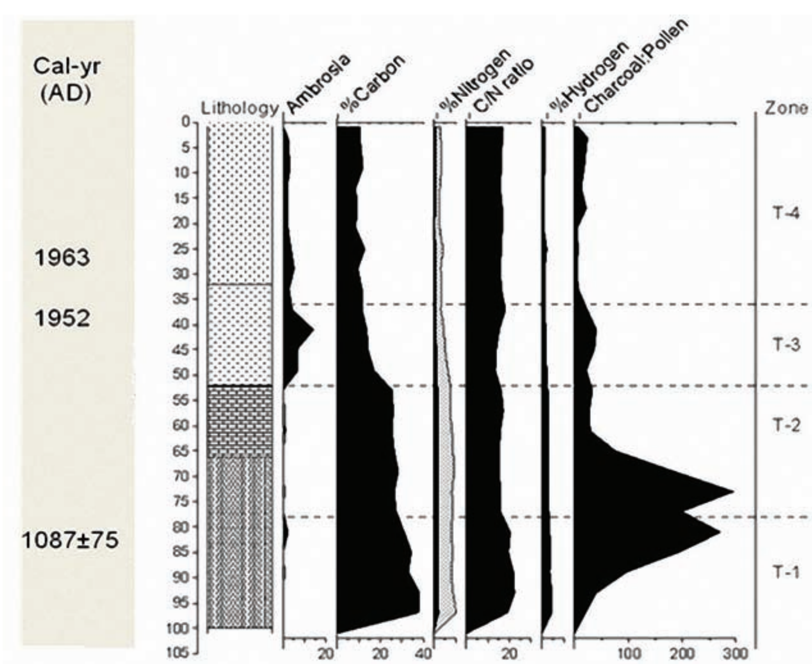


***Figure 4**. Sediment core data from Tivoli Bay, an east-bank Hudson site just south of Columbia County. The dramatic peak in charcoal (right side of image), centered roughly around the year 1000, has been associated with increased fires, due perhaps to a combination of climatic warming and drying and increased Native American burning.*

The diagram comes from the 2012 paper "A history of vegetation, sediment and nutrient dynamics at Tivoli North Bay, Hudson Estuary, New York" by Sanpisa Sriririt and collaborators in *Estuarine, Coastal and Shelf Science*, volume 102-103, pages 24-35.

period around 800-1300 AD. This is the period known as the Medieval Warm Period, and more detailed work from farther south on the Hudson indicates that climatic change during this period was associated with warming, droughts and increased fires. That burning continued at some level up through European settlement is attested to by the long-tail of carbon in the sediment records and by early accounts which specifically mention the burning of brush along the Hudson. Despite this evidence, uncertainty remains. To what degree do the carbon records show human influence, and to what degree were natural fires more common? Most likely, human fire use as a land management tool became more extensive under these warmer conditions, and natural fires were also more frequent.[5]

We also do not know where in the landscape fires actually occurred. The Tivoli Bay and Piermont Marsh sediments would suggest fires near the Hudson and, potentially, connected waterways. Adrian van der Donck, a 17th century, part-time agent for van Rensselaer and someone who probably regularly travelled the Hudson between its mouth and present-day Albany, presents one of the most vivid descriptions of early forest burning. After explaining why such fires were often lit, he continues,

> *Green trees are not at risk... the outer bark is charred … but it does not kill them. In very dense stands of pine trees that are old and resinous, it happens that the fire sweeps upward, because dying trees have fallen against and across each other or remained halfway standing and dried out. In those trees the fire settles and spreads upward along them, and when it reaches the gluey, resinous branches and knots, it begins to blaze fiercely and flies from tree to tree... Many trees are thus destroyed, but it never happens that all the bush burns down. …Such a fire is a spectacular sight when one sails on the rivers at night while the forest is ablaze on both banks. Fire and flames are seen everywhere and on all sides. Much of the blaze is driven on by the wind and follows what it feeds on, but in many spots dry wood and dead trees keep on burning; it is a delightful scene to look on from afar.*

Were such fires largely limited to areas near the Hudson shoreline (where conditions tended to be driest and indigenous use greatest)? Study of charcoal records and historical accounts for southern New England suggest that burning was most intense in coastal areas and tended to be rarer in moister upland forests.[6]

A reasonable guess is that, in Columbia County, the influence of fire declined with distance from the Hudson. We have almost no inland data for the County. Chelsea Teale's thesis on early wet meadow agriculture does include the analysis of a sediment core from the Vly in Kinderhook. She found that charcoal was rare in the sediments for at least several centuries preceding European arrival. It jumped substantially as colonists spread into the region. A similar pattern is surmised from the Highlands just to the south of us. The cooler, moister forests of the Taconics, probably used mainly as seasonal hunting grounds by native peoples, may not have experienced regular burning at all, although no doubt lightning caused occasional fires on drier hilltops. These fires were likely more frequent and extensive during warmer, drier periods. Approaching the Hudson, where the climate tended to be warmer and drier, the soils sandier and more droughty, and human habitation perhaps more dense, fires may have been more prevalent. Even then, the effects would have been complex. Aside from exceptional blazes in dense pines (likely Pitch Pines), the reports of van der Donck and other early observers usually suggest not raging crown fires but rather understory burning of shrubs and litter. Such fires, if systematically lit, would actually have reduced the chances of forest-destroying blazes by eliminating much of the on-the-ground tinder that could sustain a fire capable of spreading to the tree crowns. The greatest effect on the composition of mature forest trees would have come through fire's influence on regeneration: if the ground fires killed the saplings, then who replaced the mature trees once they died?[7]

Our Forests at the Time of Settlement

Whatever the factors that accounted for its composition, we can get a glimpse of forests at the time of settlement (but not necessarily at the time of first European impact) by looking at early deeds for land purchases. Early surveyors (see Fig. 5) often recorded property bounds by describing the trees

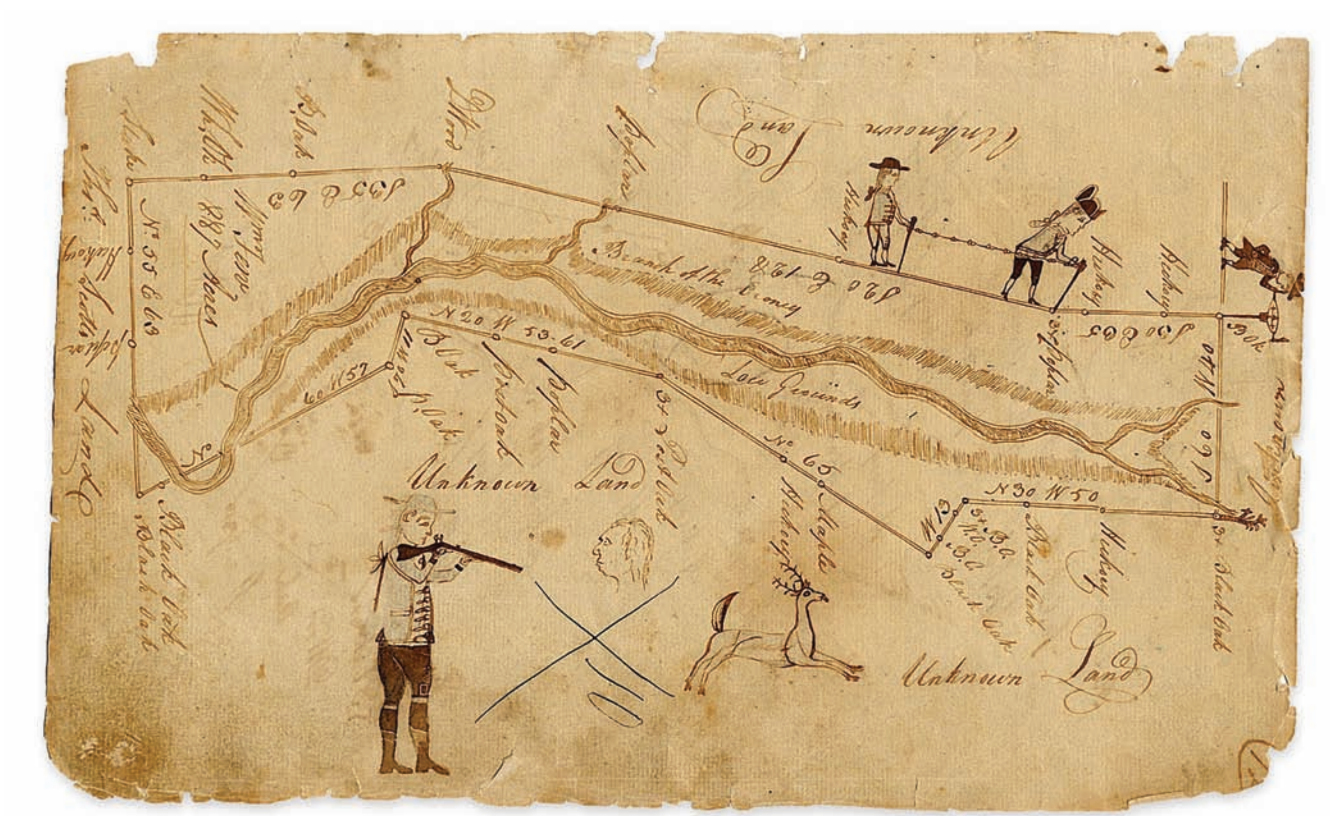


Figure 5. *A doodle-prone surveyor's notes indicating both how the surveying was done (with a measuring chain) and including his notes marking points with the names of trees. This plat is from Georgia, but similar methods were used in Columbia County and make early surveys a valuable source of information on historical vegetation.* Courtesy of the Georgia Archives, RG 3-3-26, ah00105.

they found along their survey lines. A corner point, for example, might be identified as “a large White Oak.” These accounts can be used as a form of tree survey, accepting that some trees may have been more conspicuous to or more easily recognized by the surveyors. Using such deeds, we have come up with a description of our County’s forests around the turn of the 18th century. While Europeans had had a pronounced influence on the landscape by that time, it is likely that surveys of new lands reporting on mature trees give us a glimpse of what forests may have looked like around the time of settlement, even if such forests were not as extensive by the time of the surveys and were experiencing substantial changes.

Our map in Fig. 6 shows the distribution of major forest trees in the County’s early woodlands, together with information from some neighboring areas. Oaks dominated in the southern and western portions of the County, and, in the hillier areas especially, American Chestnut joined the mix. Hickories were a secondary but relatively constant component as were maples. Pines appeared to be somewhat patchy. The northeast to southwest transition of the forest can be illustrated by a comparison of the data from Canaan and from Livingston: American Beech, maples and Eastern Hemlock add diversity to the Canaan forest and are typical of what foresters call a Beech-Maple Forest. They are largely absent from the southwest corner, where trees more typical of the southerly Oak-Hickory Forest predominate.

Although some of this geographic pattern persists today, modern forests are distinct from those of 200 years ago (see Tab. 2). This differentiation has occurred for a variety of reasons, which, given their on-going influence on current forests, are worth exploring in more detail.

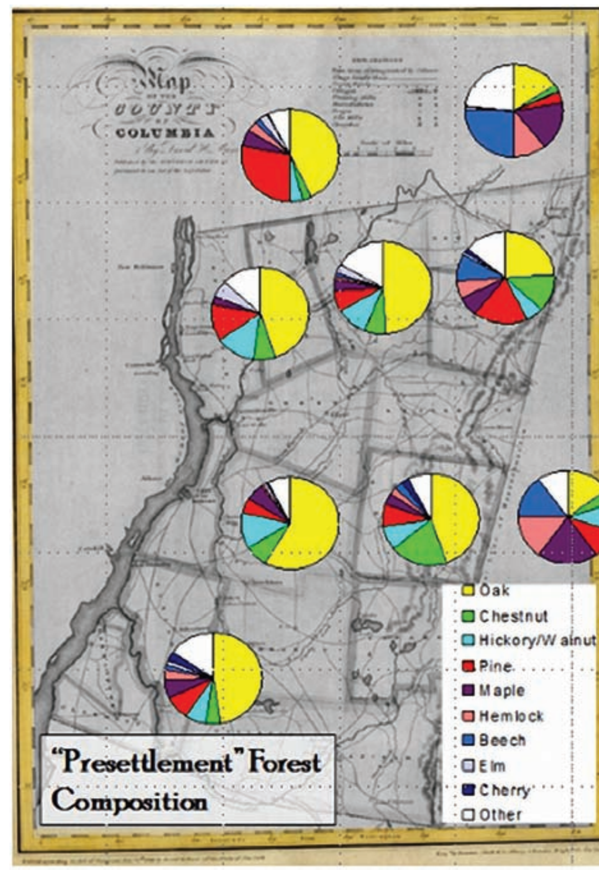


Figure 6. *Late 18th and early 19th century tree distributions in Columbia County. While extensive clearing had already happened by these times, surveyors usually noted down large trees as their markers, and surveys were most frequently done as new lands were being claimed. Data from outside of Columbia County, provided for context, comes from data summaries by Charlie Cogbill. Notice how forest composition varied across the landscape with, for example, oaks comprising almost ½ of the southwestern forests, but less than ¼ in the northeast.*

	Land Survey Data from the Late 18th and Early 19th Centuries							Recent Forest Inventory Data		
	Canaan	Chatham	Kinderhook	Hudson	Claverack	Hillsdale	Livingston	Forest Service Columbia County Data	Phudd Hill, Hillsdale	The "Kingdom", Canaan
>20%		White Oak	White Oak	White Oak	Red/Black Oak White Oak	White Oak	Red/Black Oak		Hemlock	Red/Black Oak Red Maple
10-20%	Chestnut	Red/Black Oak	Red/Black Oak Hickory	Red/Black Oak Walnut	Walnut	Chestnut Red/Black Oak	White Oak	Red Maple Sugar Maple Red/Black Oak	Sugar Maple	Sugar Maple
5-10%	Rock Oak (= Chestnut Oak) Red/Black Oak Pine Beech Oak Hemlock Sugar Maple	Hickory Chestnut Pine Oak Red Maple	Chestnut Pitch pine	White Pine Butternut Poplar	Maple Chestnut	Hickory Oak	Chestnut Walnut Pine Oak	Hemlock Ash White Pine Paper Birch	Red Maple Red/Black Oak Elm Ironwood Chestnut Oak	Ash
<5%	White Oak White Pine	White Pine Pitch pine Walnut Buttonwood (= Sycamore) Red Maple Ash	Pine Beech Elm Willow Sugar Maple	Hickory Cherry Ash Thorn bush (= Hawthorn)	Apple Pine White Pine Hickory Elm White Birch	Sugar Maple Pine Rock Oak Hemlock White Pine Beech Elm Cherry Birch	Hemlock Apple Sugar Maple Cherry Poplar (= Aspen) Red Maple	Red Pine Elm Black Cherry	Musclewood White Ash Basswood White Pine	White Pine Yellow Birch White Birch Beech Black Birch Ostrya Hemlock

Table 2. *A comparison of historical and current forests in Columbia County based upon our own data and Forest Service Forest Inventory Assessment information. The tabular data is summarized in the included graph; note the surge of maples and the drop in White Oak and American Chestnut. Direct human use of the tree, loss of habitat and imported tree diseases help account for these differences.*

Factors Affecting Forest Composition: Nature

Although natural disturbance has always been one of the factors that has influenced our forests, it can help explain the differences between historical and modern forests for two reasons. First, certain kinds of natural disturbance are very rare but very powerful; if one of these happens to occur during the period you are studying, then it can cause profound changes in the forest. For example, a once-every-500-years hurricane can have lasting impacts on a forest. Second, other kinds of disturbance, while more common and less dramatic, can, if their frequency or intensity changes, also have large effects. As we will discuss in more detail later, White-Tailed Deer, while long present in our forests, have rarely been so common, probably due to human alterations in the landscape's ecology; the effects of intensified deer browsing may be substantial.

Those hurricanes are a classical example of the first type of disturbance. As we have recently been reminded, severe hurricane damage in the Northeast is rare but not unheard of. The 1938 hurricane, which tore into the central coast of New England, left a band of forest destruction from eastern Connecticut and Rhode Island, through central Massachusetts, and into western New Hampshire (see Fig. 7); the eye apparently passed over the Berkshires. This hurricane destroyed much

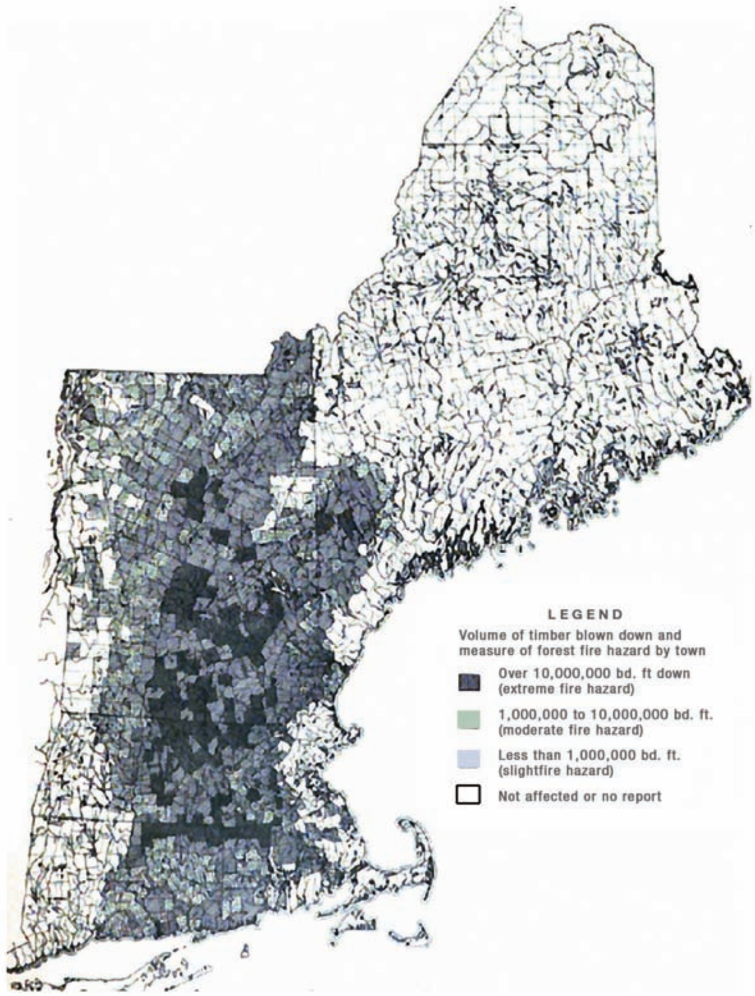


Figure 7. *Timber blowdown damage caused by the Hurricane of 1938; darker shading indicates greater damage. The damage was extensive but largely missed western Massachusetts (and, by extension, our area).*

This map is from the *Report of the U.S. Forest Service Programs Resulting from the New England Hurricane of September 21, 1938* (1944). Northeast Timber Salvage Administration.

timber, including the famed Pisgah old growth forest in New Hampshire. Damage in Columbia County was noteworthy (it included a burst dam in Philmont), but minor compared to some other areas. No other hurricane during the past two centuries seems to have struck the County's forests particularly forcefully, although the inland flooding associated with Irene and the shoreline flooding of Sandy had major impacts on the land and human welfare in nearby regions.

Natural disturbance also includes tornados, thunderstorms, ice storms, droughts, floods, fires, tree pests, and hard freezes. While these happen with some regularity, a string of such events, such as several years of drought, can have major impacts. Climatic information for the past 200 years is spotty, but certain events seem to be evident. The first half of the 20th century, for example, witnessed a period of reduced precipitation. Between 1900 and 1943, in Albany only 4 years (or around 9%) had more than 40" of rain. By contrast, annual rainfall exceeded 40" in 20 years between 1970 and 2013 (or 45% of the time). Such changes, which may have a human as well as a natural component, can alter the delicate competitive balance between different plant species. Likewise, in Hudson, during the 1820s, the first frost of the season often came a full month before the date when it has occurred during the past two decades (that is, mid-late September rather than mid-late October). Although data are sparse, we seem to be experiencing a relative surge of ice storms and, as the December 2008 ice storm demonstrated, these can certainly 'prune' the forest. The long-term effect of these climatic variations on forest composition is unclear but not necessarily unappreciable. For instance, flooding from rain, snowmelt, or beaver activity has probably long been a prime determinant of forest composition in low-lying areas. Our studies of County floodplain forests suggest that, for example, frequently and deeply flooded floodplains tend to support Eastern Sycamore and Eastern Cottonwood on exposed banks and Silver Maple in quieter backwaters; less dramatically and/or frequently inundated floodplains tend to be rich in Sugar Maple. As we discuss below, human-induced climate change may be further shaping our forests.[8]

Tree diseases are usually associated with human intervention, which exposes susceptible species to novel diseases imported from elsewhere (see below). Nonetheless, such disease outbreaks are not entirely a new thing. In North America, pollen records indicate a widespread, rapid and dramatic decline in Eastern Hemlock about 4,000 years ago; a ravaging disease has been suggested as the cause. In Europe, a generalized decline in elms occurred some 500 years ago and may have likewise reflected a disease outbreak.

In sum, forests are not naturally immutable. They change over different scales of time and space, from the short-term, often very localized disturbances caused by tree falls, lightning strikes and the like to the slower but more widespread responses to climatic and ecological changes. Humans, as we shall discuss below, are having dramatic impacts, but these are superimposed atop inherent changes.

Factors Affecting Forest Composition: Recent Human Land Use

Humans have directly influenced the forest in a variety of ways. Woods have been both a resource and an impediment. Trees were directly used for heating, building and manufacturing, but also had to be removed to make way for agriculture and settlement.

Agricultural Clearing. By 1700, European clearing in the County would no doubt have been visible during a hypothetical fly-over. However, it may have only become extensive in the second half of the 1700s. Actual statistics on cleared land (registered as "improved farmland" in the census) are not available before 1820. However, following the methods of one early observer of the New York landscape, James Macauley, we can estimate that there was an average of about seven acres of improved farmland per capita. On this basis, and using population estimates, we can extrapolate the extent of land clearing back into the 18th century, realizing that changing forms of land use will somewhat skew our results (see Fig. 8). These estimates suggest that the majority of forest clearing had occurred by 1800 and the peak extent of open farmland was reached prior to 1850.[9]

Farming, and hence the forest clearing that preceded it, was not randomly distributed on the landscape. Early farmers first sought out the best soils. Not surprisingly, this resulted in their having a particular impact on the forests of such soils. Indeed, early farmers used trees as indicators of soil quality; one reporter summarized, "In America they judge of the value of land, 1st from the species, 2nd from the size of the trees which grow upon it. Large oaks are always preferred, because the oak

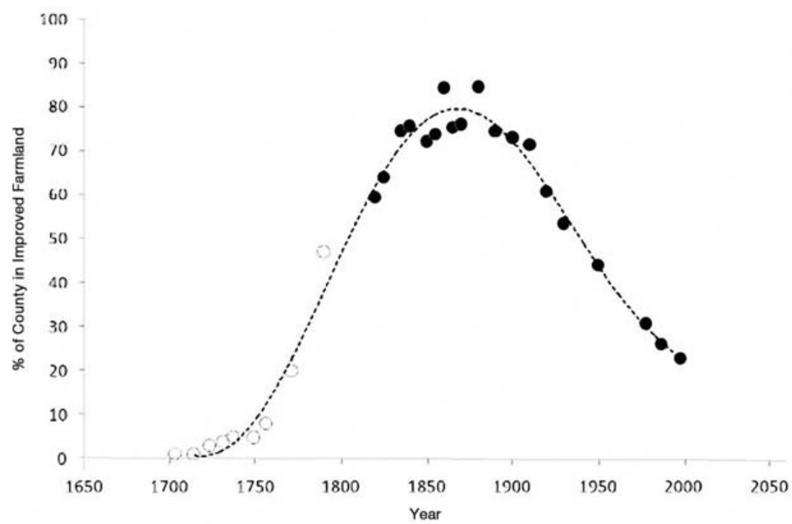


Figure 8. *Estimated (open circles) or reported (black circles) area in improved farmland in Columbia County, expressed as a percent of the County's total land cover. The period between 1750 and the early decades of the 19th century saw the most rapid rates of deforestation. After 1900, improved farmland area declined sharply. Area in forest would be roughly the inverse of this graph. Based upon US and State censuses and assessments of population, farmland and forest area.*

never attains an immense size, except upon a strong and deep soil." Of course, there were surely numerous exceptions to such a rule (for example, what did farmers in the oak-poor northern lands do?). In our County, the rule may have held to a certain degree. It seems that some of the best farmland was (and is) on the relatively flat swath of land that occurs between about 2 and 8 miles inland from the Hudson, and these soils may have been especially suited for White Oak, a tree that is less common in the hillier eastern forests (see Fig. 9). As a result, agricultural clearing may have especially hit White Oak, a 'happy' coincidence since this timber was also prized for various types of construction.[10]

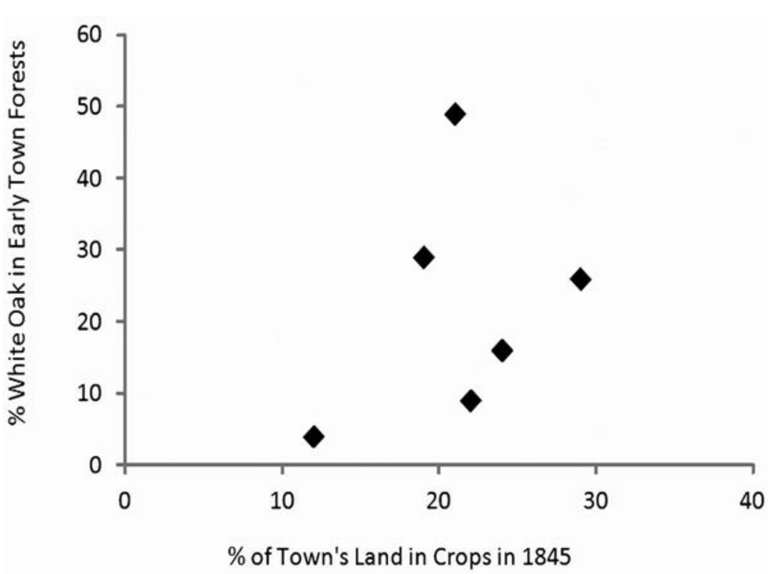
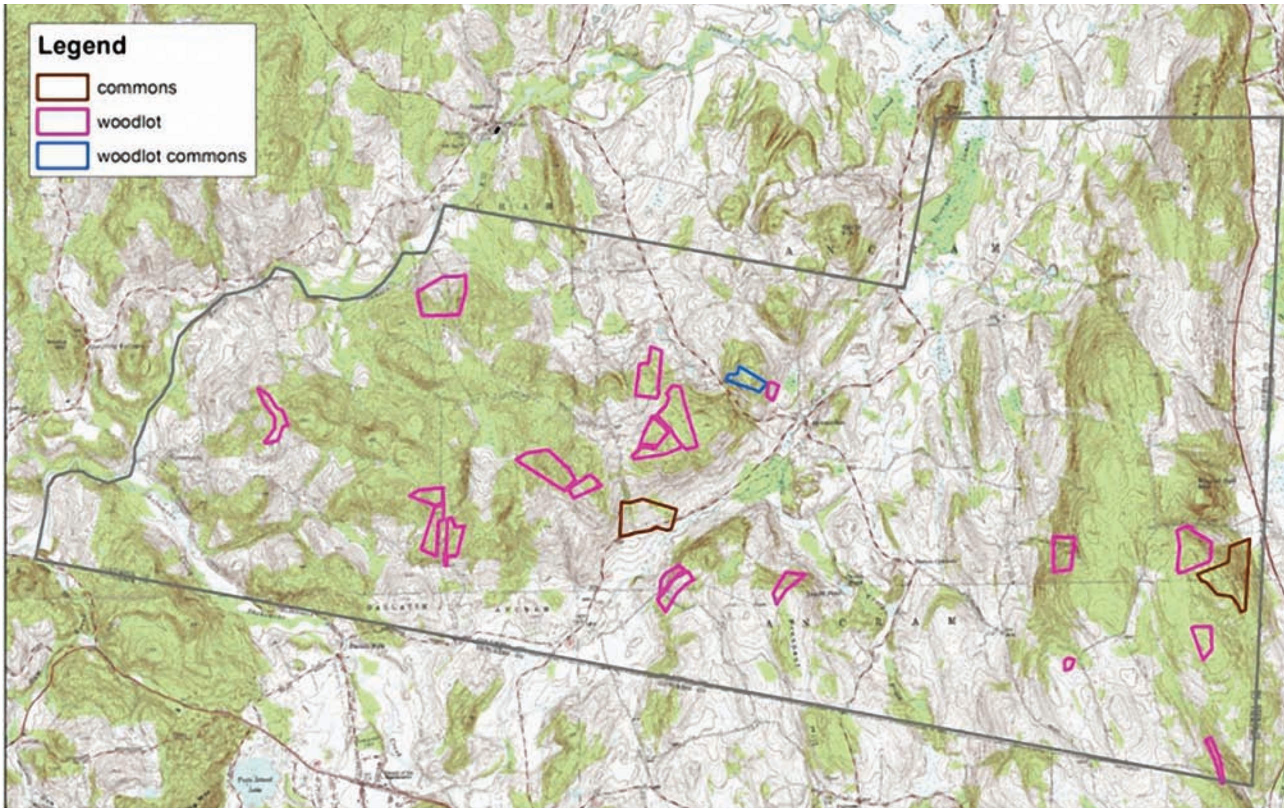


Figure 9. *The percent of White Oaks in the early forest and amount of the town in crops in 1845 (the earliest date for which we have records) for six Columbia County townships. White Oak tended to be most common in those towns which eventually opened up extensive cropland. This may partially explain White Oak's relative modern rarity in the landscape: its favored habitat overlapped extensively with prime farmland. One still regularly finds White Oaks, but evidently not as frequently as a few centuries ago. "Early" forest records come from the late 1700s and earliest 1800s and may often be for land that had not yet been fully cleared.*

The opening of forest coincided with a demand for forest resources – wood to build and heat with; charcoal for foundries; fuel for early steam engines; potash for soap, glass-making, gunpowder, bleaching, and other uses; hemlocks and oaks for tanning. It has sometimes been said that for many farmers land clearing was the most profitable stage of their agriculture. Potash (largely potassium carbonate) was a particularly important product in some parts of the state, because it was easy for the farmer to produce and had a range of uses and hence good markets. It was reportedly made by collecting ashes, leaching them, and then boiling down the leachate. The impure material that was thus produced was usually sold by the farmer to an "ashery," which further purified the potash into pearlash for industrial use. As a frontier activity, it was probably largely a by-gone by the time that formal censuses began – the only reference I found to potash in Alexander Coventry's late 18th century Stockport diary was an observation made during his travels in western New York, the location of the contemporary frontier. Census of these asheries provides one indicator of local potash production. There were five reported from Columbia County in 1825 (four in Hudson and one in Ghent; in 1835, one was still reportedly active in Hudson). They may have well been more common during the land-clearing boom of 1750-1800. Although an 18th century description of settlement in New York suggests that, at least within easy access of the Hudson, timber was the most valuable forest product, New York export statistics in the same book value potash exports at half those of timber, so it was evidently a major product.[11]

Fuel and Cooking Wood. It has been estimated that, at least through the first third of the 19th century, Northeastern homes burnt about 10-60 cords of wood per year (changes in stove and fireplace design apparently improved heating efficiency somewhat during the colonial and early federal period); something that would roughly translate into a sustainable harvest from as many acres or the clear cutting of a single acre or two of established forest. Similarly, Samuel Deane in his *New England Farmer* stated that on good soil 10-12 acres of forest (harvested so as to "keep the stock of forest undiminished") were needed to maintain one constant kitchen fire, but that that rose to 20 or more acres on poorer soils. Fuelwood's demands on the forest were probably most intense during the late 18th and early 19th century, when clearing for agriculture (with its concomitant 'incidental' production of fuelwood) was slowing, coal had yet to be widely utilized, and human population in the County was rising to novel levels. In his diary from the late 1700s, Alexander Coventry repeatedly mentions sending cordwood to Hudson. We do not have any data on the degree to which local forest clearing was occurring expressly for fuelwood or on how woodlots were managed.[12]

For some parts of the County, we do have a tantalizing map (see Fig. 10) that may help us at least understand the location of woodlots. Showing a portion of the Livingston manor, the 1844 map indicates designated, tenant-specific woodlots and at least one "common" woodlot, suggesting that here, as elsewhere, the need for conscious management of wood resources was evident by that time. Not surprisingly, many of these woodlots appear to have been on the hillier ground. One other source of



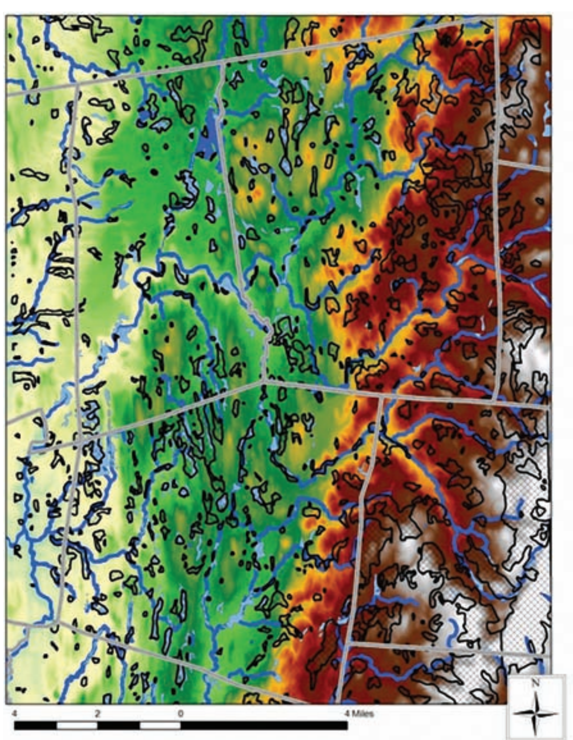


Figure 10 (above). *The location of woodlots and commons in southeastern Columbia County based on an 1844 map in the Columbia County Clerk's Office. The woodlots and commons were aligned to the present landscape based upon topographical features evident in the historical map and the shape of current property lines. While the lot locations may not be precise, I believe, because of concordance with modern property lines, that they are generally accurate. The thickest grey line indicates the extent of the historical map.*

Figure 11 (left). *A map of forest extent (black-line-enclosed cross hatching) in the north central portion of the County according to the 1933 topo map of the Kinderhook sheet. This is our best representation of forest extent at the time of maximum clearing (which probably occurred some 50 years earlier). The yellow to white gradient of color denotes altitude. Forests persisted around wetlands and on higher, thinner-soiled hills.*

information on early forest distribution is a 1933 topo map of the central portion of the County with woodland shading (see Fig. 11). It was apparently based on aerials taken in 1929 and 1930, some 12-20 years before the earliest aerial images we currently have access to. While some of the woods on that map may be re-growth and not all forests were woodlots, it seems likely that historical woodlots may be included in the forested regions of that period. Again, forests tend to be confined to steeper slopes (see Fig. 12) although, in this case, this includes not only hills but the ravines that cut down towards the Hudson.

Figure 12. *Bird's eye views of Chatham (top) and Philmont (bottom) from 1886 and 1881, respectively. As these images and Fig. 11 suggest, most remaining forest was probably on higher slopes and along drainages.* Images from the Library of Congress.

Home Building. Houses, barns and other structures were made primarily from wood; brick and stone are relatively rare, although not unheard of, construction materials in the County. Some of the most detailed information we have about home construction comes again from Alexander Coventry's diary; pines, especially Pitch Pine, seemed to have been a favored timber. He reports getting Pitch Pine boards from a Kinderhook merchant, somebody who was probably harvesting the Pine Woods on the sandy soils north of Kinderhook (woods that Coventry mentions riding through in the 1790s but describes as cut down upon his return in 1828; see page 71). In general, oaks, especially White Oak, and pines, particularly Pitch Pine, seem to have been favored construction materials both locally and regionally, and the abundance of both these species may have been affected.[13]

Industry: Charcoal and Tannins. Charcoal, which because of its porosity and high heat density is capable of producing a hotter, more sustained flame than unprocessed wood, was an important fuel in early iron foundries. We have at least sketchy records of iron production at Copake and Chatham (our two major furnaces at the end of the 19th century). From these, we can guestimate that, together, these two facilities produced about 200,000 tons of iron during the last half of the 19th century. If we assume that each ton of iron produced required around 130 bushels of charcoal and that one acre of woods could produce about 1,200 bushels of charcoal, then about 22,000 acres of forest was needed to provide this charcoal. Given that these were not the only foundries in the County, that foundries were active well before 1850, and that early foundries were substantially less efficient (one source, for example, suggests that early furnaces used 400 bushels of charcoal/ton of iron), we estimate that total acres cut for charcoal to supply County furnaces may have been in the range of 25-30,000 acres or roughly the size of the town of Copake. Of course, not all charcoal came from Copake or even Columbia County. The Chatham furnace reportedly used Vermont and Pennsylvania charcoal, and probably also Rensselaer County production; the Copake furnaces used charcoal from Mount Washington, Massachusetts and also from Vermont. However, ecological forest impacts were likely substantial. Stotts suggests that hillside clearing for charcoal was so extensive in Austerlitz that mill stream flow was affected, although his primary sources don't specify the cause of the clearing. Compared with the abundance of accounts from Rensselaer, Dutchess and Berkshire Counties, information on Columbia County is scarce.[14]

Aside from these estimations of extent and potential impacts, I have found it difficult to picture what this meant for the landscape. Were vast areas clear cut? Was the logging more selective – only hardwoods, only certain hardwoods (one account suggests that elms were sought; another that oak and hickory were preferred)? Was this usually the work of scattered farmers trying to make a buck in winter or was there a larger business and a more widespread impact? Information from neighboring areas of northwest Connecticut and Rensselaer County suggest extensive clear cuts, some of which were managed under a coppicing system in which colliers returned to cut regrowth every 25 years or so. One Salisbury account describes how such a system favored stump-sprouting trees such as American Chestnut. Beeches and maples can also be good stump sprouters. Although hardwoods were generally favored regionally, an 1885 report states that fully 1/3rd of the charcoal used at the Copake Iron Works was softwood. W.A. Miles, owner of the Iron Works, reported that 20% of their cut land had grown up in maples. The Chatham Furnace Company, the only other Columbia County operation mentioned, burnt charcoal derived primarily from "beech, birch and maple." A 1913 Flora of Copake Falls says that when the iron mines were in operation the "neighboring hills were practically denuded of their timber" yet ascribes this not to charcoaling but rather to the cutting of timber for rafters in the mines.[15]

Leather tanning used tannins extracted from the bark of Eastern Hemlocks, American Chestnut and various oaks, and this probably resulted in additional tree harvesting. The impact of this use on our forests is difficult to estimate. However, some more back-of-the-envelope estimates (an average of 23 tanneries, each consuming an average of 49 cords of hemlock bark per year, with 10 cords of bark produced per acre of hemlock) would put total hemlock acreage harvested for tanning during the first half of the 19th century at around 5,600 acres. This is an oversimplification (for example, the 1865 census reports some Columbia County tanneries also used oak bark), but it gives an idea of the scope. Tanning probably had at least a localized impact (for example, around the Shakers' large New Lebanon tannery), although it probably never reached the levels reported for Greene County.[16]

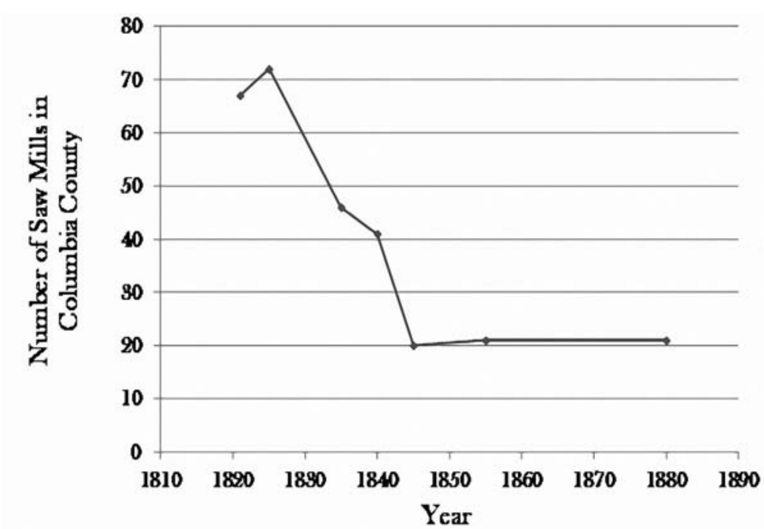


Figure 13. *The number of reported saw mills in Columbia County during the 19th century. The steep decline probably marks the end of the forest-clearing rush that accompanied the opening of agricultural lands.* Data from state and national censuses.

Railroads, which expanded through the County beginning in the early 1830s, burnt wood until about the 1860s or '70s and, during their expansion, resulted in a high demand for wooden ties. A 1901 broadside, reprinted in Stotts' book, proclaims the Chatham and Lebanon Valley Railroad's desire for ties of "Oak, Chestnut and Hemlock."[17]

As Fig. 13 suggests, extensive forest clearing for agriculture and forest industries had probably run its course by the middle of the 19th century. Selective forest clearing has continued since then but on a much more limited scale.

Not only were certain trees harvested, but the propagation of others may have been favored by human use. Sugar Maple, for example, was probably at least as appreciated for its sap as its wood and was spared or even, at least in parts of New England, planted. Chestnut and certain hickories may have been prized and preserved for their nuts. Black Locust and Black Walnut (trees native further south) were widely planted for use in fence posts and for their fine wood and nuts, respectively.

The 19th century saw the final demise of most of our primary forests. Not every tree was cut, but it is probable that few woods escaped major impacts. We have almost no pre-20th century maps of forests, although we do have landscape drawings which illustrate forest location on the landscape. One of our earliest detailed maps of forest extent (Fig. 11) is from around 1930; while some forest had returned by that time, that map is a useful approximation of minimum forest extent. Combining those data sources, it is evident that remaining forest was found primarily around wetlands, on steep slopes and on higher, thinner-soiled patches. Even on these lands, forests were probably substantially reduced – we estimate that only about 13% of the County's presettlement floodplain forests have persisted to the present day.

As the next section outlines, that was not the end of our forests – in fact, the County has since seen substantial reforestation – but, by and large, the forest that arrived has a novel composition of tree species. It is not necessarily a better or worse forest, but it is a new forest.

Arriving at Today – 20th Century Forests

Farmland Abandonment. In 1923, Liberty Hyde Bailey, who had produced the turn-of-the-century *Encyclopedia of Agriculture* and other agronomic works, wrote the introduction to a slim text on forestry, rather than on one of his usual farming topics. *The Forests of New York State* was written by Cornell Professor A.B. Recknagel. Times were changing and, although not explicitly addressed in this book, New York farmland was being abandoned at a dramatic rate, and a new natural resource identity for the State was being sought – the forests that were returning to old fields were one candidate. As one 1929 paper on farmland abandonment in New York put it, "In order that such land be kept from agricultural production and still not remain idle and unproductive, reforestation has been suggested as the logical remedy."[18]

The reasons for abandonment in Columbia County were various: competition from Midwestern agriculture now linked to the East Coast through improved transportation corridors; the global Depression that crippled most commerce; and changing modes of local farming with an emphasis on corn-based dairy – a type of farming that could import part of its feed and grow the rest on less land than the grass-based approach that preceded it.

Abandonment did not occur randomly on the landscape. Thinner, more marginal soils were abandoned first. A map of such abandonment (see Fig. 14) essentially highlights all the less productive regions of the County, with the Harlem Valley and Hudson Valley retaining more production than the hill towns. Even within those hill towns, however, abandonment was most extensive on the steeper, higher, more northerly slopes. Our localized study of abandonment in Hillsdale showed that, in comparison to land that remained in agriculture, abandoned farmlands were more likely to be on steeper, higher, and more northerly-facing slopes.

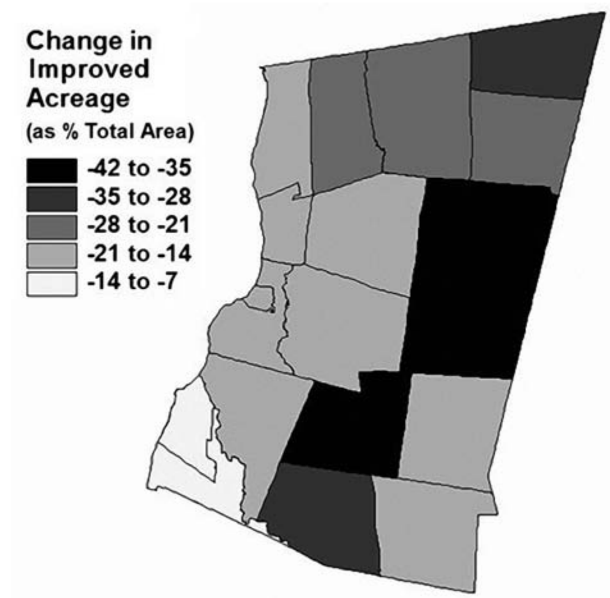


Figure 14. *Change in improved acreage from 19th century maximum to 1930, expressed as percentage of total surface area of each town. For example, the towns with the darkest shading lost between about 35 and 42% of their improved acreage during this period. The largest declines occurred in the hillier eastern and southcentral towns, probably because these lands were the least fit for the farming that was then happening.* Data from US Census.

Abandoned lands were sometimes converted to tree plantations, often as part of a state-sponsored program. However, in most cases, forest returned spontaneously, passing first to shrubland and then into a forest whose composition depended on the state in which the land was abandoned (open ground? pasture?), whether it was abandoned gradually or suddenly, the soil conditions (e.g., deep and rich vs. shallow and impoverished), and which pioneer tree species were seeding abundantly during the window of new forest establishment. Against this backdrop of forest return after abandonment, other factors such as forest disease, invasive species, climate change, and human use added shaping forces. Without trying to judge relative effects, we'll review some of them here.

Tree Disease. The most devastating regional tree disease during recorded time has been the Chestnut Blight, a fungus that was first noticed in 1904 in NYC and had arrived to Columbia County by 1911. Most mature American Chestnuts in the County had probably died by the early 1920s. Whereas American Chestnuts were once more common than hickories in certain parts of the County, they are now largely unseen except for young saplings. These root sprouts usually do not reach maturity before being killed by the latent disease. The disease was so extensive and so immediately fatal that its spread prompted chestnut wood salvage operations, and some of the barns and other structures built during this period are constructed of chestnut timber. The effect of Dutch Elm Disease has seemed particularly dramatic because these trees were often planted around houses and along streets. It seems that such urban or semi-urban trees were particularly hard hit by the blight. Although trees in more wild situations have also suffered, it is not unusual to find mature, apparently healthy individuals in forests. Dutch Elm Disease is an interesting example of the intricate ecological interactions that can make or break a disease. Although the disease itself is a fungus, a key component of the disease cycle are the Elm Bark Beetles which include both native and non-native species. Apparently, it is these insects that often carry and essentially inject the fungus into the healthy tree.[19]

Several other forest tree diseases may have less conspicuously shaped our forests during the last two centuries. White Pine Blister Rust and Beech Bark Disease are two that influenced the vigor of at least some stands of each of these species. Indeed, in another example of disease ecology, it was found that native gooseberries and currants (the genus *Ribes*) were an intermediate host for the White Pine Blister Rust. Fearing that this would hamper the (erroneously) expected region-wide return of White Pine, a widespread *Ribes* eradication program was launched. According to the annual reports of the Department of Conservation, between 1920 and 1940 around 1,000,000 *Ribes* plants were destroyed in Columbia County. While White Pine remains a relatively common part of our forests, gooseberries are scarce and the Grey Comma butterfly (see Fig. 15), a species whose caterpillars feed on gooseberries, are even rarer, although both caterpillar and host plant may now be rebounding.[20]

__Figure 15.__ A Grey Comma butterfly photographed in a Hillsdale native plant meadow. Grey Commas are rare in our area, in part because the favored food plant of their caterpillars, gooseberries, was nearly eradicated from our forests in an attempt to combat a White Pine disease which used gooseberries as an intermediate host.

Exotic Species. An “invasive species” is a non-native organism which somehow impacts the abundance of native species in their natural habitats. Thus Garlic Mustard, which can establish itself in forests and reduce the populations of native wild flowers, is considered invasive, while Dandelion, although a weed, is not usually considered invasive because it is largely confined to lawns and other highly modified habitats where it has little direct impact on native species.

Plants need certain resources to survive, including sunlight, water, and mineral nutrients. The number of trees in a forest is limited by access to these necessary nutrients. In other words, trees compete. If your soup pot is finite, then the more people who come to dinner, the less you get to eat. This is natural, and the forest development that we described earlier is largely brought about by such competition. The ecological challenge that humans pose is that they have brought somebody else to dinner and, furthermore, that somebody else may have longer arms, better teeth, and a bigger spoon than you do. Such are the so-called invasive species. "Invasive" plants are non-native species that are better able to take advantage of available resources than some native species. As a result, these newcomers can elbow some native species away from the table. Plants like Japanese Knotweed, Multiflora Rose, exotic honeysuckles, Japanese Barberry, and Oriental Bittersweet, to give some local examples, can take sunlight, water, and minerals from native plant species. By doing so, they can essentially starve some of the native plants. (The game can get even dicier. Garlic Mustard, for example, is believed to damage some important soil fungi, further crippling native plants who benefit from symbiosis with mycorrhizal fungi.) This doesn't mean that such introduced plants are without ecological value. For example, they may provide nectar for bees and butterflies, food for herbivores, and help prevent soil erosion. Scramble around a Multiflora Rose thicket, and you'll find plenty of old bird nests, some of which have subsequently been used as feeding stations for the Deer Mice who savor the rose hips.

Three of the forest health problems currently receiving the most attention are exotic insects: Emerald Ash Borer, Hemlock Wooly Adelgid, and Japanese Longhorn Beetle. All three insects have been accidentally introduced from overseas.

The **Emerald Ash Borer** is a beetle in the family Buprestidae, which includes a variety of native species. It is a skinny, emerald-green insect about 2/3rds as long as the width of a penny. Its distribution until recently was eastern Asia, where it coexists with native ash species. The Borer was first detected in North America in 2002, when ash die back in Detroit and adjacent areas was finally attributed to this species. By feeding on the inner bark, which is used to transport water and nutrients, the beetle larvae eventually girdle and kill trees. All native ashes appear to be equally susceptible, and mortality can reach 100%. In early 2012, it was first reported east of the Hudson in northwest Dutchess County. Because of that detection, multiple records from Greene County, and its occurrence in Berkshire County, it seems likely the Borer will soon be reported in Columbia County. Current control efforts focus on containment. Because transportation in firewood is thought to be one of its main routes of range expansion, firewood quarantines are in effect for various regions including our County.[21]

The **Hemlock Wooly Adelgid** has been known in North America since 1924, when it was described in British Columbia. On the East Coast, it was first recorded in 1951; genetic studies demonstrated that that population originated in Japan. Unlike the Ash Borer, containment now seems a lost cause – this all-female, aphid-like insect has been reported from at least 50% of Eastern Hemlock's North American range, including, by 2012, sites in all but the northeastern portion of Columbia County. While it continues to spread, there have been hints that, in some regions, its severity may be attenuated (or accentuated) by local conditions. Interestingly, the relative immunity of hemlocks on the West Coast, together with genetic studies of the Adelgid itself, suggest a fairly long period of coexistence and even the possibility of endemic populations. Covering needles and twigs with its characteristic white fuzz, these insects, like their aphid cousins, insert fine styluses into the plant, but unlike most of their relatives, they apparently feed upon stored plant starches which serve as energy reserves rather than upon sap sugars; they may also inject toxins. Hemlock apparently die through a combination of starvation, poisoning, and desiccation caused as water transport breaks down. Adelgids tend to be inactive during the summer, with most feeding happening in spring, autumn and, at least in some regions, winter.[22]

The **Asian Longhorn Beetle** is a member of a beetle family with many native representatives, most of which are identifiable by their characteristic sturdy, long antennae (the so-called 'horns') and by their generally elongate shape. This species, however, arrived in North America from East Asia in 1996, when it was first sighted in Brooklyn. It was later found elsewhere on Long Island and in areas of eastern Massachusetts. Many of our local species are pests of woody plants. Unlike the previous two species, the Asian Longhorn Beetle is a fairly generalized feeder. It will attack a variety of deciduous trees, although maple, elm and willow species seem to be the most frequently affected. The larvae effectively girdle trees by consuming the sapwood. Quarantine and extensive tree cutting have been used to contain outbreaks.[23]

This potentially sad trio of guests does highlight an interesting biogeographical fact: eastern North America and eastern Asia 'are family.' They share many similar plant and invertebrate groups. For example, ashes, hemlocks, and maples are common in both regions. As a consequence, there are a variety of insects which have co-evolved with the forests of one region and, when transferred across the sea, find familiar food but a refreshing lack of predators or host adaptation. It seems counter-intuitive that East Asia should have so much affinity with eastern rather than physically closer western North America. However, as discussed in the chapter on fields, it seems that geological and climatic history has made the eastern part of our continent the more similar region to temperate East Asia in terms of the climatic and topographic conditions that affect plant growth.

From a forest ecology perspective, earthworms are also considered an introduced pest with the potential to have a large influence on forest ecology. As we will discuss in more detail in Chapter 4, our native northeastern earthworms were killed off by the last glaciations and have not returned. They have been replaced by introduced species. These can have profound influences on forest nutrient cycling by changing the rate of leaf decomposition and the flow of nutrients through the soil. Forests with high earthworm densities often have relatively little leaf litter. Ironically, the same talent that makes earthworms a farmer favorite – their ability to rapidly incorporate organic matter into the soil – makes them a challenge to the ecology of forests, which over millennia had grown accustomed to the slow nutrient release and thick leaf litter of worm-free soils.[24]

Humans have also affected the abundance of native herbivores and plant competitors. One of the arch tree 'predators' in our current forests is White-tailed Deer. Deer are browsers and may never have been as widespread as they are now. We will consider their effects below under 'forest wildlife.'

Logging. Logging for timber currently occurs sporadically in the County and is not a major industry. There are small-scale salvage cuts for firewood and larger commercial timber cuts. The most pressing issue related to logging may not be its generalized ecological impact (it is probably too sparse to have a major county-wide influence, although localized effects can be large), but rather it is the lack of long-term vision in management of certain stands. Some loggers will offer forest owners a fast buck, but will then conduct a cut that leaves little chance that the forest will soon regain its commercial value. More far-sighted management can include modest if more frequent cuts that translate into greater long-term gains for the land owner. Logging has obvious ecological impacts, but some of the most ecologically onerous of these (such as the destruction of small wetlands, the introduction of invasive species, the reduction of forest plant diversity, the loss of dead standing timber, or soil erosion) can be somewhat mitigated by well-managed cutting. Done conscientiously, logging can provide important incentives for forest owners to maintain their forests (as opposed to selling them for development) and can enhance local self-sufficiency. Careless use can destroy a resource; but careful use can build greater awareness of and a stronger, partially economic, connection to the resource.[25]

Current Use and Future Conservation – Beyond the Second Clearing

Forest Trends. The middle half of the 20th century was a time of large-scale reforestation in the Northeast. In some states, the amount of land in forest nearly doubled over this period. In Columbia County, forest area tripled during the first three quarters of the twentieth century. As will be described in more detail later in this chapter, not only the forests themselves but also much of their wildlife rebounded. More recently, many parts of the Northeast have been experiencing a "second clearing" as forest gets removed for the development of residential and commercial structures and landscaping (see Fig. 16); nine out of eleven Northeastern States have experienced forest decline during the past decade or two.[26]

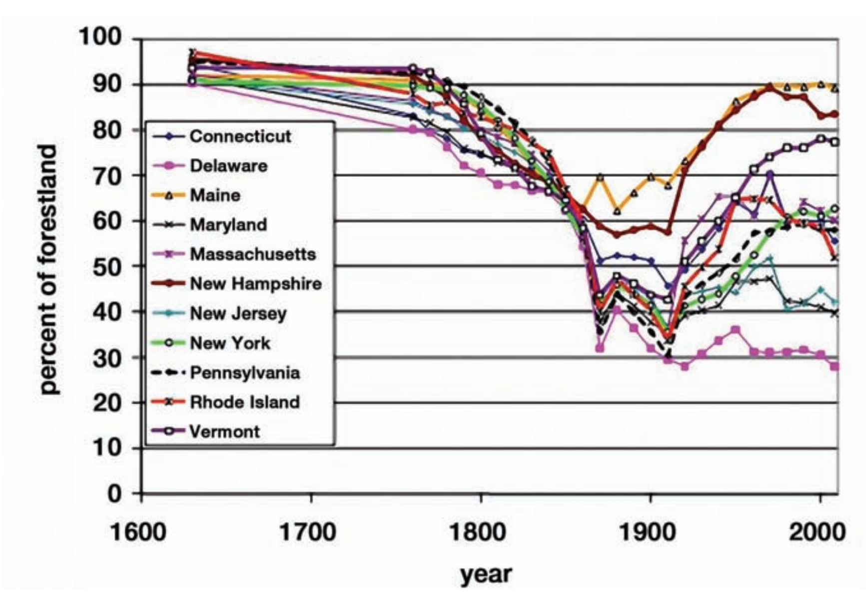


__Figure 16.__ Percent of land in forest for the Northeastern States. Note that all of these states went through a 19th century forest decline accompanying the spread of farming and how most states are now beginning to see new declines in forest area. The "second clearing" is associated mostly with non-agricultural development.
Data from the US Forest Service.

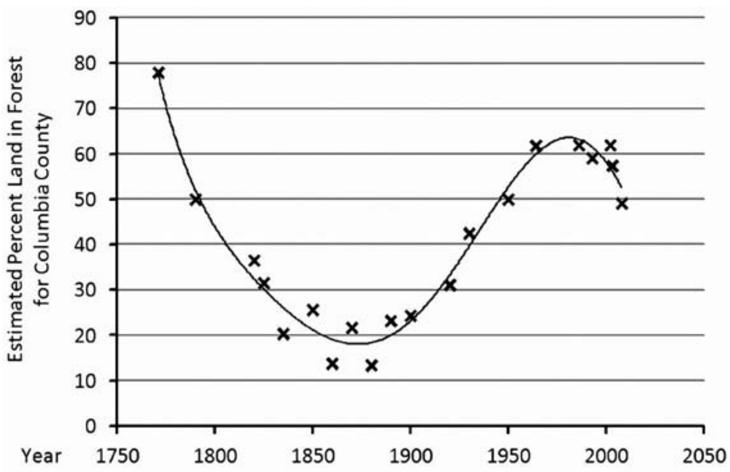


Figure 17. *Estimated and reported forest area in Columbia County over the past 250 years. As with many other parts of the Northeast, Columbia County forest area reached a nadir in the second half of the 19th century and appears to be declining again. The extent of the modern decline is not yet evident because there is often substantial variation amongst forest area estimates; it may not be as sharp as these data suggest.* Based on Forest Service Inventory Assessments, remote assessments by Amielle Dewan, earlier census data on improved (i.e., unforested) farmland, and estimates based upon early population figures.

Columbia County's forest cover paralleled this trajectory to a large degree (see Fig. 17), with massive reforestation being followed, most recently, by incipient forest decline (please note, the recent decline may not be as dramatic as indicated by the figure; some of this comes from varying data sources that provided distinct estimates of forest area). Two forest cover estimates from 1986 and 2002 derived using remote sensing by Amielle Dewan (then of the Hudson River Estuary Program) are virtually identical at around 62%. The Forest Services "Forest Inventory Assessment" estimates drop from 58% forested in 1993 to 42% in 2011, although some or all of this might be 'sampling error.' Other sources put the peak forest area closer to 70%. In any case, it seems clear that forest area is stagnant or even decreasing in the County. Fields may still revert to forest, but that reversion is apparently offset by conversion of existing forests to other uses.[27]

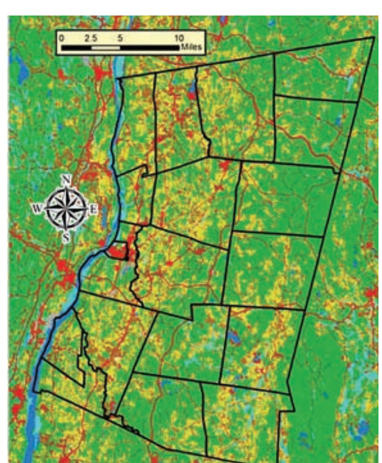


Figure 18. *Forest is indicated in green, developed lands in red, grassland (pasture and hayfield) in yellow, wetland and open water in shades of blue. Notice the forest swath reaching from the northeast corner of the County through the southcentral portion.* 2001 Columbia County USGS National Land Cover Data image.

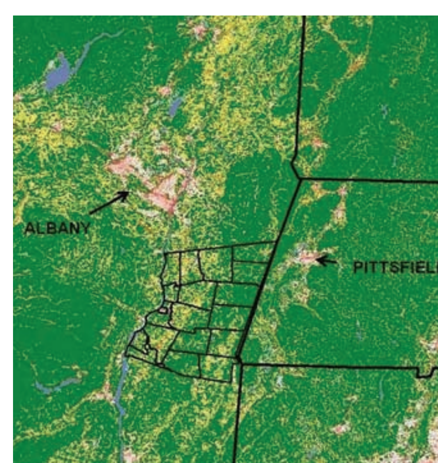


Figure 19 (right). *A recent land cover map of Columbia County and adjacent lands. Green is forest, pink is developed lands, and yellow is open fields. From this perspective, the forest swath through the County serves as an ecological connector between the Green Mountains of Vermont and the Catskills.*

As the earlier map of abandonment suggested, most of our modern forest occurs in the hill towns, including Gallatin and Taghkanic (see Fig. 18). If one ‘zooms out’ (see Fig. 19), one sees that this swath of forest is part of a green band stretching north, via the Rensselaer Plateau, into the Green Mountains and southwest, through northwest Dutchess County, to the Hudson and beyond to the Catskills. This swath of forest may well serve as a movement corridor for wildlife, and that connection probably has helped funnel some of the more boreal forest mammals such as Fisher and Moose back into the County. Maintaining the viability of that forest corridor may be crucial for maintaining populations of our forest wildlife. As many ecologists have observed, small isolated patches of habitat are usually unable to maintain wildlife populations in the long-term.

Forest Fragmentation. Forest fragmentation refers to the degree to which the forest is cut up into smaller blocks by intervening patches of other cover, for example by roads, house lots, or farm fields. Fragmentation is, to some degree, in the eye of the beholder – what may feel like a large and fragmenting structure to a shrew may be little barrier to a bear; on the other hand a bear is likely to range more widely and, if those fragments are caused by high-speed roads, for example, then relatively more bears are likely to be struck by cars.

There are different ways of evaluating forest fragmentation, but two of the most simple statistics are patch size and what is called core patch size. A “core patch” is the area of forest that is deemed to be outside of the influence of edge effects. Edge effects, in turn, are the ecological influences that trickle into a forest from its perimeter, be that added light, higher wind, greater pest or predation pressure, more non-native species, or some other effect.

Maps of average patch size and maximum core patch size show that the Adirondacks, Catskills and Alleghenies are the most intact forests (see Figs. 22 and 23). Columbia County, with its extensive agriculture, has a relatively small average patch size and

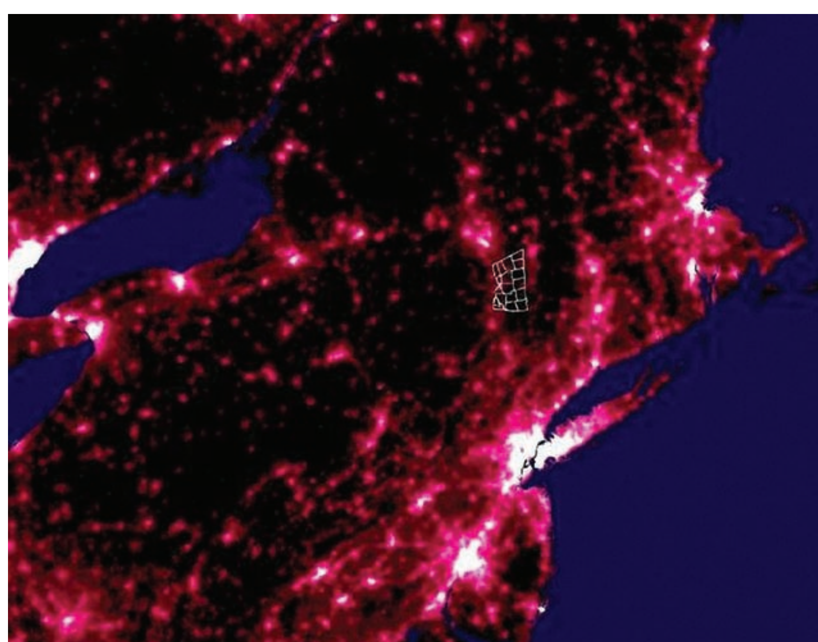


Figure 20. *A NASA image of the Northeast at night. Note how Columbia County, outlined in white, appears in a dark hole surrounded by the encroaching lights of Albany, Boston/Springfield/Hartford and New York City.*

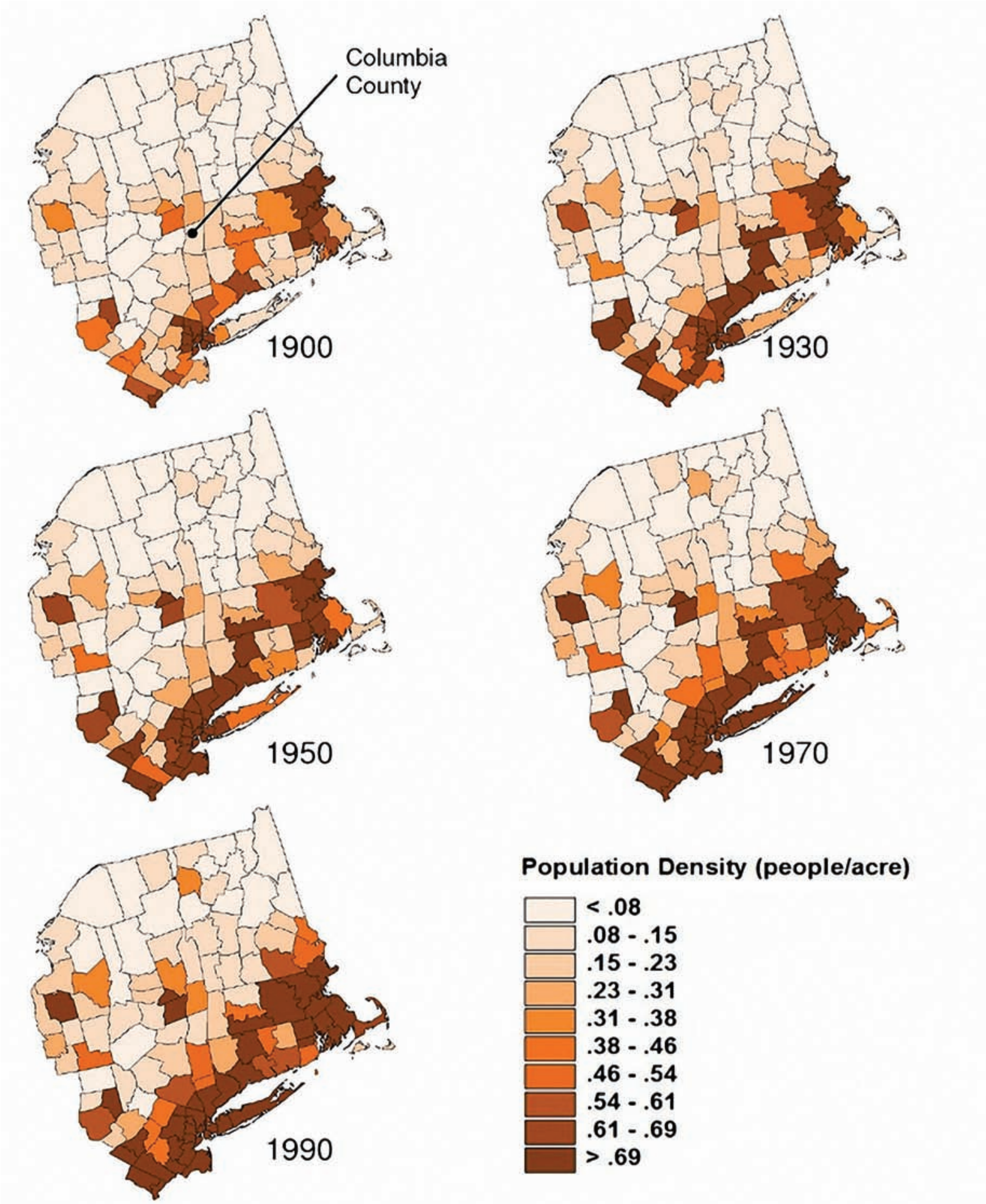


Figure 21. *Population density in and around Columbia County during the past 100 years. Columbia County remains a relatively sparsely-settled county on the fringe of the Eastern Urban Corridor.*

Data from U.S. Geological Survey. Waisanen and Bliss (2002) "Changes in population and agricultural land in conterminous United States counties, 1790 to 1997" *Global Biogeochemical Cycles*, volume 16, pages 84-1 to 84-19.

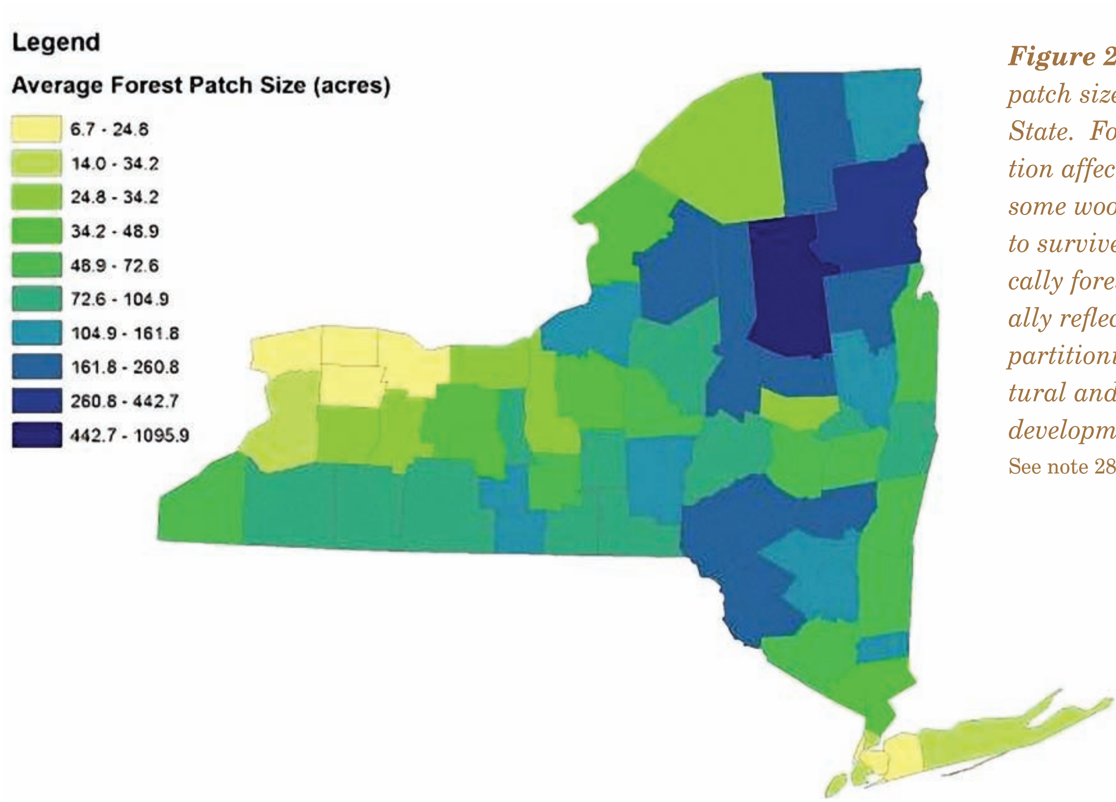


Figure 22. *Average forest patch sizes in New York State. Forest fragmentation affects the ability of some woodland organisms to survive and, in historically forested areas, usually reflects human forest partitioning due to agricultural and non-agricultural development.*
See note 28 for source.

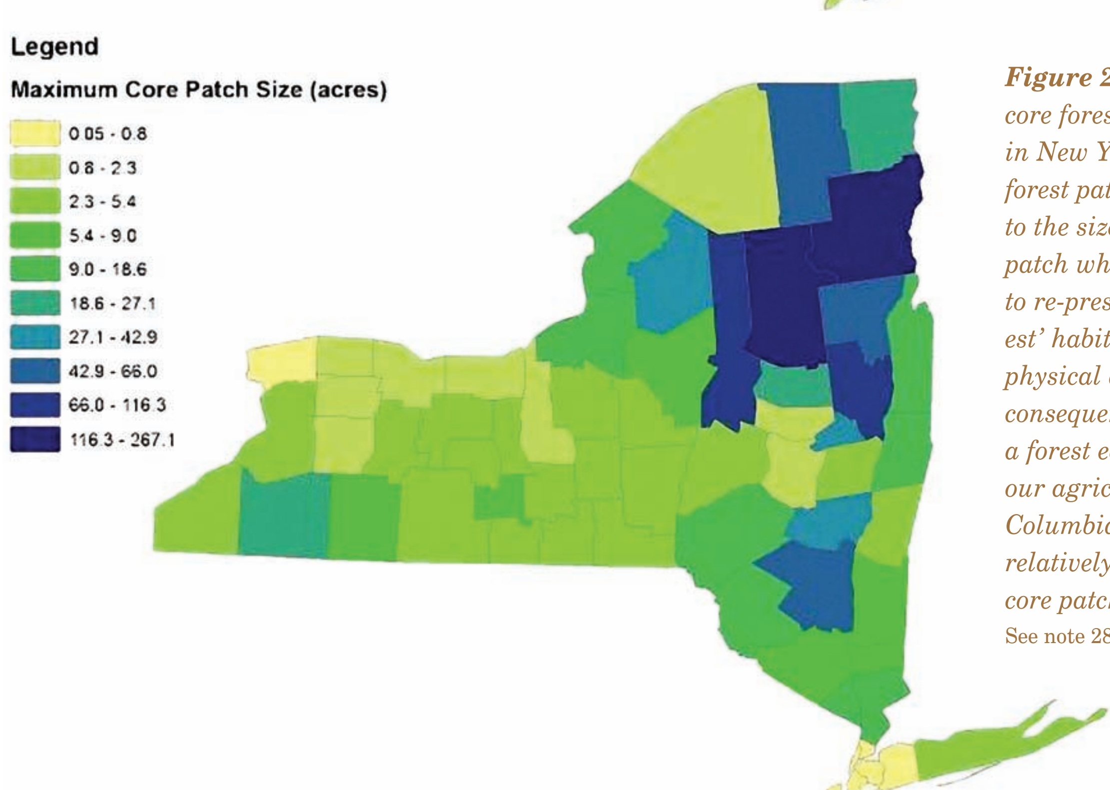


Figure 23. *Average core forest patch areas in New York State. Core forest patch area refers to the size of a given patch which is believed to re-present 'deep forest' habitat outside of the physical and ecological consequences of being near a forest edge. Because of our agricultural history, Columbia County has a relatively small average core patch size.*
See note 28 for source.

maximum core patch size. However, one aspect of fragmentation is the question of the 'permeability' of the barriers causing fragmentation: from the perspective of wildlife, there is quite a difference between having your forest fragmented by a quiet hayfield versus by a six-lane highway. To some wildlife, the first may only be an inconvenience, while the latter may be a fatal gauntlet.[28]

Future Forests. The future of our forests will depend in part on the way we plan our settlement and development. Columbia County still has a substantial amount of forest, but it is surrounded by the development foci of the Capital District, New York City, and Boston (see Figs. 20 and 21). Keeping as much of that forest as ecologically viable as possible is central to the conservation of many of our native plants and animals given that those organisms co-evolved with forests.

A central question when considering the future of forest in the County is, simply, what is forest? Almost all of us would probably agree that a 10,000 acre patch of undisturbed forest is, from most perspectives, forest: it looks like forest, and it probably supports populations of many regional woodland plants and animals. Is it still forest if we add one house? Two houses? 3? 4? 10? 100? 1,000? What such a thought experiment indicates is that forest is a nuanced term. For example, some would call a quarter-acre back lot 'forest' because it has trees, others might say they live in a forest because of the ample trees around their house and along their street. From a human perspective, there is no right or wrong answer, and what you accept as forest may depend largely on your past experience and the scale of your perspective. A young city boy travelling outside of the City for the first time might deem a five-acre patch of 50-year-old trees 'deep forest' and, to him, that would be true. Someone familiar with the vast forests of the Adirondacks might dismiss such a stand as little more than an overgrown pasture.

We can discuss our perceptions of what makes a forest for us personally, but there is also the question of what, ecologically, makes a forest? How many trees? What sort of trees? How wild and how big? As with barriers, different organisms will have different 'answers' to those questions. A ground beetle population might, for example, happily reside in a 10-acre patch whereas a single Bobcat or Lynx, whose home ranges may well exceed 7,500 acres, would probably be unable to survive, let alone reproduce in such a stand.

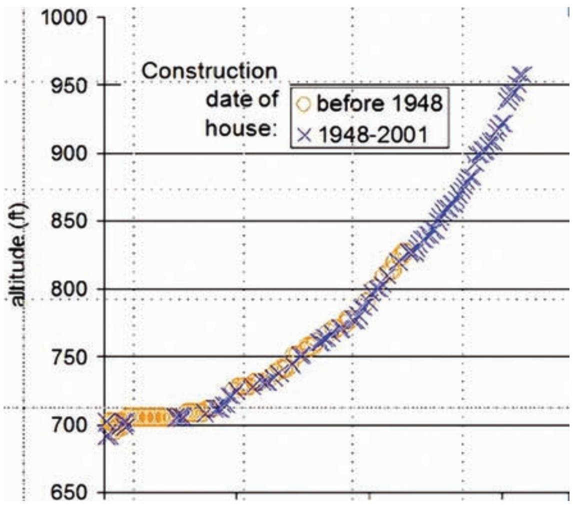
One wildlife biologist classified development densities as follows: more than 1 housing unit/acre is urban, 1 house/1-10 acres means suburban, 1 unit/11-40 acres is exurban, and 1 unit/41 or more acres would qualify as rural. Columbia County – with roughly 30,200 housing units on 412,000 acres (or 1 unit per 13-14 acres) – would, as a whole, fall in the exurbia class. However, there are no set and fast rules, and two of the most difficult aspects to appreciate are the diffusion of our ecological influence out from our houses and the consequent fact that the patterning of our settlement is a large determinant of the ecological health of a forest.[29]

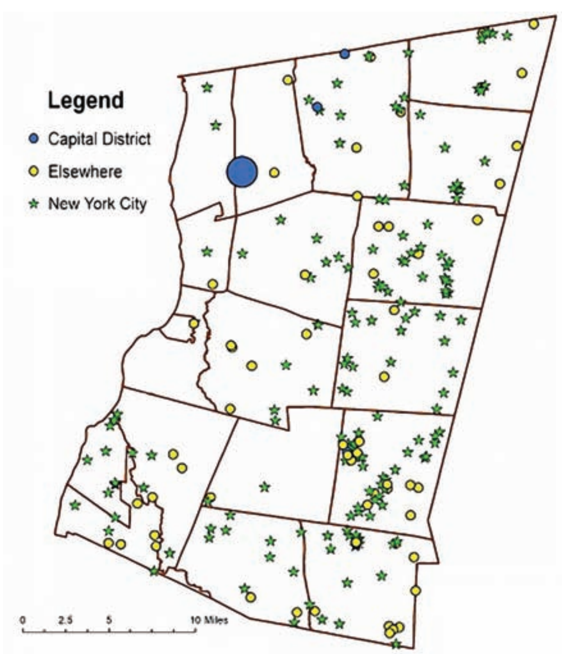
Our ecological influence goes well beyond the footprint of our house. Clearly, it extends at least as far as the bounds of our backyard. However, usually it goes well beyond that. Simply opening up a clearing in the forest creates edge – those forest/clearing transitions whose effects penetrate well into the surrounding forest. Walk into a forest from a large edge and you're apt to notice the shrubbier nature of the margins and higher densities of some non-native (or, at least, non-forest) plants and animals. Similarly, unless we come and go by helicopter, there will be roadways and driveways leading to our houses, these have a physical footprint and halo of influence just as surely as our house. Picture what the land would look like if all roads were, instead, strings of houses; things would certainly look more 'thickly settled.' True, not all roads have the same ecological impact as a house. A dusty, seldom-driven backroad may serve as a functional wildlife path, however a heavily-driven highway can have a more fatal effect than stationary houses.[30]

Studies of bird populations in western Massachusetts show that bird populations are impacted by housing densities at least as low as one house per 4-5 acres. This influence reflects both pushes and pulls. In other words, our intentional or unintentional (e.g., compost piles) feeders may attract birds to the neighborhood of our houses, at the same time our pane-glass windows and house cats may kill them. The generalized result is that certain species tend to increase while others decline. The declining species tend to be those most closely tied to undisturbed forest, while the increasing cohort tend to be the likes of the familiar rabbits, squirrels, Northern Cardinal, House Sparrow and European Starling. Notice that two or three or even four of the animals just listed are not even native species – the House Sparrow and European Starling are European. If the rabbit is an Eastern Cottontail, as is most likely, then it was originally a more western animal, and the Northern Cardinal was largely unknown in the County 100 years ago, although the reasons for its spread into the Northeast may or may not be related to human influence. The interactions are complex, as illustrated by Darwin's comment in *The Origin of Species* that the number of spinsters living in England determined the amount of clover in its fields: Spinsters liked to keep cats, cats eat mice, mice would otherwise decimate the nests of the bumblebees who fertilized the clover; the clover, in turn, as Huxley added, was a key forage for England's beef cattle; so spinsters were crucial to the Empire.[31]

These considerations lead to the question of how best to arrange our settlement on the land if we wish to maintain the ecology of our forests, realizing that "forest" means not just the standing trees but the wide range of plants and animals which compose the less conspicuous life of the forest. The geography of development has a localized and a regional component. In other words, there is the question of do we put this particular house here or x feet to the north, south, west or east. And there is the question of whether we spread our houses evenly like butter over the landscape or clump them more heavily like blobs of strawberry jam.

Two examples illustrate the considerations that go into local decisions. As anybody who has lived in the County for the past several decades can tell you, ridgelines have become newly tempting sites for



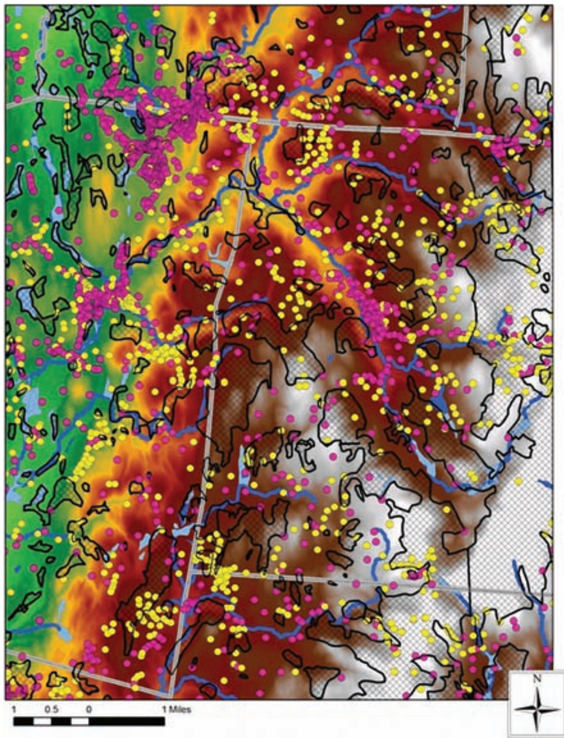


residential development. Originally scorned because of their remoteness, cold and poor soils, their vistas have now drawn people to erect houses and clear view paths. Long driveways or private roads often lead to those perches. I can understand this urge – I regularly climb the little hill behind our house so that I can get to a small (and, as yet, uninhabitated) clearing at the top and look down on the valley where I live. However, we need to be conscious of what we are doing by setting our houses on those ridges. Primarily, perhaps, we are encroaching upon forest that, largely unconsciously, we have hitherto left relatively untouched. As one example of our encroaching tendencies, we studied the elevation and construction dates of houses within a square mile of our office.

The results (see Fig. 24) show that houses constructed after 1948 had an average elevation of around 776 feet, while the older houses average 733'. Furthermore, while many new houses were at low elevations, many were placed much higher than the older ones. In the same landscape, fields had an average height of 703', while forest averaged 807'. Our settlement is leaving the fertile valleys and heading into the forested hills. This can also be seen in the distribution of second homes (see Fig. 25). These tend to be clustered in the higher and more forested eastern and south-central terrain. Similar conclusions can be derived

Figure 24 (top). *A small illustration of house-building propensities. This graph shows the altitudinal location of older and newer houses in a one-square-mile area in northwestern Hillsdale. Houses are arrayed from left to right in order of increasing elevation to form a hypothetical hillside. Modern houses are being built at higher elevations than older ones, implying the arrival of certain development pressures to those lands. Historically, some of the higher areas were opened for farming but were the site of few homesteads.*

Figure 25 (bottom). *The mailing addresses for the owners of recently constructed houses owned by individuals from outside the County (the owners of 15% of all recently constructed houses). The large blue dot indicates the location of 10 such homes. Homes owned by Capital District residents are most common in the northwest corner of the County; home owners from elsewhere built most commonly in the eastern side of the County.*
Derived from NYS Department of Taxation and Finances Real Property Database.



from studying larger scale maps of our County. Our earlier depiction of the 1933 topo map showed how many of the forests which survived maximum 19th century clearing were on higher lands. These are the same lands which have now become more attractive to residential development (see Fig. 26) for both aesthetic (sweeping vistas) and practical (the availability of machines to make the long driveways and to access water supplies from such heights) reasons. More recently, they have also become prime sites for wind power development.[32]

Ecological studies around the Northeast have shown that "ancient forests" (that is, lands which have remained wooded for long periods, albeit with substantial logging or other management) can be home to plants and animals rarely found in recently regrown forests. Thus, as we consider the conservation of our County's ecology, preservation of these patches of older forest should be one of our priorities.[33]

It is not just that these ridges tend to be some of our last patches of ancient forest, but they also are unique habitats in their own right. Timber Rattlesnakes, certain migrating birds and butterflies, and perched vernal pools all tend to be most common in this portion of our landscape. That last item, vernal (or seasonal) pools, points out another, more localized aspect of house locating – the avoidance of wetlands.

Figure 26 (top). *Recent houses (yellow, built after 1969) and older houses (pink) in the area of Ghent, Hillsdale and Austerlitz overlaid on altitude and old forest based on the 1933 forest-shaded topographic map. Recent houses tend to be built at higher altitudes and encroach on older forests.* House data source same as for Figure 25.

Figure 27. *A section of Hillsdale forest as it appears on a recent aerial photograph. Houses, roads, and driveways are apparent, but the primary impression is of forest.*

Although simple construction practicalities usually rule out placing a house in the middle of a large wetland, smaller, sometimes temporary wetlands can appear as little more than puddles, easily filled in or built around. I recall one vernal pool in a residential development that had been completely encircled by a driveway. These pools are crucial to several of our native forest frogs and salamanders and so are an example of a sometimes inconspicuous landscape feature whose unwitting destruction can make a forest less of a forest. They will be discussed in more detail in Chapter 5.

Next comes the issue of how we place our structures on the landscape. Do we take the butter or the jam approach? Do we concentrate our homes in relatively confined villages or do we spread them more evenly across the landscape? Here, we come directly up against human perceptions versus ecological effects. A single apartment building housing fifteen families can look much more 'urban' than 15 houses spread throughout the forest. Ironically however, the ecological effect can be exactly the reverse. By grouping or, to use a hot-button term, 'clustering' our houses we can reduce that diffuse ecological impact that radiates out from each and every house, and we can reduce the roads and driveways needed to reach them. Fly over a non-urban western European landscape, and you will tend to see dense villages surrounded by noticeably less densely settled land. This pattern goes back to the Middle Ages when villages were surrounded by the worked farmland. Fly over a semi-rural portion of the Northeast and, while discrete villages will certainly be visible, the settlement is much more diffuse.

Although denser human settlement requires more conscious approaches to services such as water, sewage and trash, it can, if the total population remains the same, have a substantially lower ecological impact. The trouble is that we don't have the precedents for such a landscape. For many, the arrival of 'multi-family dwellings' heralds urbanization, something to be avoided. Given our landscape history, this is a reasonable conclusion; after all, in our region, urbanization did historically sometimes arrive in this way. However, new approaches to land use may be needed because the patterns of settlement have changed. Some of the primary settlement pressures in our area are no longer those associated with the establishment of factories or businesses but rather with the building of individual houses widely distributed around the countryside. The practicality of this dispersion has been aided by the internet which can allow easy access to workplace and information from physically remote locations. If we care about urbanization, as defined as an ecological rather than purely aesthetic or social process, then we should have a keen eye for the incipient "urbanization" present in dispersed housing development.

The potential ecological effects of such dispersed settlement can be illustrated using a section of Hillsdale. While houses are apparent in the aerial photograph (see Fig. 27), forest appears to predominate. However, if one highlights lawns and other clearings together with roads and driveways, you get a dramatically different impression of the ecological impact (see Fig. 28). The boundaries of our effects are certainly not as sharp and clear cut as the second image might make them appear – certainly forest animals will enter yards and cross roads; at the same time, however, our influence through roaming pets, invading garden plants, noise, light, etc. may extend well beyond the lines indicated. The point is not to argue about exact spheres of influence, but rather to appreciate that our human perceptions of what is forest may be very different from the perception of organisms who, ecologically, rely upon the forest.

Figure 28. The same image shown in Fig. 27 — with non-forest habitats highlighted in yellow and ecological impact zones drawn in yellow around each house, reflecting the consequences of human activities and pets. Mapping the landscape in this way, albeit with some imprecision, indicates that, despite a forested look, many of our hills are actually quite fragmented.

The issue is not black and white – how we live in our houses can also influence their ecological impact. Gardens working with native plants can help support native insects; belling cats can reduce their impact; letting your ponds develop marshy, well-vegetated borders and not introducing fish can enhance their value to woodland amphibians; reducing the trees cut down around the home can shrink negative edge effects. However, our consciousness also needs to go to the next level of deciding on goals for our landscape and translating those goals into land planning. If we truly want to live near ecologically-functional forest, then we need to consciously think about what a forest needs in order to be 'ecologically-functional.' Discussions of land use are sometimes framed as debates about government intervention vs. individual freedoms. Perhaps more constructively, they can be seen as discussions of the shape of the landscape we want: both poles (i.e., absence of zoning and strict ecologically-based zoning) can have profound effects on each of us. However, by not planning at the landscape scale, we make ever more likely the inexorable parceling up of our landscape and the gradual loss of ecologically valuable forest. Such loss is an eventual restriction on our potential enjoyment of the landscape just as surely as any immediate legal restrictions on land use; both confinements of our liberties need to be considered during land use debates.

Such a 'considered' approach to land use might be less possible if high population pressure were the primary spur of development, but it is not. Based on a study during the 1980s and 90s and illustrating what is likely a continuing trend, Hudson Valley urbanization rates (based on the change in remotely-sensed land cover classified as 'urban') have substantially outpaced population growth. The implication is that it is life-style changes, rather than population pressures, which are driving land conversion. If we want to conserve the ecological (and agricultural) potential of our land, then it is for us to (re)define our lifestyles in compatible ways.[34]

Climate Change: Moving the Hudson Valley Uphill

Since the early 19th century, mean annual temperature in Albany and in Hudson has increased by about 3 degrees F. Since 1920, our growing season (time from a year's last frost to to its first frost) has increased by nearly 20 days (about the same amount of time that defines the difference between growing season on the banks of the Hudson and the slopes of the Taconics). The number of extreme rainfall events (>1" in 24hrs) has more than doubled in Hudson since 1947. Predicting the future is based on uncertainty, but, in the same way that increased suburbanization pressures seem likely given current evidence, climate change seems probable barring substantial modifications of our behavior. What effect is such climate change likely to have on our forests?

In brief, the 'tension zone,' which we described earlier and which appears to pass through the County, would likely move north. This would mean that the southern range boundaries of more boreal tree species would inch out of our area while the northern boundaries of more southerly species would creep into the County. In broad strokes, our forests would become more dominated by what foresters describe as 'Oak-Hickory' forests, and less by what they call 'Maple-Beech' forests. However, paleontological evidence suggests that forests don't move as intact communities but rather as individual components. In other words, the trees and understory that we associate with a modern Oak-Hickory forest may get teased apart as some species are more or less affected by changes in the climate. The result of differential response to climate changes, new combinations of meteorological conditions, and varying lag times in responding can produce what have been called 'no-analogue' communities; that is, novel species collections unlike any that we currently have or that, perhaps, ever existed. The post-glacial histories that we described earlier illustrate earlier versions of no-analogue communities: for example, because oaks arrived twice as long ago as hickories, there may have been extensive, hickory-less oak forests where, today, oak-hickory mixes are the norm. Similarly, there were apparently widespread hornbeam-heavy (*Ostraya* and *Carpinus*) forests in the central US some 10-15,000 years ago. One can only wonder what flowers bloomed therein.[35]

In some ways, therefore, it is more appropriate to speak in terms of individual species biographies. The US Forest Service has done extensive modeling and predicted the likely consequences of various scenarios for particular tree species. They predict that Sugar Maple, American Beech, White Pine and Eastern Hemlock will likely become less common while others, such as Tulip Tree, Red Mulberry, White Oak and Post Oak (a species not currently present in the County) will probably increase. One can imagine, looking at our earlier map of plant distributions in the County, that the species more common in the south and west will expand to the north and east, while the species unique to that region, such as Hobble Bush, will decline. Or, at the least, conditions will become less or more favorable for these species. Whether or not climate change will occur at rates that allow forest adaptation and whether or not other ramifications of human activity will enter the mix is not known. Many of the disease and pest issues we have already mentioned may be affected by climate change, and complete physiological intolerance to new climatic conditions may rarely be the proximate cause of a species' decline. Instead, greater stress may make a species more susceptible to new or long-extant threats which then appear as the immediate causes of decline.[36]

These results echo those of Rogers McVaugh in his *Flora of Columbia County, NY,* written in the 1930s. He pointed out, in a pre-climate change awareness context, that the retreat of northerly trees can be sped up by human action. At intermediary stages, relict populations of northern species will likely persist in small pockets of suitable habitats, surrounded by a matrix of more southern species. If these pockets are destroyed, they are unlikely to be repopulated with northern plants, even if climatic conditions remain compatible, because there is no nearby seed source. Because, even in McVaugh's day, we were located on the more southerly side of the tension zone, he envisioned a County flora which human action would progressively 'australize.' The rate of this process would only be exacerbated under climate change prognostications.

Natural History Profiles: Trees

Trees are, by definition, a forest's most prominent vegetation. They are also, because of their year-around presence (albeit not always with leaves), relatively large size, and relatively low diversity, one of the most tractable plant groups for beginning botanists to tackle. In this section, we will describe some of our most common trees. Become familiar with these, and you are well on your way to learning the trees of your forest. This is not an identification guide, although we do try to give you some of the tips we use to distinguish species. Perhaps the most useful approach to reading this section would be to find yourself a good field guide (see suggestions in notes), and then follow along as we talk about some of the different groups.[37]

Conifers

If you look at a conifer needle and compare it to the leaf of, say, a maple, it is easy to imagine that the papery leaf is not as good at guarding water as the compact needle. Indeed, conifers tend to be most common in forests where drying is a large risk. These can be cold areas (where freezing regularly creates a shortage of liquid water), sandy/thin soils (where 'excessive' drainage can cause soils to quickly dry out), or, ironically, bogs where a surplus of water makes a terrestrial plant's water physiology challenging. We tend to find most of our conifers on rocky hillsides or in ravines, on the sandy soils of Glacial Lake Albany beach front property or of glacial outwash, and in the higher, more northerly portions of the County. In addition, some of them, like White Pine and Red Cedar, are particularly good at invading abandoned or partially abandoned farmland.

"Conifer" refers to those trees that produce cones. While this seems to easily cover many of our needle-bearing trees, some 'conifers' such as the junipers actually produce a fruit that resembles a blueberry more than it resembles a cone. Junipers are, nonetheless, considered conifers because their 'berries' apparently evolved from the same ancestors as trees with more typical cones. "Evergreen"

Figure 29. *White Pine as illustrated in Michaux's 1841* North American Sylva. *White Pine has long, wispy needles in clusters of five, together with an elongate, banana-shaped cone.*
Image courtesy of the New York Public Library

Figure 30. *White Pine doing what it does best – invading an old field. The green sprouts in the foreground are young White Pine; in the background are adult White Pine and White or Grey Birch trunks, both evidence of former clearing.*

is sometimes used interchangeably with conifer, but at least one of our conifers isn't actually evergreen: Tamarack, also known as American Larch. This conifer, which is not particularly common in our area (its European sister is sometimes planted as an ornamental), turns a yellow-gold in autumn and drops all its needles.

White Pine (see Fig. 29), with its five, long, wispy, greenish-white needles in each clump and its cones shaped like small bananas, is probably our most common conifer. It can be found scattered through many of our forests, emerging above the deciduous canopy and perhaps marking the sites of former openings. Journey to the top of Beebe State Forest and look out over the surrounding hills, and you'll see a forest dotted with mature but largely lone White Pine. However, this tree is particularly common on former farm fields (see Fig. 30). If the field was abandoned without going through a period of reduced but active grazing and if that abandonment occurred during a year when White Pine were producing many seeds, then White Pine sometimes grew up in almost pure stands. It is often possible to scan the land during the winter and see former farm fields outlined in dark green.

This tendency for White Pine to enter old fields led foresters in the early 20th century to proclaim much of New England (which, ecologically, pretty much includes us) as the "White Pine Region." White Pine was described as the future of timber in the area, and much effort went into its planting. Aside from fighting the fact that most forest land here did not 'want' to stay in White Pine, foresters also had to fight a variety of diseases or pests that plagued this species. We have already mentioned the White Pine Blister Rust and its link to gooseberries and the Grey Comma butterfly (see page 53). The White Pine Weevil was another important challenge; it bores into the leaders (i.e., growing tips of the trunk shoot) and kills those sections. While the tree itself is rarely threatened, it responds as most trees do to pruning of their leader: lateral branches take over the job. As a result, the trunk may branch or at least bend as it circumvents the point of the Weevil's attack. This, in turn, causes irregularities that reduce the affected tree's value as lumber. Such twisted trees are most commonly seen where White Pines grew up in sunny openings (such as old fields), apparently because the weevil relishes those more sunlit conditions.[38]

Aside from White Pine, we have two other native pines in the County: Red Pine and Pitch Pine. **Pitch Pine** (also sometimes called Yellow Pine; see Fig. 31) tends to be a squatter tree than either White or Red Pine. It has three relatively short needles and, characteristically, often has clumps of needles emerging in odd tufts from its trunk or other unlikely spots. These tufts actually are potential branches and so are associated with this species' ability to send up shoots if cut or burnt, a rare trait amongst our conifers. The Pitch Pine's cone is relatively short and conical. It can remain on the tree for several years, with the result that the cone's short stalk is sometimes partially 'consumed' by the twig's growing diameter. On some individual trees, most cones don't open until they are fire scorched. Its bark is relatively thick, somewhat resembling White Pine's but coarser; it forms a

Figure 31. *Pitch Pine is a squatter tree than White Pine. It has clusters of three, relatively stout needles, compact cones with no stalk, and a chunky, fire-resistant bark through which needle tufts commonly sprout. In Columbia County, this is primarily a tree of drier, more fire-prone areas.*

flame-retardant shield that is yet another adaptation to fire. As the frequent references to fire suggest, this is a species of our drier zones.

It is a common tree in the Albany Pine Bush, and early accounts suggest the Pine Bush essentially extended into the sandy soils in the northwest part of the County (see Chapter 4, Fig. 3). While these pine plains have largely been supplanted by development and agriculture, ample historical references exist. Aside from Coventry's reference alluded to earlier (see page 49), in 1755, the Rev. Samuel Chandler mentions the "Pitch Pine plain" between Kinderhook and Schodack, Dwight in his *Travels* (vol. 4) mentions the "pine ground" and "Yellow Pine plain" that he observed around Kinderhook while passing through in 1804; Spafford, in his *1813 Gazetteer of the State of New York*, mentions "large tracts of pine-plain"; and Woodworth in his two reports (1839 and 1840) on the botany around Kinderhook, mentions not only Pitch Pine, but also that Pine Bush flagship, Wild Blue Lupine. McVaugh, in his *Flora*, reports Pitch Pine's occurrence on "Dry, sandy, soils….Very abundant on the sandy soils in Kinderhook and on the rocky summits of the hills in the southeastern part of the county." We have seen it as occasional scattered trees. Whether by planting or the invasion of open soils, it has apparently come in along certain Columbia County sections of the Taconic State Parkway. We are still looking for remnant Pitch Pine forest in the Kinderhook and Stuyvesant area.

Beyond its earlier-mentioned use in house construction, Pitch Pine was apparently eagerly sought during our history. Emerson, in his 1846 book on Massachusetts trees, reports its frequent use for boats and waterwheels because of its ability to withstand water with minimum rotting or swelling. In Columbia County, it was the stated cause for settling the Palatines in Germantown. At that time (beginning of the 18th century), much of the tar used to seal and protect ships and navel gear came from Pitch Pine. The Palatines were settled in Germantown for the express purpose of collecting and processing these 'naval stores.' Contemporary accounts of their subsequent efforts suggest that the pitch they did extract was 'not up to snuff' and that Pitch Pine itself was not as common around their settlement as some of the project's promoters had suggested.[39]

Red Pine (sometimes misleadingly called 'Norway Pine') is our third native pine. It tends to grow straighter and with fewer divided trunks than many White Pines, perhaps because it is largely free from the distorting effects of the White Pine Weevil. The bark, especially lower on the trunk, is of an orangey tinge, although not quite the bright and flaking trunk of the sun-burnt, introduced Scotch Pine. Red Pine has but two long, brittle needles (bend them in your fingers and they snap in two). McVaugh describes it as "rare" in the County, and we have usually only come across it as scattered groves. However, many of these were probably the result of attempted plantations, and so its natural distribution is not clear to us. It is said to grow on poorer soils than White Pine; however, we have not observed it to be a vigorous invader of exhausted lands in our area. In Vermont, it is described as naturally forming small stands on thin-soiled, rocky hilltops. The relative abundance of Red Pine plantations may be owing to the fact that this species was not only resistant to the White Pine Weevil but also to the White Pine Blister Rust, and thus was thought more likely to grow into commercially viable stands.[40]

In addition to these natives, one often finds **Scotch Pine** plantations. Like Red Pine, Scotch has two needles, but these are twisted and shorter (around 2-3" long). The origin of the pine plantations that one still finds around the County is worth an aside. In the middle half of the 20th century, pine plantations were planted extensively throughout the Northeast. The motivation was probably multifaceted: widespread farmland abandonment meant that, in the eyes of some, good land was going to waste and plantations seemed a good way to rescue such land. At the end of the 19th century, in the face of extensive clearcutting and widespread farmlands, there had been marked concern about timber shortages; some of the resulting urge for reforestation extended into the 20th century, even once the forests started to come back on their own. Additionally, as already alluded to, because many abandoned fields were seeding to White Pine, there was the perception that 'working with the land' meant planting pine and that these would form stable, sustainable forests suitable for prolonged harvests. Finally, the Dust Bowl and the New Deal combined to provide motive and manpower (via the CCC) for the active planting of many acres. In 1927, for example, an inventory of state-run reforestation nurseries in New York reported over 86 million saplings or seedlings. All of these were conifers; more than 34 million of these were White Pine. Red Pine, the second most common tree, accounted for 17 million stems. After the Second World War, however, as prescient observers were already noting in the 1950s, plantation fever faded, and many of these plantations went unmanaged and, ultimately, unharvested. It was becoming clear that the forests would return on their own and that the more effective management was usually that of trying to tweak what the land naturally 'wanted' to produce (which, at least after the initial flush, was often not pine), rather than imposing a plantation.[41]

Our other common conifer is the **Eastern Hemlock**. Unlike the pines, the needles of the Hemlock are flattened. They are also, at roughly ½", shorter, and its cones are correspondingly diminutive. We have found this tree most commonly on steep, often somewhat north-facing hillsides where it often co-occurs with Chestnut Oak. It also occurs in ravines. Perhaps, in part because of the topography that it chooses, Eastern Hemlock rarely gets as lofty as White Pine. Although a visit to the impressive hemlocks of Ice Glen, just across the border in Stockbridge MA, demonstrates the species' potential. Eastern Hemlock is considered a late-successional species in that it can grow up and maintain itself in the deep shade of a well-established forest. Its strategy appears to be that of biding its time. Small hemlocks will establish themselves, but they grow very slowly until an opening in the canopy provides them with a sun fleck to grow into. Some hemlocks with a diameter of only an inch or so may already be many years old. Even once 'released' to grow more rapidly, growth is relatively slow: according to our ring counts on cut hemlocks on a west-facing Hillsdale slope, a 10.5" tree might be 175-200 years old. Because of this slow, shade-tolerant life style, extensive Eastern Hemlock usually indicates that a forest has been relatively undisturbed, at least for the past century or two.

As already mentioned, the prime historical use of hemlock was for tanning. The best concoction was reported to be a mixture of ground oak and hemlock bark, with the reddish effect of the hemlock balancing the lighter color of oak-tanned leather. We have an interesting mid-19th century account of tanning in the County from the tanner at the New Lebanon Shaker village. At that time, he reported using hemlock, but his process was also spiced with chicken manure and tansy.[42]

Our other common conifer is the **Red Cedar.** This tree is, in fact, not a true cedar, but rather a juniper. The blue, berry-like fruits of cedar are used to flavor gin. Red Cedar is unique amongst our conifers in having two distinct needle types: on low branches, it produces sharp, pin-like needles that, as a quick handshake with such a branch demonstrates, likely would discourage browsing; higher up, the needles become flatter and softer, perhaps less of an impediment to browsers, but better solar power collectors. Its reddish bark peels off in shreds that some birds use in their nests. Birds return the favor by dispersing the Red Cedar's seeds.

In Columbia County, Red Cedar seems most apt to invade old pastures on calcareous soils. We know of farms in the relatively alkaline or basic soils of the Harlem Valley where it forms dense, almost pure stands. In Ontario, it is reportedly a plant of thin-soiled but again limestone-based alvars. In northern New England, Red Cedar's shrubby sister, Common Juniper, replaces it as a pasture invader. We have found Common Juniper only occasionally in the County. Note that Red Cedar, given its somewhat protective foliage, is particularly indicative of old pastures. As the grazing intensity on a pasture declines, Red Cedar begins to sneak in; so long as as livestock can eat something else, they do so.

Although farmers may not have welcomed Red Cedars to their pastures, they did and do welcome its presence for other reasons – its rot-resistant wood (reportedly lasting about twice as long as White Oak in the ground, perhaps four to five times longer than ash, beech, Red Oak or birch) and its tendency to not grow much larger than 6-8" in diameter make it a preferred material for fence posts. Of our local trees, apparently only the introduced (from farther south) Black Locust lasts longer.[43]

Red Cedar also is part of a relationship similar to that which we already mentioned in relation to the White Pine Blister Rust. It is an intermediate host for Apple/Cedar Rust. On apples, Apple/Cedar Rust produces 'unsightly' rashes on the fruit and leaves. On the Red Cedar, it produces so-called cedar apples. These golf-ball sized lumps are dry and corky for most of the year, but erupt into multi- (much more than eight-) footed octopi with drooping orange, jelly-like legs (see Fig. 32). These structures produce and help disperse the spores that will then cause the rust upon the apples.[44]

Figure 32. *The orange octopus of Apple-Cedar Rust. This fungus, which afflicts apples, uses Red Cedar as one of its hosts. This is a springtime photo of the fungus's ripe fruiting body.*

Several other conifers appear in the County but are not as common. Northern White Cedar is relatively frequent along the banks of the Hudson. Red Spruce and Balsam Fir may also trickle into the northeast corner of the County. Both these species are somewhat common on the Rensselaer Plateau just north of us.

Deciduous Trees

Because of space, only our most common oaks, hickories and maples are described below. Many other deciduous trees occur here, including American Basswood, American Beech, a variety of cherries, poplars, ashes and birches, and at least two species of elms.

Oaks, as a group, are the mainstay of many of our forests, especially outside of the eastern hill country. Unlike most of our conifers, most of our oaks have their center of distribution farther south. Their presence is typical of the so-called Oak-Hickory Forest that occupies (or used to occupy) much of Appalachia and extends into New York primarily along the Hudson Valley and into the warmer climes around Lake Ontario.

There are around ten species of oaks in the County, but only three of them (Red, White and Chestnut) seem to be common. The oaks are generally divided into two groups: the Red Oak Group and the White Oak Group. Species of the former group have sharp-pointed leaf lobes that usually terminate in a short spike, while those of the White Oak Group are smoothly round-lobed. The acorns of the two groups also differ. Red Oak-type acorns usually are high in tannins, mature on the tree for two years (and hence Red Oaks bear tiny acorns through the winter), and do not germinate until the spring after they fall to the ground. White Oak group acorns tend to have less tannins (and hence be sweeter), take only one summer to grow, and germinate late in the year that they fall. Squirrels know the difference: they eat the White Oak acorns when they fall, but cache the Red Oak nuts for the winter.[45]

Red Oak is our most common oak, and one of our most common trees. Historically, White Oak may have been more common, but our last two or three centuries of land use seem to have favored Red Oak in several ways. First, Red Oak timber was not as desirable as that of White Oak and hence may have been less intensively cut historically; second, Red Oak's occurrence may not have been as concentrated on the arable farmlands as White Oak's and so might not have been as impacted by agricultural opening of forest; third, Red Oak seems to be a more ardent stump sprouter, meaning that, if cut, it quickly sends up new shoots from its stump; finally, Red Oak may not be as delectable to deer as White Oak, and so might cope somewhat better with our currently high deer densities.

Red Oak (Fig. 33) is characterized by the moderate lobing of its spike-tipped leaves (not as deep as on the leaves of Scarlet Oak and Pin Oak), the shallow, saucer-like acorn cup, and the tight bark that flattens to polished plateaus higher on the trunk. It most closely resembles Black Oak, although the latter has tufts of hair on the underside of the leaf where the side veins join the main vein. Mature

Black Oaks also have blockier bark, and a scruffier, deeper acorn cup. Today, Red Oak is generally considered a good wood. The selective cutting that typifies much recent logging in our region seems to favor this species. One frequently finds multi-trunked individuals. These usually reflect previous logging when, facilitated by low deer densities, stump sprouts grew up around the cut mother tree.

Red Oak is broadly distributed in the County, and one can expect to find at least occasional Red Oak in almost any situation except the wettest or driest forests. It is most common in our somewhat dry forests where it usually co-occurs with hickories.

Aside from its more rounded leaf shape (see Fig. 33), **White Oak** can be distinguished from Red Oak by its smaller, deeper acorn cup, and its lighter, flaky bark. Once you acquire the search image, you'll be able to scan a forest of tree trunks and pick out the White Oaks just from their bark. For many building uses, the hard but workable wood was deemed ideal timber. In 1846, after describing this value, George Emerson, wrote, "The great value of this tree has caused the destruction of almost all trunks suitable for timber, so that it is [now] rarely found of large size." The acorns are said to be palatable raw or cooked, but they are rarely found given their sporadic production and their eager consumption by wild animals. Although it has apparently declined in the County during the past few centuries for the reasons explained earlier, it is one of the species which climate change models predict will increase regionally.[46]

Chestnut Oak does not occur as widely as Red Oak or White Oak, but where it does occur, it can be quite common. Chestnut Oak was so named because its unlobed, ripple-edged leaves somewhat resemble those of American Chestnut, an analogy that is now lost on a generation who so rarely see the latter tree. The bark of older Chestnut Oaks is unique, it is tight and yet deeply furrowed, almost as if the trunk had swelled inside a one- to two-inch-deep mud mask. Its acorns are amongst the largest of our oaks. Although little wider than those of Red Oak, they are almost twice the length.

Chestnut Oak is found mainly on dry hillsides and ridges where its spindly, twisted form joins the likes of Eastern Hemlock and, sometimes, on flatter ground, Red Oak, White Pine and hickories. Its irregular growth form, rough terrain, and relatively small size mean that it has only occasionally been used for timber. Its bark was, however, reported to be excellent for tanning, and was said to provide balance to the red tanning of Eastern Hemlock (which, conveniently, often grows beside it).

This tree's thick bark and willingness to re-sprout suggest that it is a fire-adapted species, i.e., a species that can deal better with and hence is more favored by fire than most of our other native trees. Did fire play a role in establishing Chestnut Oak in our landscape? It is hard to find direct evidence for fire's importance in our County. Hemlock, with which it frequently co-occurs, is not considered a fire-adapted species, and so it seems unlikely that fire strongly shaped such stands. Instead, it appears that they share a tolerance of shallow soils.

Our remaining oaks are much less common than these three. Black Oak seems to be scattered through some Red Oak forests. Scarlet Oak is widespread but "occasional" in drier forests, Pin Oak might be rare in some wetter forests, Bur Oak pops up here and there, at least in the more south westerly woods, and Scrub Oak (a shrub rather than a tree) is found on dry hilltops, especially in the Hill Country.

Oak forests support a wide diversity of insects. As Alpheus Packard, in his 19th-century forest insect book, put it, "the oak is preyed upon by a larger number of kinds of insects than perhaps all other hardwood forest trees mentioned in this work put together"; a bane to the oaks, but a boon to our native insects. He goes on to refer to over 400 species that feed on oaks. The gallmakers are one group of such insects. Galls are the bubble-shaped swellings that one often finds on oak leaves. They seem to vary from the size of a blueberry to that of a quail egg. Although other plants also have galls, oaks are particularly afflicted. Galls have apparently evolved to protect and feed the young of certain wasps, flies and moths. They are formed by unusual, swelling growth of the host plant's tissues that is caused by the insect parasite. The maturing larvae usually lie at the heart of the gall and feed upon a dense sphere of plant flesh. Many galls have a spongy layer around this harder, central 'pit.' There are estimated to be some 800 species of insects, mostly wasps, who form galls on oaks. One European Oak gall is the source of a key ingredient in the indelible dye that we still use in printing money.[47]

Figure 33. *Red and White Oak (top and bottom) as illustrated in Michaux's* Sylva. *Oaks of the Red Oak group (which, aside from Red Oak itself includes the likes of Black and Scarlet Oak) tend to have more pointed lobe tips than those of the White Oak group (which also includes species such as Swamp White Oak and Chestnut Oak).*
Images courtesy of the New York Public Library

Oak forests are likewise home to a diversity of moths. One New Jersey study recorded more than 1,200 species of moths (and a few butterflies) in a single oak forest. While not all of these had caterpillars that fed on oak, most probably did. Oak forests contain by far the largest number of moth species of our different forest types. These range from small, non-descript species through some of our larger saturnid moths, such as the Cecropia and Polyphemus moths (although the larvae of neither confine their diets to oaks). Sadly, many of our most prominent forest moths are now rare, apparent victims of larval parasites introduced to combat pests such as the Gypsy Moth. A moth collection made by John Adams in Canaan during the 1950s contains numerous examples of Luna, Cecropia and Polyphemus moths, species which today, despite (or perhaps because of) all our bright lights, we see more rarely.[48]

Figure 34. *The buds of our common hickories, Bitternut, Pignut and Shagbark (from left to right). The sulfur-yellow buds of the Bitternut are good for ID at almost any age and season. Buds are to scale – the buds of Shagbark are noticeably larger than those of Pignut.*

Why oaks should be particularly blessed (or damned) is not completely clear. In part, it probably reflects the fact that oaks have long been a dominant and diverse group in our forests, meaning that insects have had ample time and material for diversifying.

Our most common hickories are Bitternut, Pignut and Shagbark (Fig. 34). All hickories have compound leaves. This means that their leaves are formed by a collection of distinct leaflets (picture an oak leaf whose leaves were so deeply cut that each lobe came to resemble a miniature leaf, i.e., a leaflet). Unlike the ashes (our other common group of compound-leafed trees), hickory leaves emerge from alternate sides of the twig rather than being situated in pairs located opposite to each other. All hickories produce nuts that are shielded by a tough husk that is green on fresh nuts, but which subsequently turns brown.

Shagbark Hickory is the easiest and, in some ways, most rewarding hickory to identify. Its grey bark peels off in long, hard flakes or strips, giving the tree a shaggy appearance. The fruits are about the size of golf balls. Once ripe, their thick husk falls away to reveal a nut about the size of a large jaw breaker. The nut is edible and tasty, although it requires some work with nutting tools to extricate the sweet meat. Native Americans apparently pounded the nuts whole, added warm water, stirred, and then filtered off the floating bits of husk and meal. Our own attempt to do this produced a pleasing nut milk which, some suggested, a dollop of maple syrup would have perfected.

Shagbark nuts, now so rarely sought by people, were, 150 years ago, a matter of great commerce. In Boston, for example, Emerson reported the marketing of nuts from the surrounding countryside plus the importation of New York nuts. The wood apparently is strong and wears well, promoting its past use in wheel shafts and agricultural tools. It's also said to be one of the best firewoods, producing a clean fire and the highest heat per unit weight of any of our woods.

Shagbark Hickory illustrates a pattern that is true for many of our fruit- or nut-bearing trees: production occurs in periodic bursts during some years (called masting years). In some species, it tends to be coordinated so that almost all or almost none of the trees of a given species are producing. Nut production during masting years is many times that of off years, and the bonaza ripples through the demographics of nut-feeding animals like mice and squirrels. For Shagbark, such masting reportedly occurs at intervals of 1-3 years. Shagbark Hickory is usually found scattered in the woods, on somewhat moist to somewhat dry soils. We once found a stunted, weather-beaten 'alpine specimen' sitting in an exposed position on rocks at the top of the Knob in Canaan.[49]

Bitternut Hickory, as the name advertises, is not to be sought for human food. The nuts are made bitter by a high concentration of tannins, a group of protective plant chemicals that are also responsible for the bitterness of Red Oak acorns (and of tea) and for the tanning properties of oak and hemlock bark. Tannins are one of the set of compounds known as 'plant secondary chemicals.' The name originated because plant biochemists couldn't figure out their metabolic purpose and decided that they must be 'secondary.' In fact, they are important self-defense mechanisms for the plant, part of the perpetual arms race between plant predators and the plant's defenses. These chemicals can be directly poisonous or can simply reduce the nutritional quality of the plant's flesh (picture dipping a candy drop in wax). Those insects that surmount a plant's chemical defenses often don't stop there. They incorporate the toxins into their own chemical defenses – the Monarch Butterfly's use of milkweed chemicals is a well-known example of this pattern. Many of these chemicals are also important for humans, being the foundations of many medicines (e.g., the salicylic acid that is the basis of aspirins comes from willows) and stimulants (such as caffeine or nicotine). It's believed that humans aren't the only ones to medicate themselves, and that some other animals have learnt that those plants that might be poisonous in excess, can be healing in moderation. Cattlemen have incorporated this behavior into the idea of medicinal leys, diverse pastures that are fitted into a herd's grazing rotation so as to give the animals the chance to treat themselves. Just as animals learn to avoid the plants that make them ill, they can also learn to favor the plants that, when they are already feeling ill, make them feel better. Whether or not Bitternut Hickory nuts are in any species' medicine chest, we don't know.[50]

The bark of Bitternut is much tighter than that of Shagbark. Its interlaced sinews give one the impression that the trunk swelled up inside of a wicker mesh. The nut itself is roughly the same size as a Shagbark's, however the husk is much thinner and is less apt to easily peel away. The most distinctive characteristic is the color of the buds – during the seasons when they are visible, they are a bright, sulfur yellow (see Fig. 34). Bitternut seems most common in moister forests. During a study of 15 of the County's floodplain forests, we found Bitternut Hickory at all sites; it accounted for an average of 5 to 12% of the trees in each of our four floodplain forest types. Shagbark and Pignut each occurred at only two of our sites. Except for its unpalatable nuts, Bitternut shares many of the same uses as Shagbark.

Pignut Hickory seems to shadow Red Oak in our forests, although it is rarely as common. It is sometimes split into two species, with the other species being called the Oval Pignut or Red Hickory. Most modern taxonomists conveniently lump these species together, but that shouldn't mask the fact that there is ample variation within the hickories and hybridization that can sometimes blur the lines of discrete species. Pignut is somewhat non-descript. Its bark is not as shaggy as Shagbark's nor usually as tight as Bitternut's. Its buds lack the yellow roughness of Bitternut's and are smaller than Shagbark's. Its fruit tends to be slightly larger than Bitternut's but smaller than Shagbark's. The husk is intermediate in thickness and the fruit is somewhat pear-shaped. Its uses are similar to those of the Bitternut. It is not clear if their bitter nuts were actually relished by forest-going pigs or if the denomination was a more generalized insult emphasizing how unfit they were for humans.

The ecology of our **maples** is, in some ways, intermediate between that of our conifers and that of our oaks and hickories. Many of the maples extend quite far north (there's a good reason why the Canadian flag does not bear a stylized hickory leaf!), although not as far north as our more boreal conifers. The maples also extend well into Oak-Hickory Forest to the south. We have five or six native maple species in the County: Red, Sugar, Silver, Mountain and Striped Maples; Box Elder, actually a maple, is believed by some to be a non-native imported to the region from farther south. Our two most common native maples are the full sized trees Sugar Maple and Red Maple (another relatively common maple, at least in the Eastern Hill Country, is Striped Maple or Moosewood, but it is an understory tree that rarely exceeds 3-4" in diameter).

Maples have entire, opposite leaves. That means that unlike the hickories (or ashes) but like the oaks and many other trees, their leaves are not dissected into leaflets but, instead, have a single, "entire" fan of green tissue on each leaf stalk. "Opposite" leaves mean that the leaves emerge directly across from each other on the twig rather than in an alternate fashion. (In winter, it is still possible to discern leaf arrangement because twigs extend from larger branches with the same opposite arrangement and the side buds of twigs are also opposite.) Maples are our only large tree with opposite, entire leaves. Norway Maple, whose leaves somewhat resemble those of Sugar Maple, is one of our few invasive trees.

Sugar Maples, together with maple syrup, are emblematic of New England. The value of Sugar Maple's sweet sap was long recognized by indigenous peoples, although they also tapped other trees such as some birches and hickories (the sap of these species can also be boiled down to syrup, but sugar content is substantially lower). The sap that is tapped in the Spring is the energy-laden, upward flow that Sugar Maples are pumping towards the twig tips as the tree wakes up for the next growing season. The sugars that give us energy also give the nascent leaves the energy that they need to grow and unfurl. In the 18th and 19th century, Sugar Maple's apparent potential attracted New York entrepreneurs who hoped to get a part of the West Indies' sugar market. One enthusiastic proponent acquired 130,000 acres near Rome, NY for a planned Sugar Maple sugar business. Technological difficulties seem to have plagued the first year, and the project never progressed. James Fenimore Cooper's father also evaluated entering the Sugar Maple sugar industry. In 2007, Columbia County reported the production of 913 gallons of syrup, or about .4% of New York's total production.[51]

Sugar Maple's internal sweetness seems to be reflected in some way in its bark chemistry. Lichens are those 'collaborative ventures' between a fungus and an alga that one sees as flakes or crusts on trees, rocks and some other structures. They often (but not always) have a greenish cast, be that as a tarnished copper color or a bright yellow-green. The fungal partner in the lichen provides the local structure, while the alga provides the photosynthetic machinery. As such, lichens are not parasites, instead the trees are mainly used as scaffolding for getting closer to the needed sunlight. Lichens are, however, very sensitive to the chemistry of the particular substrate they are growing on, probably because that surface largely determines the chemistry of the water with which the lichen is bathed during each rainfall (some lichens also have enzymes that let them 'mine' nutrients from mineral surfaces) and from which they gather nutrients. The bark of Sugar Maple is apparently a relatively rich substrate, and Sugar Maples are said to have a particularly diverse and lush lichen flora. One of these lichens is the so-called Can-of-Worms Lichen (*Conotrema urceolatum*).

It grows in large white patches on the trunks of Sugar Maple, often looking like a splash of whitewash. It is common and consistent enough that one can use it in the field as a reliable identification feature for Sugar Maple trunks.[52]

Sugar Maple is one of the trees that has apparently benefited from recent forest changes. One of the most obvious reasons for this may be that, unlike White Oak, Sugar Maple is as valuable alive as it is in the form of cut timber. Its wood is OK, its sap superb. Its life style is also favored by the selective cutting typical of much of our region's forestry during the past couple of centuries. It does best where scattered openings in the canopy let in some sun, and it will eagerly stump sprout if cut. It is most common in fairly moist, rich soil. Climate change models however predict its regional decline. It is a favorite winter browse of White-tailed Deer.

Red Maple (see Fig. 35) shares Sugar Maple's stump sprouting ability and may excel over that species. It is a scrappy tree that tolerates a wide variety of soil conditions. One can find it with its roots in standing water (as in Red Maple Swamps) or sharing a thin-soiled hillside with the likes of Eastern Hemlock and Chestnut Oak. We know of one such hillside where the slope is broken by a large ledge which cups a small vernal (i.e., seasonal) pool. There, its base surrounded by water for much of the year, stands a rotund Red Maple.

Red Maple is fast growing, but, although rarely reaching the proportions of some of our County's majestic Sugar Maples, can regularly reach two feet or so in diameter. It is however easily damaged by ice storms, fire and fungi.

Figure 35. *Typically ragged-edged Red Maple leaves beginning to head into autumn. Red Maple is one of our most wide-ranging species, ecologically speaking.*

Natural History Profiles: Mammals

Forest Mammals. Most of our larger native mammals are, more or less, associated with forest. Some appreciate edge or mixed habitats, but all are primarily woodland dwelling. Their historical ebb and flow has largely reflected the ebb and flow of woodland, human exploitation, and urbanization. Fig. 36 presents approximate New York State range maps for these species at various points in history. Note that these are occurrence maps and may not reflect established residence.[53]

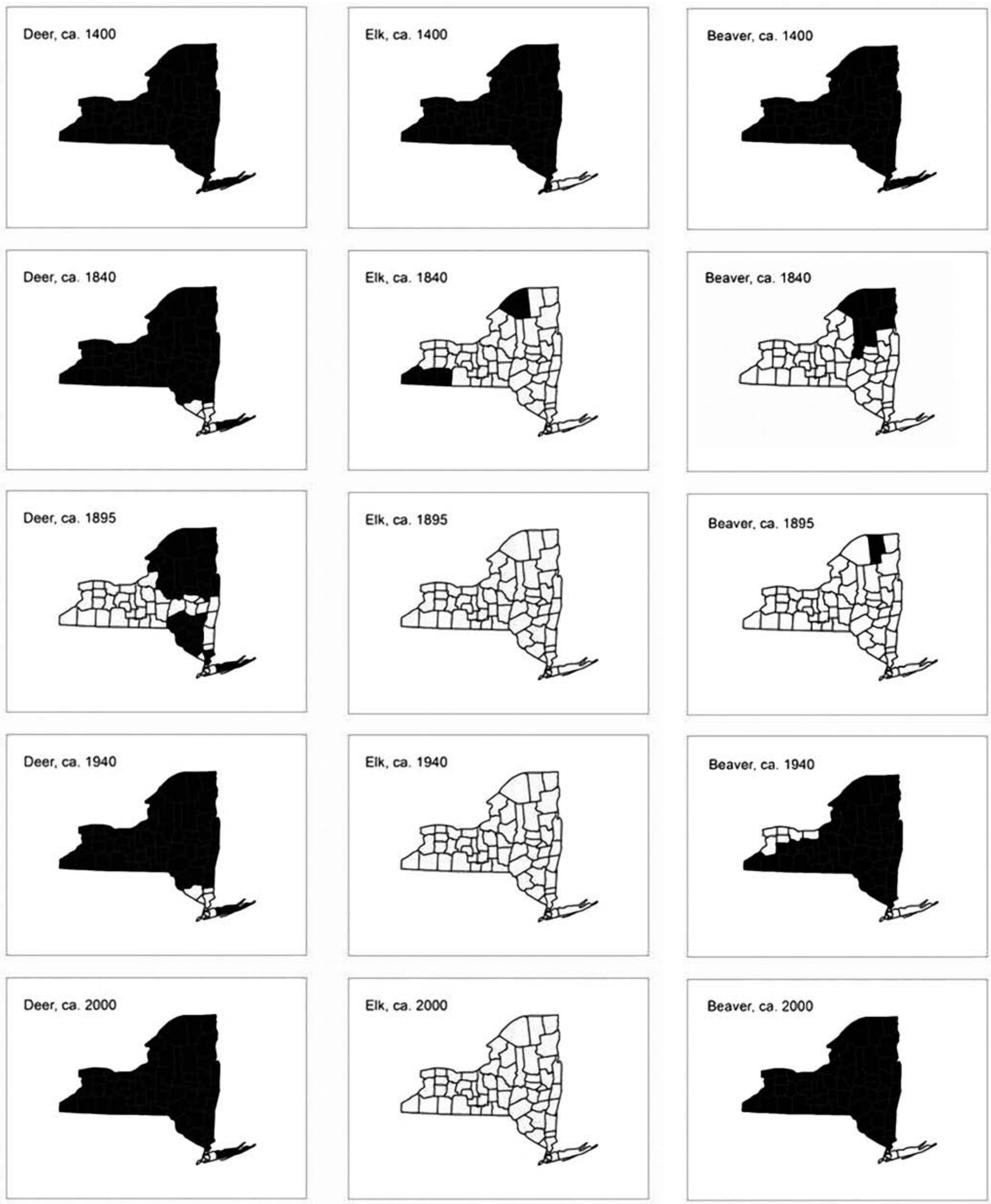
Prior to European settlement, several large mammals ranged throughout most of the State, but then disappeared, and breeding populations have not returned. These include Elk, Eastern Timber Wolf, Eastern Cougar and Wolverine. Other mammals, such as Mastodons, existed in the County after the last glaciations but were already extinct by 1500. In 1705, Claverack happened to be the site of the first recorded find of Mastodon remains in North America. Wooly Mammoth, Reindeer and American Bison also occurred in New York, although there are no records of any of these specifically for Columbia County, and it is still unclear how far east the American Bison came (teeth were reportedly recovered near Albany).[54]

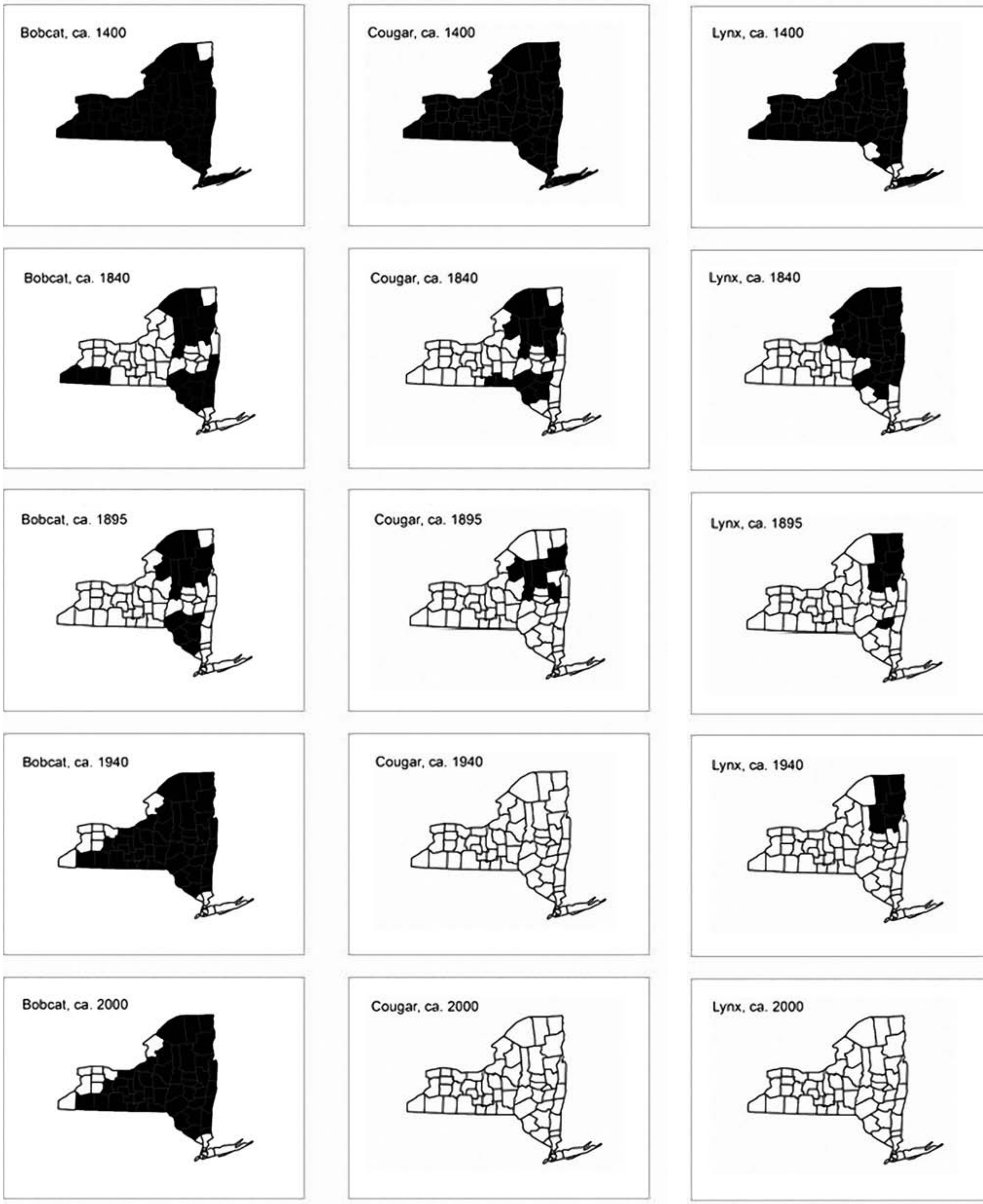
Elk are large relatives of the deer, weighing up to twice that of the latter species. It is supposed that they existed throughout almost all of New York except Long Island at the time of European settlement. They waned quickly, possibly because they were prime game animals and their herding habits made them conspicuous and their breeding congregations could be easily disrupted. By 1840, they were, except for some last pockets, all but gone. They went extinct in New York State in the early 20th century, and despite efforts to re-introduce them, they have not returned. (Although, as with many of these species, there have been occasional apparent strays – one was shot in Essex County in the 1940s or 50s). While their diets overlap with those of White-tailed Deer, Elk probably graze more and browse less. Moose showed a similar ebb, but have since begun to return with regular, if scattered, reports from the County during the last decade.[55]

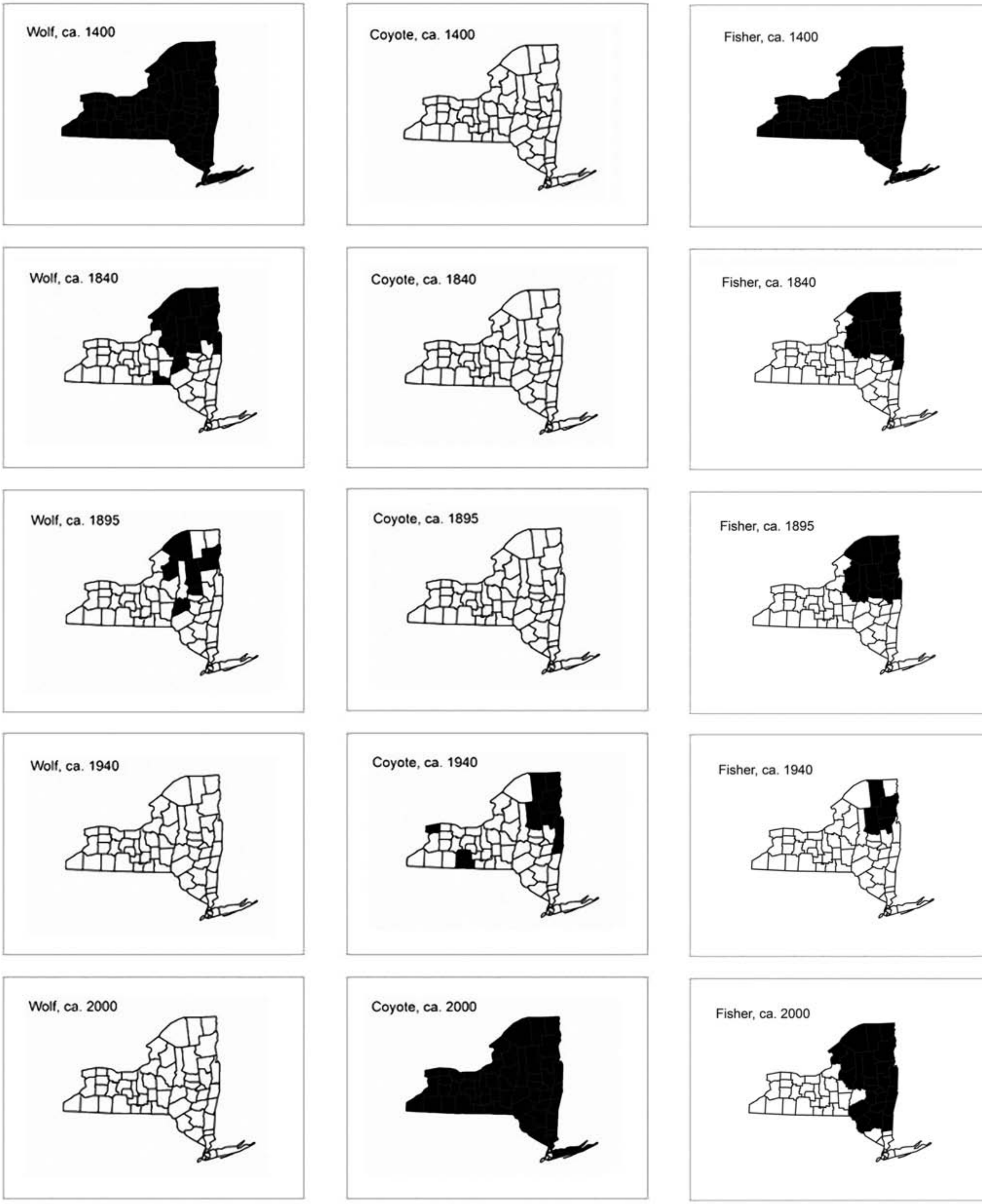
Deer warrant more detailed consideration, given their familiarity and current abundance. Our local species is the White-tailed Deer; Mule Deer (also called Black-tailed Deer) is the analogous western species.

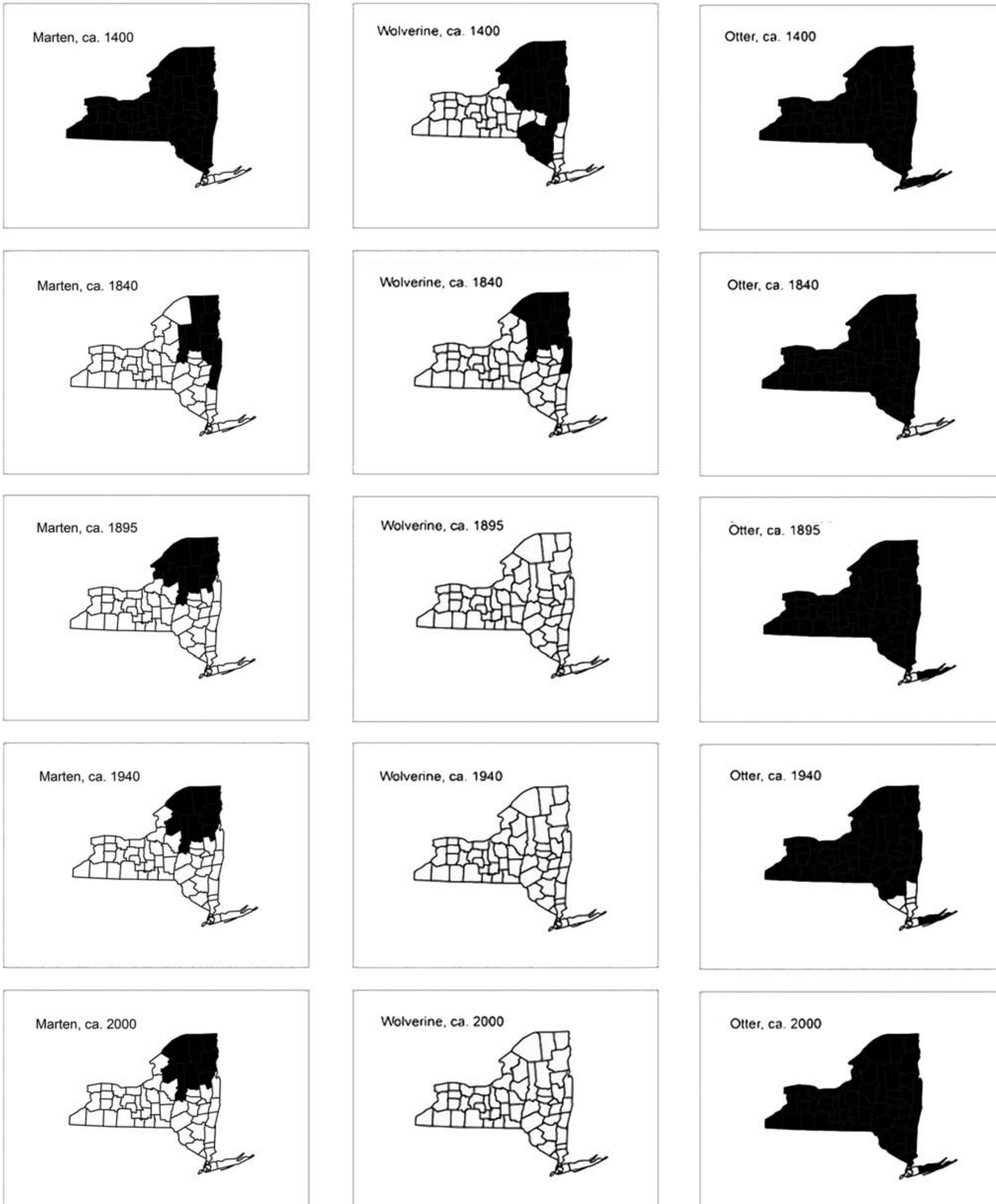
Early European visitors to the Hudson Valley and much of the East Coast commented on the abundance of deer and other game. Certainly, compared with densely settled Europe, game animals abounded in unimaginable numbers, despite the effects of Timber Wolves, Eastern Cougar and Native Americans. Europeans were quick to exploit this source of food.

Figure 36. *Maps on the next four pages show changes in the approximate New York distribution of several of our forest mammals as garnered from historical publications. Almost all species were probably widespread prior to European settlement. Most contracted during the peak of 19th century agriculture; some have since rebounded, others continued to decline and went extinct in New York State.* See Note 54 for sources.


Deer, ca. 1400
Elk, ca. 1400
Beaver, ca. 1400
Deer, ca. 1840
Elk, ca. 1840
Beaver, ca. 1840
Deer, ca. 1895
Elk, ca. 1895
Beaver, ca. 1895
Deer, ca. 1940
Elk, ca. 1940
Beaver, ca. 1940
Deer, ca. 2000
Elk, ca. 2000
Beaver, ca. 2000


Bobcat, ca. 1400
Cougar, ca. 1400
Lynx, ca. 1400
Bobcat, ca. 1840
Cougar, ca. 1840
Lynx, ca. 1840
Bobcat, ca. 1895
Cougar, ca. 1895
Lynx, ca. 1895
Bobcat, ca. 1940
Cougar, ca. 1940
Lynx, ca. 1940
Bobcat, ca. 2000
Cougar, ca. 2000
Lynx, ca. 2000


Wolf, ca. 1400
Coyote, ca. 1400
Fisher, ca. 1400
Wolf, ca. 1840
Coyote, ca. 1840
Fisher, ca. 1840
Wolf, ca. 1895
Coyote, ca. 1895
Fisher, ca. 1895
Wolf, ca. 1940
Coyote, ca. 1940
Fisher, ca. 1940
Wolf, ca. 2000
Coyote, ca. 2000
Fisher, ca. 2000


Marten, ca. 1400
Wolverine, ca. 1400
Otter, ca. 1400
Marten, ca. 1840
Wolverine, ca. 1840
Otter, ca. 1840
Marten, ca. 1895
Wolverine, ca. 1895
Otter, ca. 1895
Marten, ca. 1940
Wolverine, ca. 1940
Otter, ca. 1940
Marten, ca. 2000
Wolverine, ca. 2000
Otter, ca. 2000

By the middle of the 19th century, White-tailed Deer were becoming a rare beast in some rural areas, probably including Columbia County. Reporting from nearby Williamstown, Ebenezer Emmons in 1840, affirmed that "it has also been taken within the past year in Williamstown." Obviously, deer were rare enough to make this a noteworthy occasion, although he does go on to say they were common in the "Hoosic Mountains." DeKay, writing two years later about New York mammals, confirmed that Catskill populations were still supplying New York City, but cautioned that "the united attacks of men and wolves are daily decreasing their number." Audubon and Bachman, writing in the 1840s, reported that it existed in all Atlantic states, albeit in "diminished numbers." From Concord Massachusetts, Thoreau (1860) noted in his journal that "Farmer says that a farmer in Tewksbury told him two or three years ago that he had seen deer lately on the pine plain thereabouts." White-tailed Deer appear to have been approaching the stuff of urban myth. All agreed it was an elusive animal, rarely seen in the open. Ernest Thompson Seton, a noted artist and naturalist, put the nadir of New York State White-tailed Deer populations at 1890, when they were found only in the Adirondacks.[56]

By the end of the 1800s, White-tailed Deer were extinct or nearly so from several Midwestern and Mid Atlantic states, although in some regions legal protection was apparently helping populations begin to rebound. One author, writing in 1902, commented, "It is said that in some parts deer are already making decided nuisances of themselves by foraging on the farmer's crops; I trust it is not a far look ahead to the time when it will be true of them where I live in New Hampshire." In 1914, William T. Hornaday, director of what is now the Bronx Zoo, proclaimed, "The author is proud to be able to say that in Putnam County, New York, his family garden is regularly visited and browsed by real wild deer."[57]

This general scenario is reflected in the graphs showing buck harvests in Columbia County and New York (Fig. 37). During the first quarter of the twentieth century, there were very few White-tailed Deer in New York. As populations rebounded during the second quarter of the 20th century, hunting seasons were opened and harvest increased. The White-tailed Deer populations continued to grow through much of the remaining decades of that century. According to DEC numbers, recent drops in harvest probably partially reflect declining hunter numbers — between 2002 and 2007, New York State big game license sales declined more than 7%; in Columbia County, total resident hunting license sales declined more than 15% over the same period.

The history of White-tailed Deer in Columbia County during this period is perhaps best summarized by the short essay from the November 27th, 1941 issue of the *Chatham Courier*:

> *While records are not as yet available as to the number of deer shot in Columbia County this season, yet from all reports the take should be quite high.*

> *To have an open season in this county is a matter of only recent years and it is not so very long ago that the mere sight of one of the animals was worthy of newspaper comment.*
>
> *Why deer have increased here in the last thirty years is probably due to two factors, the first of course is the greater interest of thousands of persons in the proper observation of the Conservation Law and secondly, because of the importation about forty years ago of a number of Virginia White Tailed Deer into Vermont to replenish the diminished herd in the Green Mountain State.*
>
> *These deer, or rather their descendants, increased very rapidly and moved south into the Berkshire Hills and from thence they migrated across the New York State line. While there may be some who advocate that because of the destruction of the bucks and the apparent increase of does which would throw the herd out of balance in relation to its reproductive capacity, yet it would not seem that the time was yet at hand when the females could be shot as well as the males.*
>
> *Opening this sort of wholesale slaughter would soon find Columbia and most of the eastern New York counties without the necessity of a deer season whatsoever, because there would be no deer to shoot.*

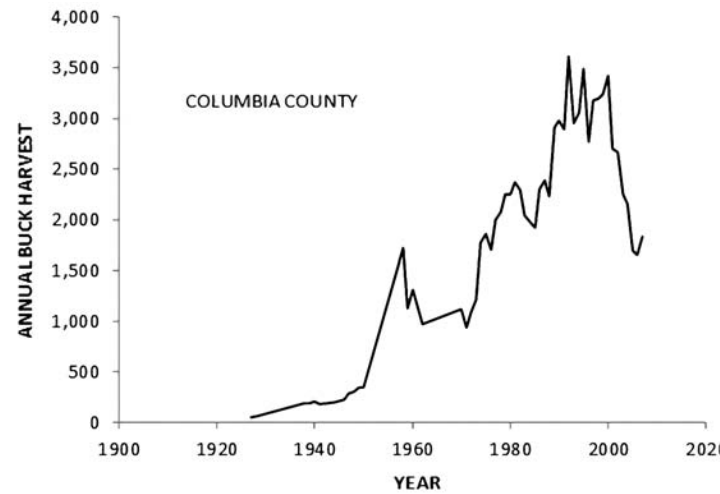
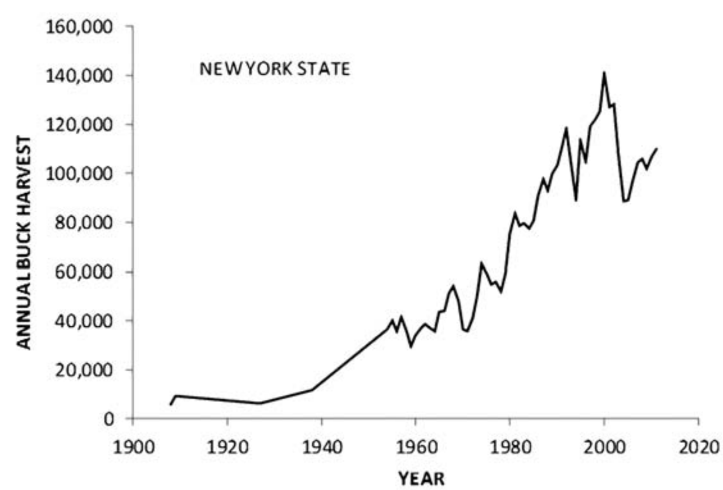


***Figure 37.** Buck harvests, as reported to the NYS Department of Environmental Conservation, for Columbia County and New York State as a whole. While these graphs reflect factors other than just buck abundance, they clearly show the post-1950 growth of the White-tailed Deer populations. Recent declines in harvest may reflect declines in hunters rather than deer.*



As this article implies, early in the century the mere sighting of a deer was cause for newspaper comment ("Virginia White Tailed Deer" was the common name for the species, and probably not indicative of the introduction's origin). For example, in 1898 there was apparently the published record of a single deer seen near Cheviot in Germantown. In 1902, the sighting of two deer in Canaan apparently made front-page news. The December 23, 1913 issue of the *Hudson Evening Register*

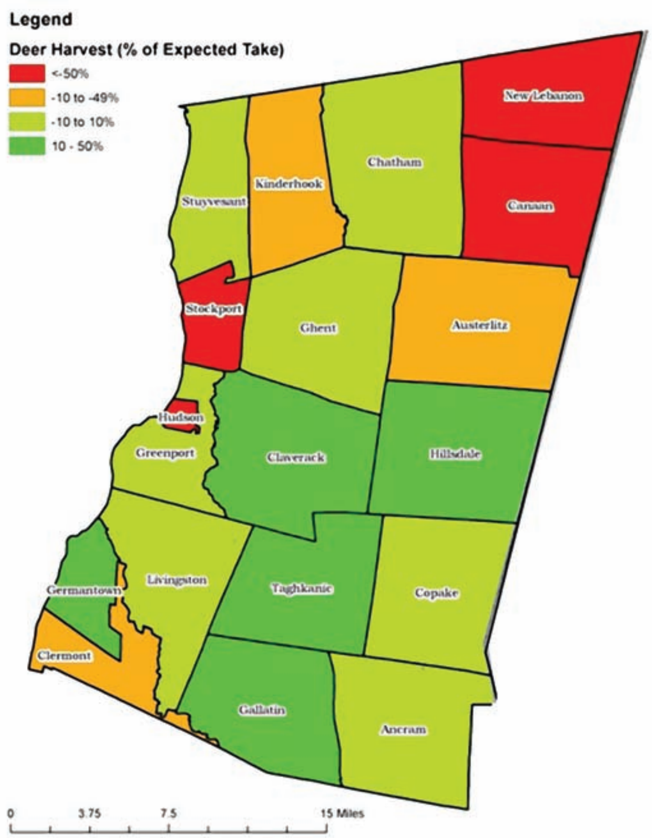


Figure 38. *The 2007 buck harvest in Columbia County (according to DEC data). The map shows actual take as a percent of the harvest predicted based upon the town size and the assumption that harvest is uniformly distributed. Compare to Fig. 18. Note that the highest harvests seem to come from towns with intermediate amounts of forest.*

contains the news that eight deer were seen near Harlemville and six fawn near Hollowville; in the April 8th issue of the following year, the sighting of five deer in Hillsdale and two near the Greendale railroad station (just southwest of Olana) made the paper. During the end of the second decade of the 20th century and throughout the following, deer sightings apparently climbed, with deer reported to be plentiful in Austerlitz and the Green River Valley in 1916, and numerous reports during following years. In 1928, deer were again reported to be numerous in Austerlitz. In 1934, British novelist John Cowper Powys and nature writer Alan Devoe got together near Harlemville as, essentially, the former gave the latter the keys to his house; on their last outing together they observed a herd of some 20 deer. That said, Rogers McVaugh remembered seeing no deer during his 1938 botanical fieldwork in the County, perhaps in part because deer are less conspicuous during the summertime.[58]

The demographic rebound was probably the combined result of the introduction of hunting laws and the lack of natural predators, together with the post-agricultural resurgence of the shrubland and secondary forest which White-tailed Deer so appreciate. The rebound has been fortified by our landscaping emulation of English parklands with their sweeping lawns and interspersed bushes and trees; in England, such parks were originally designed expressly to support the royal deer herds; they continue to effectively fulfill this demographic function in our landscape today.[59]

A mapping of the recent harvest statistics (see Fig. 38) suggests that White-tailed Deer are most common in some of the towns which are intermediate in terms of forest cover, regions that have ample forest shelter but also substantial open land for foraging.

Surges in deer populations were initially welcomed as a demonstration of a conservation success, but these mounting deer populations were soon recognized to cause damage to other native species. While the shade of the canopy is sometimes responsible for a relative dearth of understory and herbaceous ground plants in our forests, deer browsing is often the explanation. The late Mike Greason reportedly observed that forests near cornfields tend to have better regeneration because, he explained, the neighborhood deer eat more corn and fewer saplings. The deer-browsed forest tends to feel more open and airy than one with a thicker growth near the ground, a growth that clutters the view and trips the foot; but, if the majority of saplings are browsed, then it is, in some ways, a forest without a future. In work that raised the ire of some traditional game managers who had become focused on the goal of raising deer populations, botanists soon began pointing out that the forests were being radically altered by deer activity. All of a sudden, wildlife managers whose *raison d'être* had been the maintenance of deer populations were being criticized for succeeding too well.[60]

Today, it is widely recognized that deer have profound ecological impacts on forests. When they exist in population densities well above historical levels, they can have very measurable effects on plant communities. For example, in our outings we rarely see Canada Lily, a graceful chandelier of a lily with large, drooping flowers reminiscent of an upside-down Day Lily. According to Dr. McVaugh, Canada Lily was common in our landscape during the 1930s. This Lily is apparently a favored deer food, and while Rogers McVaugh recalled seeing few if any deer during his days afield, none of the forested sites we visit today are without deer. Their trails often criss-cross the wet forests where this flower abides. Other herbaceous (that is, not woody) native plants said to experience high levels of browsing include trillums and orchids. Quebec researchers found that if one excluded deer from certain plots of forest, those sections grew 2-4 times (depending on the plant groups assessed) more plant material by the end of the season.[61]

Deer population management is not a simple issue, but we should be aware of the consequences of our choices: if, for example, we choose to do nothing to control White-tailed Deer populations, then we should be conscious that we are thereby choosing to reduce forest plant diversity and forest regenerative ability.

Mustelids are the family of mammals that include weasel, mink, badger, marten, fisher, wolverine and otter. It appears that, because of their small pelts and inconspicuous size, Short-tailed (aka Ermine) and Long-tailed Weasels and American Mink were able to survive throughout most of New York during the past four centuries. The **Northern River Otter** also seems to have been surprisingly resilient, although the historical literature makes frequent mention of severely reduced populations. Otter's ability to bounce back may have been due to its highly aquatic life style which meant that its habitat was less directly affected by humanity's changes to terra firma (although water pollution, fishing, and siltation no doubt had their influence). River Otters are occasionally seen in the County.; according to DEC records, 17 were trapped in the County during the 2012-2013 season.

The biggest of our native mustelids was the **Wolverine**, with males averaging perhaps 50% larger than male River Otters. They are muscular scavengers and predators. At the time of European settlement, they apparently occurred in the Adirondacks and Catskills, but by the middle of the 19th century they were gone from the Catskills and by end of that century, they were gone from the State. I have found no definite record of them in Columbia County, but there are historical reports of them in Rensselaer County and in the Hoosic Mountains of northwestern Massachusetts, so it wouldn't be surprising if they had occasionally roamed into our woods. Wolverines were apparently trapped and hunted for their pelts and as pests. The timing of their disappearance parallels that of the Beaver to some degree, however, there were no subsequent efforts to re-introduce them.

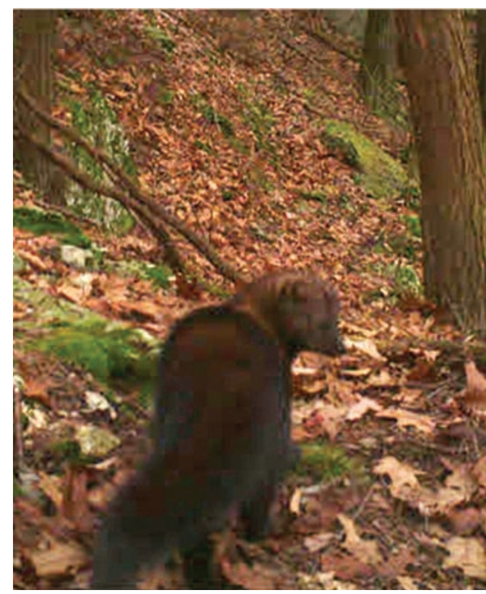


Figure 39. A game camera image of a Columbia County Fisher. These are dark-furred members of the weasel family, slightly larger than house cats. Fisher have returned to Columbia County during the past few decades.

American Pine Marten and **Fisher** (see Fig. 39) are large, weasel- or mink-like animals that share the same genus (*Martes*). Both animals seemed to also share similar pre-settlement ranges in the County, although the former was apparently absent from the environs of New York City and Long Island. Both probably occurred in Columbia County, and there are specific reports of marten from adjacent western Massachusetts during the first half of the 19th century. By the beginning of the 1900s, these animals had retreated to the Adirondacks, and today American Marten remain largely confined there, although in 2013 naturalist Nancy Kern reported seeing one near her Hillsdale house. When I was growing up in the County in the 1970s, these animals were exotic, distant animals. Fisher, at least, have returned. By the late 1990s they were wandering through the County, and we now regularly find their tracks in the snow. Why the Fisher should have rebounded but not the American Marten is unclear. It may be that New York is near the southern margin of the marten's range, and so that species was never as common here as the more-southerly Fisher.

Three species of wild cats range or have ranged through the County: the Eastern Cougar (also called Puma, Mountain Lion, Catamount and, sometimes, Panther), the Canada Lynx and the Bobcat. The first two are now, except perhaps for the occasional visitor, probably extinct in our area, the last has returned like the Fisher.

Eastern Cougar shared the fate of Eastern Timber Wolves and were assiduously hunted out of the state as dangerous varmits. In New York, bounties were paid for Eastern Cougar through the end of the 19th century. At the same time, as we have already described, White-tailed Deer, the Eastern Cougar's main prey (see Fig. 40 for a general description of the diets of some of our regional carnivores), were being decimated. Direct persecution and loss of food led to the effective extinction of the Eastern Cougar by the middle of the 20th century.[62]

The current debate over Eastern Cougar is threefold: Are there cougars in the Eastern United States? If so, are they a self-sustaining population or merely occasional escaped pets or disperers from the Midwest? And, was/is the Eastern Cougar a distinct subspecies from the Western Cougar? The answer to the first question appears to be a definite yes. Repeated sightings of cougars or their sign, occasional photographs, and now even a roadkill all confirm that, at least occasionally, cougars occur in the Northeast. No doubt many sightings are erroneous, but not all.

The population status is less clear. In the summer of 2011, a two- to five-year-old male cougar was killed on a Connecticut road. Its DNA and its condition suggest that it was a wild animal which had dispersed east from the Black Hills of South Dakota; indeed, DNA evidence linked that individual to sightings during the previous two years in New York, Minnesota and Wisconsin. This corroborates other evidence suggesting that, in addition to escaped pets, a few mid-Western Cougars do regularly come eastward. Most may be young males seeking new home ranges. At present, there is no solid sign of an established breeding population in the Northeastern United States; their status in eastern Canada is unclear.[63]

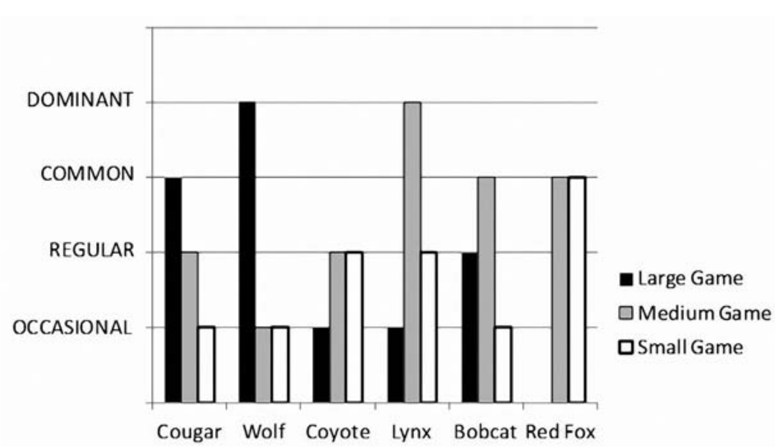


Figure 40. *The generalized diets of some of our larger, local carnivores based upon published information from elsewhere. "Large game" refers mainly to deer in our region; "medium game" would be rabbits, squirrels, groundhogs, and the like; small game are mice and song birds. Wolves and cougars are our main deer predators, although the bobcat apparently takes a surprising number under certain conditions; lynx favor hare, while the Red Fox is probably our biggest mammalian mouse predator.* Diet information gleaned from books such as *Wild Mammals of North America* (1982) by Chapman and Feldhamer, *Wild Mammals of New England* (1977) by Godin, Whitaker's unpublished *Mammals of New York*, and Jackson's *Mammals of Wisconsin* (1961).

On March 2nd, 2011, the US Fish and Wildlife Service declared that the Eastern Cougar, as a genetically distinct subspecies, was extinct and may have been so since the 1930s. This does not mean that, officially, there are no cougars in the Northeast; rather, biologists sometimes partition species into subspecies populations (these are populations that seem to have been sufficiently isolated so as to have developed somewhat distinct genetics; for example, some consider Neanderthal Man to have been a now-extinct subspecies of humans), and USFWS had declared that one such subspecies, formerly described as endangered under the Endangered Species Act, was extinct. Aside from the Eastern Cougar, the USFWS continues to recognize one other cougar subspecies east of the Mississippi – the Florida Panther, with a population of <1,000 individuals). Other biologists suggest, based on genetic analysis, that there is and has long been only one subspecies of cougar north of Mexico.

In sum, there have been occasional, sometimes highly credible, cougar sightings in or near Columbia County and in other areas of the Northeast. It seems likely that one or more cougar may have moved through the County during recent decades. On the other hand, the reports are so sporadic that it seems very unlikely that any long-term residents exist. Cougars are elusive, but not invisible, and an established population would probably not go unnoticed for long. Based on the identity of cougar recorded from elsewhere in the Northeast, it is likely that those cougar which did enter the County were either released pets or far-ranging Midwestern dispersers, rather than relicts of an original, established, East Coast population. Given the suggestion that such a population was never, in any case, genetically distinct, such dispersers may have historically been part of cougar demographics in the East, and the natural re-establishment of a population from such individuals would represent a return in the same way that we earlier described the re-colonization of New York by certain other forest mammals.

Canada Lynx probably occurred at least occasionally in the County prior to colonization. There is a 19th century record from Rhinebeck in Dutchess County; and it was described as "not very infrequent" in Berkshire County around the middle of that century. Naturalist Alan Devoe even reported seeing one in the town of Hillsdale. The Canada Lynx's range shrunk as trapping and forest removal took their toll. In 1940, some Canada Lynx remained in the Adirondacks; today, they are apparently extinct in the State. Despite several attempted re-introductions, they have reportedly not re-established themselves. Some attribute the Lynx's final extinction in the Adirondacks to the increase of Bobcat. **Bobcat** favor lower, more southerly climes than Canada Lynx but also seem to do well in semi-open forest such as created around human settlements or in logged forests. As their numbers rose during the height of Adirondack logging, it is thought that Bobcat may have out-competed the Lynx. Adirondack Bobcat numbers are now waning, and new attempts are being made to re-introduce Lynx to those mountains. Bobcat or their sign are regularly seen in or around the County; like Fisher, they were rare or absent during my childhood in the 1970s.[64]

The **Eastern Coyote**'s distribution is a reverse image of the **Eastern Timber Wolf**'s, with coyotes appearing as the wolves disappeared from the state. Wolves were apparently found throughout New York State prior to European arrival, and coyotes were likely absent (there are some anecdotal early reports that could describe coyotes or, instead, the dogs of Native Americans). Wolves, like Cougar, were pursued as vermin. Bounties assured their demise, but deer depletion probably also contributed. Although wolves apparently occurred in the Adirondacks at the turn of the 19th century, they were soon gone. Coyotes apparently found their way in from the West at around the same time; they were first sighted in New York State in 1920 and in Massachusetts in 1936. It is thought that coyotes benefited from both the removal of wolves – who will attack coyotes – and the improving, human-caused habitat for White-tailed Deer. Their arrival may have been aided by intentional or accidental introductions. Today, coyotes are found throughout the state. The Eastern Coyote is noticeably larger (50-70% heavier; a very large male may top 70 or possibly even 80 lbs) than the Western Coyotes. Indeed, recent genetic work suggests our 'coyotes' are a mix of Western Coyote and Eastern Timber Wolf; with a little contribution from either domestic dogs or the Grey Wolf. Some have suggested that, rather than being considered a subspecies, they be considered their own species. (The Eastern Timber Wolf (*Canis lycaon*) is itself something of a genetic goulash; not everyone agrees it is a species distinct from the Grey Wolf.) Coyotes are frequently heard yipping and sometimes almost howling in our woods. In some places in the County, they are common enough to occasionally threaten small livestock.[65]

Red Fox (whose range is not illustrated in Fig. 36) also seems to have been rare or absent in much of New York in the 17th and 18th century, but increased subsequently. This species occurs in both North America and Europe, and, because of its popularity in the hunt, it has sometimes been suggested that eastern Red Fox were partially descended from European imports. Recent genetic work however shows no evidence of this. It is favored by habitat mosaics and, unlike its more forest-dwelling brethren, the Grey Fox, was probably aided by the spread of farmland.[66]

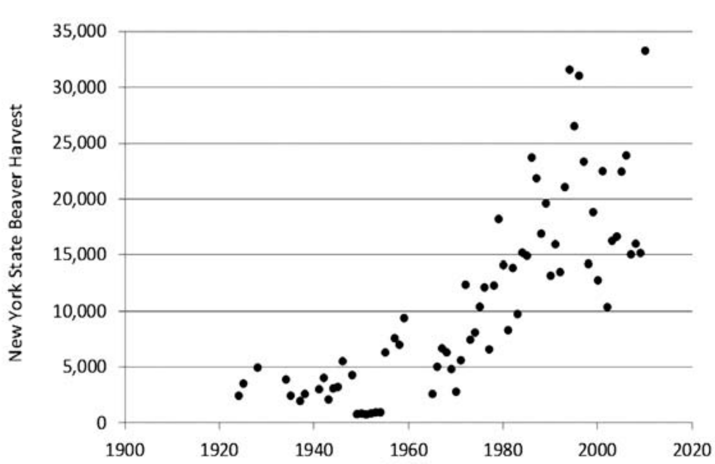


Figure 41. *New York State beaver harvest based upon DEC records and early statistics scattered in the literature. American Beaver numbers really appear to have blossomed after 1970. Again, harvest records reflect both population numbers and the number of hunters or trappers who are active.*

American Beaver spurred much early settlement in the County. Early Dutch commerce was based largely on beaver pelts. Most trapping was apparently actually done by Native Americans, and an intricate economic network resulted with Albany (Beaverwijk) as a central point. Beaver were widespread prior to intensive exploitation, but trapping quickly drove down their numbers. It seems probable that beaver were nearly extinct in the Hudson Valley by the end of the 18th century. By 1900, the state's remaining beaver lived in a small reserve in the northern Adirondacks. Reintroduction programs began in 1901, and the results were dramatic (see Fig. 41): by 1924, a beaver season was opened in the Adirondacks. Beaver populations built from that point, aided by re-introductions at various locations including an apparent 1930 Austerlitz reintroduction. A 1937 beaver colony in Hancock, MA, was frontpage news, and in 1940 the first beaver in the "Spencertown Valley" were heralded. By 1946, beaver were being deemed a nuisance by some residents, although the following decade apparently saw a notable decline perhaps due to intense trapping, before numbers resumed their rebound. Today, beaver live throughout almost the entire state and are commonly seen in the County.[67]

It seems unlikely that current densities in the County approach presettlement values although we can only speculate. Information published by the DEC for the eastern parts of Columbia and Dutchess Counties suggested densities of about .4 beaver colonies/mi^2. This compares with maximum densities of around 2.6 colonies/mi^2 in Canada and about half that in Massachusetts. Trapping is legal, and beaver are regularly removed and/or their dams breached. The current level of persecution and harvest may not threaten the survival of our beaver populations, however it certainly does reduce the extent of their dam building and wetland creation. That, in turn, likely affects the beaver's role as an "ecological engineer" (see Fig. 42), influencing the populations of plants and animals which co-evolved with such habitats.[68]

Figure 42. *This Beebe Hill State Forest beaver pond had Blue Heron roosting in the flood-killed snags, a pattern we've also seen elsewhere in the County. Numerous other plants and animals take advantage of the wetlands created by beaver.*

Various small and medium sized mammals also inhabit our forests, from the miniscule long-tailed shrews through the squirrels and rabbits. Most of these have probably continued to make a living in our forests despite periodic reductions in forest habitat. The rabbits and hares provide interesting insight into the history of our wildlife. During the past 100 years, four (or possibly as many as five) species of so-called Lagomorphs have roamed the County: New England Cottontail, Snowshoe Hare, Eastern Cottontail, European Hare and, although it's unlikely, perhaps some variety of Jack Rabbit. Entering the 20th century, the first two species may have been our only residents of this ilk. The **New England Cottontail** was *the* cottontail east of the Hudson until the 20th century. It is even suggested that, at the time of European settlement, no other cottontail occurred in the entire state. Changing habitats and extensive introductions by hunters helped spread the **Eastern Cottontail** throughout New York and into New England. In the current landscape, that species appears to generally be displacing the New England Cottontail, and the latter is now under consideration for Endangered Species status. New England Cottontails do still occur at least in the southeast corner of Columbia County. It is not possible to definitively distinguish the two species from their size or pelage, and so identification relies upon skull or DNA characteristics. This difficulty has hampered an understanding of the current distributions of the two species. The **Snowshoe Hare** or **Varying Hare** (thus called because it turns white in winter) was commonly reported in the eastern part of the County in the first half of the 20th century (and presumably earlier). At least 220 were hunted in 1930. However, decline followed. In 1960, "a few" were known "from the upper reaches of the Austerlitz Mountains," and, by 1989, a single sighting was worth a newspaper article. Devin Franklin reported seeing sign in the New Lebanon hills in the early 2000s. The **European Hare**'s precise history is a bit confused because of ample reference to "**Jack Rabbits**" from the early 1900s. True Jack Rabbits are a western species and were not widely introduced in this area. It seems likely that 'Jack Rabbit' actually referred to European Hares. Today, we don't believe that wild European Hare exist in the County.[69]

The future of our mammals may be affected by a variety of factors including habitat succession and destruction (see Fig. 43), and climate change. Hunting and trapping may continue to influence deer and beaver populations, and possibly those of some other furbearers. Brush land and open field continue to be replaced by either forest or development, although, as noted previously, total forested land may no longer be increasing given its periodic removal for development. The decline of shrublands may already be decreasing rabbit populations; conservation efforts for the New England Cottontail call for maintaining or creating brush. White-tailed Deer are also an 'edge' species, although they seem to demonstrate an ability to invade suburbia, a progression that predation by pet dogs and cats may deny to rabbits. Forest species, such as the Fisher, Moose, Grey Fox, North American Porcupine, and Black Bear may continue to seep into the County, slowly returning in response to what was, until recently, forest expansion.

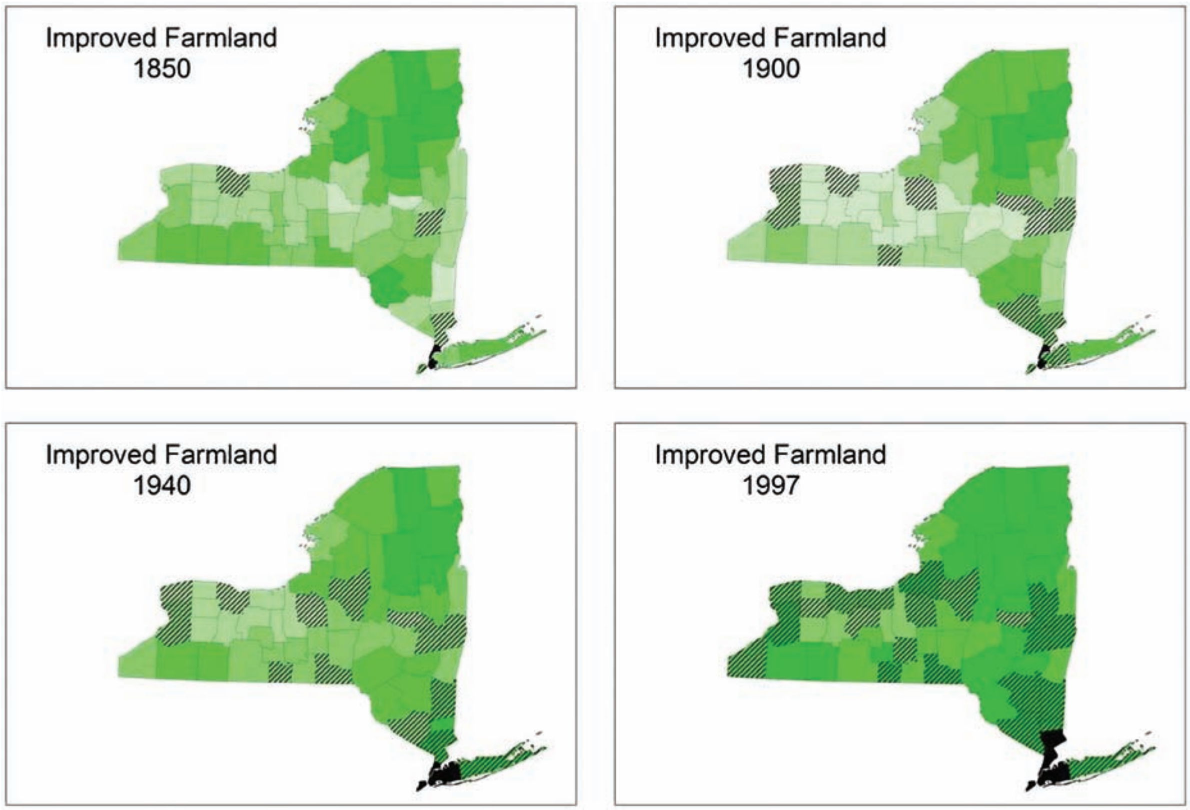


Figure 43. *Land in improved farmland (with darker green indicating less such acreage and hence a proxy for forest extent in rural areas); solid black, hatching and no black overlay indicate progressively lower human densities. New York has reforested, but at the same time urbanization has spread.*
Data from USGS. Waisanen and Bliss (2002) "Changes in population and agricultural land in conterminous United States counties, 1790 to 1997." *Global Biogeochemical Cycles*, volume 16, pages 84-1 to 84-19.

The effects of climate change are perhaps more difficult to forecast. It is likely that more boreal species which are attuned to ample snow cover may decline. The Snowshoe Hare, whose white winter coat is sadly conspicuous on a snowless winter landscape, seems to already be gone. The Snowshoe Hare's absence, together with lack of snow cover, may also largely exclude one of its chief predators, the Canada Lynx. Likewise, diminishing snow cover may stymie any return trends of American Pine Marten, a species apparently adapted to below-snow hunting. Bobcat and Fisher, both of whom are less snow-adapted, might be correspondingly favored. Ironically, some suggest that New England Cottontail might also be favored by climate change, although, as already mentioned, decreasing shrubland may counteract that. Red Squirrel, a species attuned to conifer forests, may slowly lose ground to Grey Squirrel if, as suggested earlier, Oak-Hickory Forest becomes more extensive.[70]

Our forests and their residents have been changing, and will continue to change; that is natural. It is also partially due to the human hand. Judging and managing our role in that change remains our task.

The Nature of the Place ~ Three

FIELDS: SQUARES OF THE LANDSCAPE QUILT

The other major texture, besides forests, in the irregular checkerboard of our County is fields. These vibrant, but in some ways more transient, patches are home to a somewhat distinct group of plants and animals. In this chapter, we will first look at the ecological history of our fields. By understanding the various ways that fields can come about and some of the factors influencing their evolution, one can gain an appreciation of their diversity of forms. We follow that history forward by considering what we might learn about our future landscape, including its fields, by looking at landscape evolution to the south of us in more suburbanized Westchester County. We close by profiling the ecology of select wildflowers and butterflies – those flashes of color we often associate with fields.

What is a field?

Before further exploring the origins of fields, it is important to understand the range of places that can be described as "field." We define fields as any place dominated by non-woody (what botanists call "herbaceous") vegetation; often, but not always, that vegetation includes ample grasses. Pastures and hayfields are two examples, and probably are what most of us envision when "field" is mentioned. Together these two categories account for about 15-20% of our County's land cover and are our commonest type of field. Cropland can also be considered field; in this case, corn, soybeans, vegetables, or some other cultivated plant is usually the primary cover. Cropland occupies approximately 7% of the County. Lawns are also fields of a sort. It is difficult to estimate the County's total lawn area, but this must be the most rapidly increasing, perhaps the only increasing, type of field in our landscape. One need only look at the changing selection of tractors for sale in local 'Farm & Garden' stores to appreciate our changing grasslands. Finally, some natural, field-like areas, such as rocky ledges and beaver meadows, also occur in the County; prairies, those famous grasslands of the Midwest, are absent, however. We are also, needless to say, lacking in sea-coast grasslands, the most extensive type of natural grassland in the Northeast. However, ice-scoured banks of the Hudson River and our large streams could be described as a kind of field. Open wetlands, such as marshes, bogs or fens, are considered in Chapter 5.[1]

Ecological History: Natural Potential & Succession

A map of the natural vegetation of the United States and Canada shows the grassy heartland – the Great Plains – fringed to the west, north and east by forest (and spotted by patches of desert and rocky mountains). Elsewhere in the temperate world, one similarly finds the Pampas of Argentina and Steppes of Russia cradled in continental interiors. Why are some lands grassy and others forested? Why is Columbia County, New York primarily a forested land while Columbia County, Wisconsin has, or at least had, ample prairie?

To a large degree, natural vegetation can be predicted based upon water balance: how much water is deposited from the skies and how much is removed by evaporation (and draining). As a generality, at our average annual temperatures, areas that receive less than about 30 inches of rain and more than about 12 inches will tend to move towards grasslands (less than 12" tends towards desert); Columbia County averages more than 40 inches per year, putting it in the forested biome (Fig. 1). It is the 'middle of the road' conditions of relative warmth and dryness which, indirectly, result in grasslands. "Indirectly" because often it is not the soil moisture *per se* that leads to the grasslands, but rather the associated susceptibility to fire. A fire-probability map goes a long way towards modeling the distribution of forest and grassland.[2]

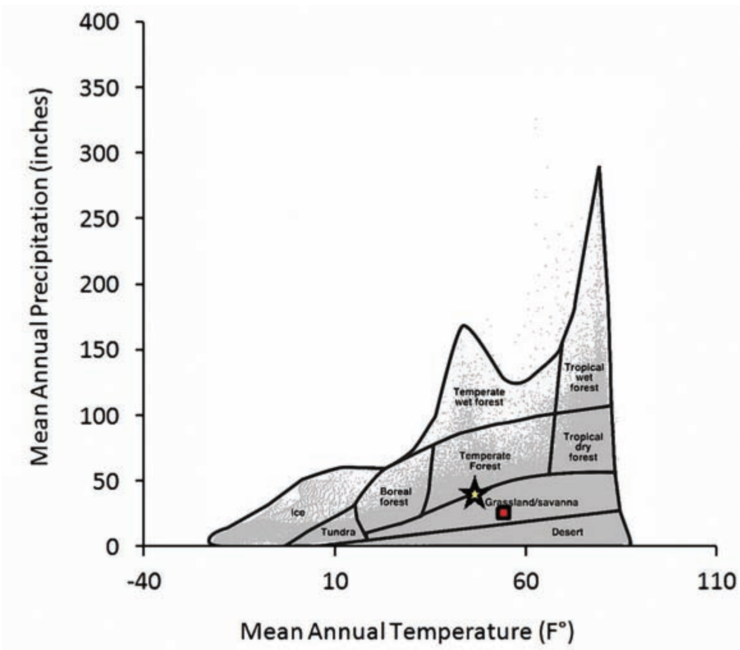


Figure 1*. A modified Whittaker Biome Diagram. This figure, created by Joe Craine and Andrew Elmore and used by permission, shows not only the temperature and precipitation combinations at which various types of vegetation occur, but also the frequency of those combinations on the planet (grey shading indicates existing combinations). The star indicates the approximate climatic location of Columbia County. None of the dividing lines on this diagram are hard and fast, and, in a zone like ours, factors such as seasonality of precipitation and the frequency of fires push us solidly into the temperate forest side of the divide. The red square indicates typical Kansas conditions, well within the grassland region.*

Fire is important because of succession, the ecological process that we mentioned earlier under forests. Barring fire, many grasslands will become populated with trees and slowly convert to forest. Early attempts to restore the Midwestern Prairies led to the realization that simply setting aside a patch of prairie rarely did the trick. To maintain the grasses and other prairie plants, the patch also had to be regularly burned, an activity that sometimes alarmed neighbors. Fire scorches both herbaceous plants and woody ones, but the herbaceous plants rebound quickly and can produce seed within a season of resprouting; woody plants, on the other hand, usually grow more slowly and don't produce seed until they are several years old. Regular fires thus favor fields of non-woody plants.[3]

The real pattern is slightly more complex. Different plants are more or less 'fire-adapted,' that is they have physiological and morphological traits that help them cope with fire. For instance, the thick bark of some oaks can help these trees survive a quick-moving ground fire; one often finds oaks on the drier sites (see Fig. 2). Furthermore, grazing and browsing animals, such as American Bison (aka Buffalo) and Elk (and cows and sheep), can influence succession too. And there are gradations. Along the fire gradient between grassland and forest, one finds savanna: essentially fields with scattered (fire-resistant) trees. Finally, as we'll note below, fields can occur under other conditions such as on thin or waterlogged soils. However, a key concept in the Northeast is that fields usually require some sort of disturbance to be maintained. Historically, that may have been fire or flooding; more recently cultivation, grazing, haying and lawn mowing have become prominent.

Figure 2. The base of a fire-scorched Chestnut Oak. This species tends to grow on drier soils where fires might be most common; the thick bark of this species may help protect it from passing fires.

Natural Northeastern Fields

For the most part, the Northeast is moist enough to naturally be home to forests rather than to fields or even savannas. In the area that is now Columbia County, it seems likely that, after forests returned post-glaciation and before human disturbance was extensive, the majority of our 'fields' were found in three situations: savanna-like stretches on the thinnest soils of some of our highest hills (where lightning-caused fires may have been particularly common); wet meadows, which were part of the cycle of flooding and forest clearing linked to beaver; and thin strips along the regularly-scoured creek and river banks. In addition, although the historical vegetation records are largely absent, a pine barrens-like stretch may have existed on the sandiest soils north of Kinderhook, complete with lupines.[4]

Hilltop Fire Fields. Hilltops tend to be dry (because of wind, drainage and thin soils) and prone to lightning strikes – prime conditions for fires (Fig. 3). Today, however, fire control has reduced the frequency of forest-scorching burns. As a result, some of our hilltops may have become more densely forested, shading out grasses, sedges and other ground-level herbaceous plants. A few random reports hint at the extent of fires early in the 20th century: between 1920 and 1940, Columbia County averaged over 30 forest fires per year and slightly over 1,000 acres of forest burnt annually. Between 1891

Figure 3. One location where natural fields are found in the County is on thin-soiled hilltops such as this site along the Taconic Ridge. The grasses here may include native species such as Little Bluestem and Hair Grass together with certain native sedges. Such hilltop openings may be at least partially fire-maintained.

and 1921, it was estimated that nearly 1,300,000 acres of forest (around 9% of the then-extant forests) burned in New York State. While this indicates the potential of our forests to burn, it probably does not reflect the long-term average extent of forest fires. In part, this is because fire prevention was already well-established when these figures were recorded, because humans were the main cause of these fires (lightning accounted for only about 5% of all fires, with railroads, smokers, and escaped camp fires causing the vast majority of blazes); and because timber harvests that scattered the ground with dried 'slash' could substantially increase 'combustibles.' However, the main reason that these acreages do not reflect the long-term average is because, given changing climate and human activity, there probably was no "long-term average."[5]

As discussed in the previous chapter, both climate and human activity have patterned fire occurrence. Today, forest-clearing fires are rare or absent in the County and so they are not important agents in the creation of new fields. Hill-top barrens (or at least open woodlands) occur on some of our peaks, but we estimate that such fields account for little more than a couple hundred acres in the County given that the majority of our summits are well-wooded.

Beaver Meadows. Despite the drama of trying to estimate how much of our landscape went up in smoke during various epochs, it is likely that beaver, through their creation of wet meadows, had a more important role in the creation of fields (Fig. 4). As we will explore in more detail in our waters chapter, one can estimate the area of such meadows by estimating the pre-trapping density of beaver and the area they would likely have influenced. Using this approach, it seems that prior to major beaver trapping beginning in the 17th century, beaver meadows of various ages might have covered

***Figure 4**. Beaver remove forest not only by cutting trees but also, as this image suggests, by flooding and the resultant drowning of upland trees. Once beaver abandon a site, their dam eventually breaks and the ponded water recedes leaving open land. Early in the ecological succession, a field-like stage, the so-called "beaver meadow" is established.*

roughly 2,500-4,000 acres (or nearly 1% of the County) during any given year. A substantial amount, but not unrealistic according to literature values – at a study site in Minnesota, for example, ponds and wet meadows went from about 1% of the area to around 13% after beaver were re-introduced.[6]

Beach Grass. The banks and beaches of streams or rivers may also account for long, stringy 'fields' that wind through the landscape (Fig. 5). There are roughly 600 miles of medium to major streams in the County. Even if the low-water beaches and ice- and flood-scoured banks average no more than three feet wide (realizing it is often much wider in spots but also frequently non-existent), this would still signify some 250 acres of stream-front fields. The more extensive open wetlands along the Hudson would add roughly another 650 acres, and so the actual total for such 'fields' might be as high as 900 acres.

Assembling these estimates, one can say that, once our vegetation recovered after glaciation, natural fields probably never covered more than about 25,000 acres (about 6% of the County), and their maximum extent may have been much less.

Ecological Analogies and Context

One reason for estimating the extent of these different field types is to give an approximate indication of the landscape which native plants and animals settled into after the last glaciation. What was the landscape these organisms 'grew up with' and so what are they still 'looking for' today? Given the above calculations, it isn't surprising that most of our native 'field organisms' are associated with wet meadows or stream banks. Certain creatures also populate the rocky, thin-soiled uplands. Thus, as we try to assess the ecological value of our modern fields, one question to ask is: where and for whom are there analogies? Beaver and fire, for example, are largely controlled. Where might some of the species who originally relied on habitats created by these disturbances

***Figure 5**. The ice- and water-scoured banks of our creeks form another field setting. The herbaceous vegetation on these shores is a combination of perennials, whose roots largely survive the flooding and scouring, and annuals who recolonize this open ground each year.*

now find ecologically analogous lodgings, even if their new homes are hardly complete ecological restorations?

To end our description of natural fields, it is appropriate to take a step back and look at the broader regional or even continental context. As 19th century grass-based agriculture expanded west, prairie organisms seeped into the fields from their original Midwestern haunts. Furthermore, some biogeographers believe that the Northeast already had a stock of prairie organisms occupying some of our natural grasslands and left behind by a gradual shrinking of a prairie band that skirted almost the entire margin of the glaciers. The Midwestern prairies occupied more than 160,000,000 acres in 1400. Numerous kinds of plants and animals co-existed in those prairies. Today, while rangeland and substantial amounts of Shortgrass Prairie still exist in the Far West, the more easterly Tallgrass Prairie that once covered at least 67,000,000 acres has now been reduced to about 3% of its original extent. Because of the extreme reductions of native prairie habitat, the Northeast now has a role to play in the conservation of prairie organisms. For this reason, we will also consider the ability of our modern fields to serve as ecological analogies to prairie grasslands for at least certain creatures such as grassland-nesting birds (Fig. 6).[7]

Figure 6. *In certain ways, for certain species such as some grassland birds, our hayfields (bottom photograph) can serve as ecological analogies for long-grass prairies (top photograph, courtesy of Wikipedia). When native grasses are common, as is the case for Little Bluestem on this Ancram field, then even some native grassland butterflies, such as the Indian and Cobweb Skippers that occurred here, find habitat.*

Recent and Modern Fields

To a large extent, the history of recent fields is a history of our agriculture. While natural fields have continued to exist in certain areas, the fields created by agriculture covered around three quarters of the County at the peak of agriculture around 1875. This was an extent of fields not seen since reforestation after the last glaciers. Below, we sketch the history of our hayfields, pastures and croplands over the last 200 years, and, based upon current ecologies and historical natural history descriptions, discuss what ecological analogies these lands may have provided.

Early Hayfields. "Meadow" initially referred primarily to unplanted hayland. Meadows were often located in floodplains. They were unsuitable for ploughing or intensive grazing, but produced reliable hay crops due to the regular input of nutrients from flooding (indeed, early efforts were made to re-route floodwaters through fields in order to 'fertilize them by flooding'). Evidence for such lowland hay meadows comes in part from 1830s mapping of adjacent Berkshire County, Massachusetts (see Fig. 7). Chelsea Teale's 2013 dissertation, *Agricultural Wetlands in New Netherland, 1630-1830,* is an explicit exploration of the role of wetlands in Hudson Valley Dutch agriculture; she documents their use for pasture, hay field and crops such as wheat. Upland hay meadows were an innovation that slowly grew in importance during the late 18th and early 19th centuries (see the chapter on soils). Hay was required to keep working livestock or milking animals through the winter, although many meat animals were slaughtered in the fall. Demand for hay increased with time, and upland hay meadows were often ploughed and seeded with Timothy Grass to improve hay quality and yield. Living in Claverack shortly after the Revolution, Alexander Coventry wrote in his diary of collecting both upland and meadow hay, and of seeding the former.[8]

Much of the early nineteenth century haying apparently occurred in the southwest corner of the County (see Fig. 8). The topography of Germantown and Clermont is dominated by a series of north/

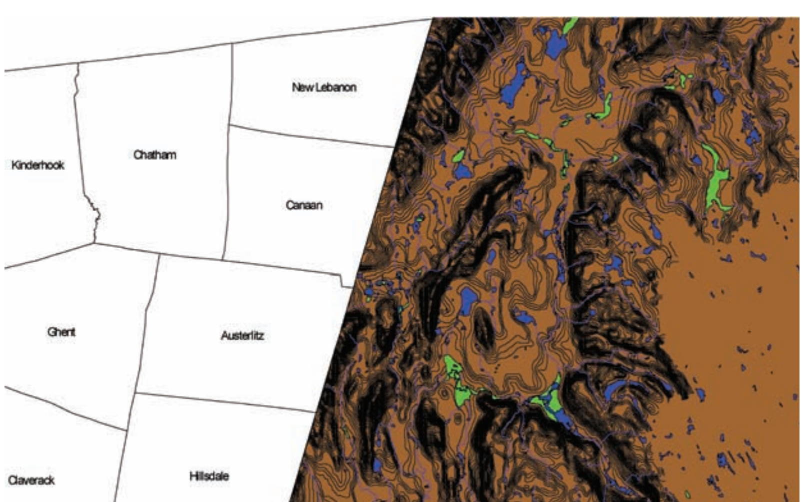


***Figure 7**. In 1830, Massachusetts created detailed land-use maps. Brian Hall and his colleagues at the Harvard Forest digitized those maps, and they provide insight into historical land use in our neighborhood. This illustration depicts a portion of Berkshire County adjacent to northeastern Columbia County. Hay meadows are indicated in green, and were clearly located in lower, moister areas. As agriculture evolved, upland hayfields became the norm.*

south ridges with small wetland valleys in between them; perhaps these were well-suited for use as wet hay meadows. As Horatio Spafford put it in 1824, “The surface is but gently undulated, and the soil is good for grass.” The clayier soils near the Hudson may also have been more prone to water logging and so less suitable for ploughed croplands. However, this water-holding capacity may have helped to maintain green hayfields even during summer dry spells. These natural tendencies favoring hayfields in that region may have been re-enforced by transportation considerations: hay could be sold down-river to New York City, but bulky hay was difficult to transport to river ports over the initially poor inland roads. Haying also seemed to have been common in New Lebanon in the north-eastern corner of the County, mostly on the floodplains of the Wyomonac and Kinderhook Creeks. Spafford described that town as “good farming lands, dry and warm or wet and *grassy*” (emphasis added); a portion of this land was worked by the Shakers.[9]

Many of the lowland hayfields were probably created by opening up floodplain forest, something that may have already been done in some places by the native peoples. While we will discuss the ecological value of these meadows below, it is important to realize that another habitat was thus being reduced: through an examination of the earliest aerial photos available from our County (1940s), we estimate

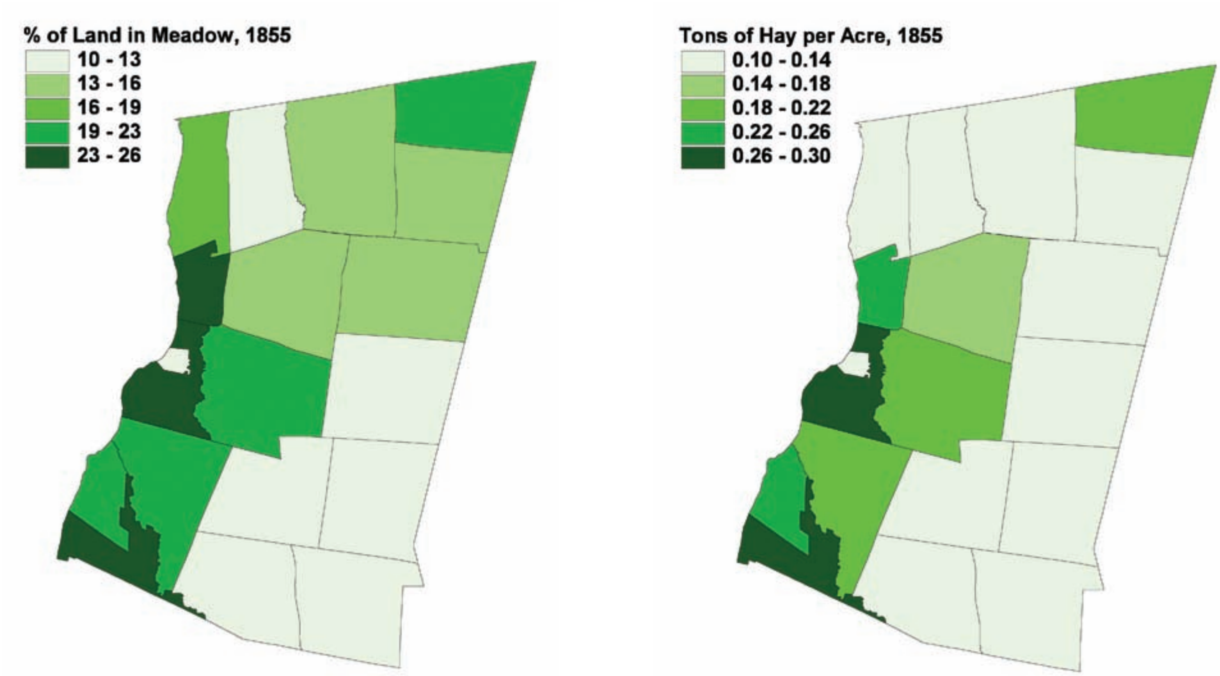


Figure 8*. Understanding the nature that fields replaced and provided for involves, in part, knowing what land they were located on. These maps of Columbia County provide two depictions of the distribution of hayfields: the proportion of a given town occupied by such fields (left) and the production of hay (tons produced per total acres in the town). Hay production was concentrated along the Hudson, with an outpost in New Lebanon perhaps associated with the Shakers. Riverside hay production may have been favored in part by the relatively easy access that such areas had to important down-river hay markets.* Data from the 1855 New York State census.

that, at the most, 14% of the original floodplain forest habitat has maintained its forest cover over the last 200 years; the 86% that has been cut was largely opened for farming.[10]

These new wet meadows may have been partial ecological analogies for the then-rare beaver meadows. The primary impetus for initial Dutch settlement in and around the County was the fur trade, with beaver pelts being the mainstay. As a result, beavers were apparently trapped to near extinction in the mid Hudson Valley by the end of the 18th century (although a 1729 deed from Columbia County does mention a beaver dam), and the ecosystems that they had created in the landscape were thus very scarce. For some of the former residents of beaver meadows, these man-made wet meadows provided usable habitat. The wet hay meadows also attracted some of the species which usually congregated around natural marshes and fens (habitats considered in Chapter 5).[11]

Today, numerous native plants (Fig. 9) and animals are found in wet meadows that were created for or are maintained by agricultural activity. Examples of the native plants that were listed as occurring in "wet meadows" by Torrey in 1840 include species that are still holding their ground in wet meadows on today's farms, such as Northern Blue Flag, Blue-eyed Grass, Common Monkeyflower, Common Vervain, Golden Ragwort, Green-headed Coneflower, Yellow Avens, and Meadowsweet, as well as a rich variety of native sedges, grasses, and less conspicuous plants. However, there also seems to have been a group of plants associated with early wet meadows which we now rarely, if ever, see in this habitat: Canada Lily, Mayapple, Ragged-fringed Orchid, Purple-fringed Orchid, Nodding Lady's Tresses, Purple Milkwort, Canada Anemone, Swamp Saxifrage, Winged Monkeyflower, and the fern Adder's Tongue. Animals include numerous rare species such as Bog and Spotted Turtles, Eastern Ribbon

Figure 9. *Wet meadows, such as those created by beaver meadows and some early hayfields, can be home to a variety of native plants including (from left to right) Tufted Loosestrife, Joe Pye Weed, Blue Vervain, and various species of sedges.*

Snakes, Northern Leopard Frogs, and Northern Harriers. We have found native wetland butterflies including Bronze Copper, Appalachian Brown, Black Dash, Mulberry Wing, and Baltimore Checkerspot in and around on-farm wet meadows.[12]

Later Hayfields. Hayfields evolved from mainly providing feed for home-farm livestock into being major commercial ventures that reached their zenith in terms of area around 1875; maximum production occurred somewhat later (see Chapter 1, Figs. 12 and 13), presumably due to new practices and inputs. Much of this hay was probably delivered via river to New York City. Hay fields apparently shifted from being largely on wet meadows to being principally on uplands (for more on upland 'artificial meadows' see Chapter 4). This vastly expanded the area available for growing hay. We have no early statistics for Columbia County, but Gordon Whitney describes the situation in Worcester, Massachusetts where upland hayfields accounted for 49% of all hay meadows in 1780 and for around 75% by 1850. In 1841, 1842, 1851 and 1853 (the years for which we have detailed records), about half or more of the hay cut by the New Lebanon Shakers came from so-called "swamp." Between 1850 and 1875, hay meadows in Columbia County increased by over 38,000 acres, and all towns in the County reported an increase in hayfield area. A large part of this land may have already been cleared for other purposes, e.g., sheep pasture (all but three towns reported a concomitant decrease in pasture), however some of this increase may have come as farmers opened new land.[13]

These mid to late 19th century hayfields provided the heyday for at least some local grassland organisms. For certain species, aspects of upland hayfields are ecologically analogous to the prairies, especially the Tallgrass Prairies. Many of the birds and some of the native plants currently and/or historically found in hayfields originally had their demographic heartlands in the prairies of the Midwest. Bobolinks, Eastern Meadowlarks, Dicksissels, Upland Plovers, Vesper Sparrows and Grasshopper Sparrows (Fig. 10), amongst others, are all birds that occupy, or at least occupied, eastern hayfields but which probably reached their largest populations on the Prairies. (Note, however, that they did not all necessarily co-occur in the same types of hay field.) Historically-minded birders debate whether or not these species dispersed east



as cultivation opened an ecological bridge to the Prairies or whether small populations of these birds already existed along the East Coast at the time of European settlement and then blossomed from those cores.[14]

Support for the latter scenario comes from early accounts of the Bobolink in the Northeast. Macauley (1829) and Thompson (1842) primarily associate it with low meadows or even marshes where it joined company with Red-winged Blackbirds. While Bobolinks are generally considered ground nesters (a poor plan for wetland nesting), accounts do mention the occasional construction of nests off of the ground, hinting at alternative strategies. Such breeding populations may have expanded their habitat as surrounding lands were opened to cultivation. A study of ornithological and agricultural history in England, for example, pointed out multiple cases in which bird habitat use shifted to fit the changing agricultural landscape. In any case, whether from *in situ* habitat cores or as part of an eastward expansion, these species were able to take advantage of the fields offered to them by 19th century agriculture. In the mid 1800s, Bobolinks were very common (see for example Kent's 1933 description of "great flocks in migration" along the Hudson). However, this boom was soon dampened by the changing calendar and technology of mowing. [15]

A contrast between grassland birds and butterflies offers a cautionary illustration of the partial nature of our ecological analogies: grassland nesting birds are apparently looking for suitable habitat structure, regardless of the exact plant species providing it; butterflies, given the picky diets of their caterpillars, are much more sensitive to the botany, and prairie butterflies are generally not found in planted hay fields where prairie plants are absent. However, like the birds, some butterflies did show ecological flexibility, and the caterpillars of several species seem to include non-native grasses and field forbs in their diets.

Upland hay meadows were often seeded to Timothy Grass (Fig. 11) and clovers and so only provided limited habitat for native plants. Anecdotal accounts suggest that the use of such "English grasses" (clover is not considered a grass today, but was historically) was well established by the end of the 18th century. However, in 1840 Torrey listed a number of plant species that occurred in "meadows" and which we still find in "wild" hayfields today. These include Fleabanes, Spiked Lobelia, Eve-

Figure 10*. Grassland birds, from De Kay's 1844 volume on the birds of New York State (left to right): male Bobolink, Northern Shrike, Eastern Meadowlark, Vesper Sparrow and Upland Sandpiper. These birds reveled in the extensive grasslands of 19th century agriculture, but have suffered as agriculture evolved during the 20th century.*

ning Primrose, and Small-flowered Crowfoot. He also described the orchid Slender Lady's Tresses as "common," Common Lousewort as "very common" and Blue Toadflax as "not rare" in meadows. None of these later species are easily found in Columbia County today, perhaps in part because of deer pressure and in part because they too cannot sustain the repeated hay cuts that came to typify hayfield management.[16]

A nice summary of the evolving ecology of hayfields comes from Eaton's 1910 work on New York birds:

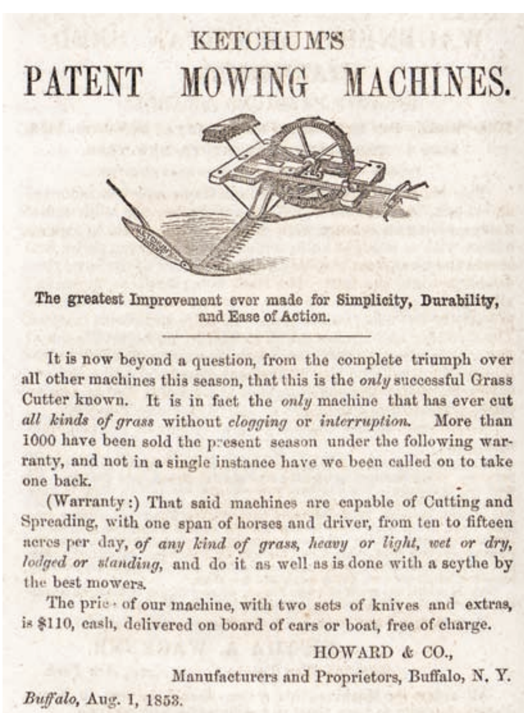
> *When the State was first settled [by Europeans], waterfowl fairly swarmed…shore birds flocked by the thousands….Wild turkeys, Ruffed grouse and Bobwhites were well distributed….It is difficult to obtain reliable information in regard to the abundance of small birds, like the warblers, flycatchers, sparrows and thrushes, but the writer believes they were less abundant during colonial times….*
>
> *The general law of variation in abundance seems to be as follows. Birds which prefer the open country begin to increase as the forests are cut off, and many which live in the forests themselves increase as long as clearings are few and scattered. As the cultivation of the country progresses and a large percentage of the forests has been cut off, the hawks, owls, grouse, jays, Pileated and Hairy woodpeckers, tanagers and many wood-warblers and thrushes decrease in number. When the swamps are drained there are fewer nesting places for snipe, rails, bitterns and Marsh wrens. As the pasture and meadow lands increase in area, birds like the Bobolink, Meadowlark, Vesper sparrow, Killdeer and Bartramian Sandpiper [Upland Sandpiper] find favorable nesting places and increase.*
>
> *But as the modern style of agriculture develops, new dangers arise to threaten the field birds. Late plowing and extensive cultivating and early mowing destroy great numbers of eggs and young birds. A high degree of agriculture is likewise accompanied with danger from the spraying of fruit trees . . . The cutting of all dead limbs and trees also destroys the nesting sites . . . Thus in many ways the increase of native birds is discouraged, unless artificial means is taken to counteract the evil….*[17]

Figure 11. The dense flower spike of Timothy Grass, one of the English upland grasses whose cultivation led to the spread of hayfields into areas beyond wet meadows.

This scenario, written during the first decade of the 20th century, adds important perspective by placing the timing of decreased on-farm, openland (i.e., to a large extent, hayfield) bird diversity before the highest rates of farm abandonment, which later added insult to injury. In the Connecticut River Valley, the beginning of this decline in grassland bird habitat is put as early as 1875.[18]

Compared to changes in bird life, upland hayfields may have changed little in plant composition throughout most of the 19th and 20th centuries. Timothy Grass and "Timothy and clover" accounted for some 50-60% of haylands in the County at the beginning of the 20th century; alfalfa hay was becoming more common, and in 2007 it accounted for nearly one quarter of all hayland, although "other tame hay" including Timothy, still made up 55% of hayland. The value of tame or wild hayland as an analogy for the bird habitat of the Prairies was probably more influenced by changes in the technique and timing of harvest than by these fields' botanical composition.[19]

Because of its major impact on the suitability of hayfields as habitat for native species, it is worth exploring evolving mowing practices in more detail. In the first half of the 19th century, hay mowing was largely done by hand scythe. Cutting was slow and laborious and may have extended for several weeks. A practical, horse-drawn mechanical hay cutter was introduced before the Civil War (Fig. 12), and its use seemed to gain momentum after the War, perhaps in response to the resulting labor shortage (Fig. 13). Prior to the end of the 1800s, mechanization and new ideas of progressive agriculture may have favored and facilitated an earlier cut, possibly followed by a second cut later in the year. Haying became even more intense in the second half of the 20th century as the blue Harvestore silos provided storage for haylage and then, during the latter part of the century, plastic-wrapped baleage spread. The fermenting of green grass permits the May hay cuts that now make triple-harvest-



KETCHUM'S
PATENT MOWING MACHINES.

The greatest Improvement ever made for Simplicity, Durability, and Ease of Action.

It is now beyond a question, from the complete triumph over all other machines this season, that this is the *only* successful Grass Cutter known. It is in fact the *only* machine that has ever cut *all kinds of grass* without *clogging* or *interruption.* More than 1000 have been sold the present season under the following warranty, and not in a single instance have we been called on to take one back.

(Warranty:) That said machines are capable of Cutting and Spreading, with one span of horses and driver, from ten to fifteen acres per day, *of any kind of grass, heavy or light, wet or dry, lodged or standing,* and do it as well as is done with a scythe by the best mowers.

The price of our machine, with two sets of knives and extras, is $110, cash, delivered on board of cars or boat, free of charge.

HOWARD & CO.,
Manufacturers and Proprietors, Buffalo, N. Y.

Buffalo, Aug. 1, 1853.

Figure 12. An early advertisement for mechanized haying equipment. Technological advances like these helped lead to earlier haying, and resulted in ecological impacts on grassland nesting birds. The New Lebanon Shakers apparently got their first mowing machine around 1861, and it prompted a round of stump clearing.

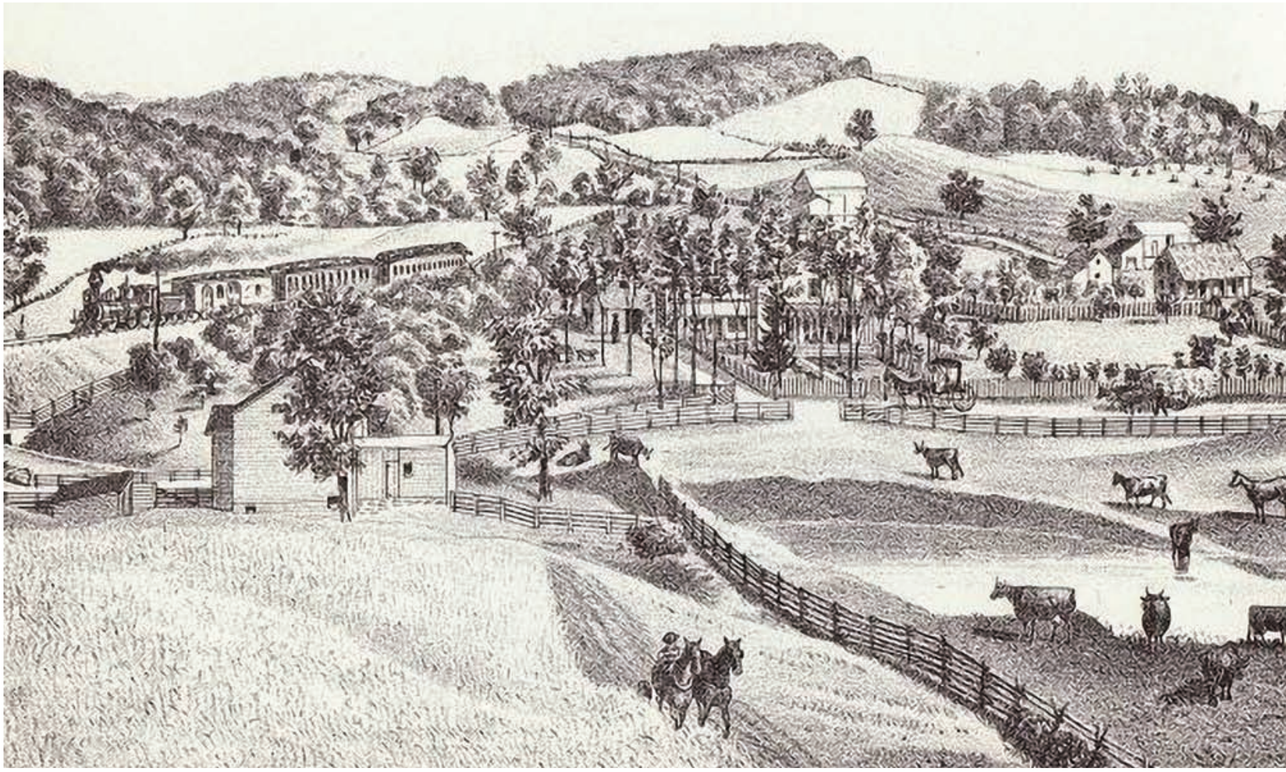


Figure 13*. This image published in Ellis' 1878 History of Columbia County depicts a farm near Chatham. The horses and driver in the foreground may be haying with a pull-behind hay cutter. Such cutting was quicker and less labor intensive than the hand-cutting that preceded it and made earlier, multiple cuts practical. Note the prominent train in the background – a sign of the times. Railroads, and the increased transport they represented, had major impacts on regional agriculture.*

ing of hayfields possible and, because haylage need not be so extensively dried, also releases the farmer from some of the challenges of hay cutting during a wet year.

Looking at the specifics of this scenario in Columbia County (Fig. 14), Coventry's diary suggests that haying stretched from mid June to early August, with most happening in July. Emmons, in the mid 1800s, put the beginning of the first hay cut at roughly 12 July in Hudson. Based on journals from the late 18th century through 1865, New Lebanon Shakers concentrated their haying in July. (The earliness of Coventry's cut relative to the Shakers' might be due in part to his slightly warmer conditions along the Hudson and the fact that a good portion of his hay was riverside meadow that may have matured earlier.) July continued to be the haying month in the 1930s, based on the John Cowper Powys diary. Today, based on 17 years of farmer records from Hawthorne Valley Farm, about 45% of the haying days occur before 1 July whereas, for the Shakers and Powys, less than 20% had occurred by that date. These data suggest that current haying schedules likely destroy more unfledged birds than historical schedules.[20]

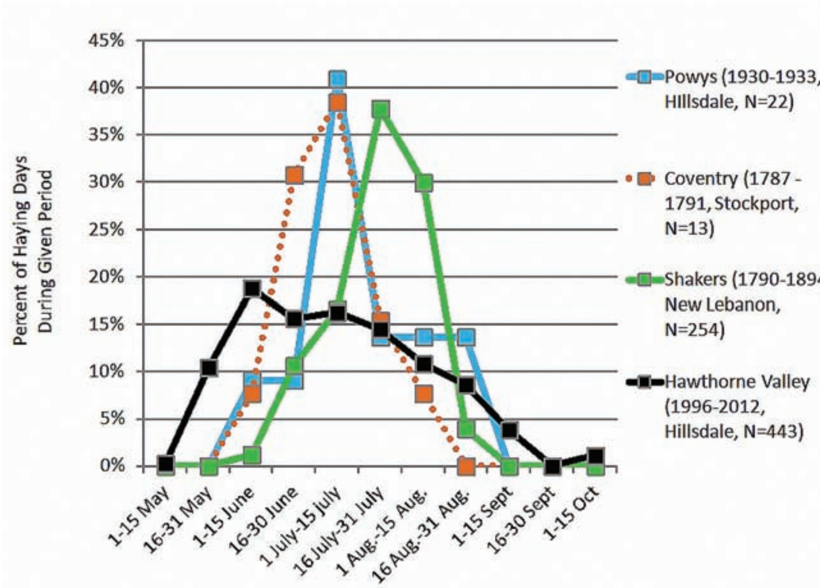


***Figure 14**. Percent of total haying days reported during the given calendar period. The modern condition (for a grass-based dairy in Hillsdale) is shown by the black line; haying begins relatively early and, as fields are cut two or even three times per year, extends through much of growing season. The colored lines represent various historical data from the County; haying tended to be more restricted in time and to peak later in the summer. The date of first cut has gotten earlier, threatening the nest success of grassland birds.* See Note 20 for sources.

The results of these changes in harvesting techniques were momentous for birds and possibly orchids in the County. A key consideration with regards to grassland birds and haying is the timing of the cut relative to when the young leave the nest. If the hay cut occurs prior to fledging (that is, prior to when the young birds can fly), then the hayfields become 'ecological traps' that entice birds to breed but then foil their nests. In Columbia County, we regularly see Bobolink fledglings around the first week of July. When haying began at about this time and proceeded slowly, most Bobolink nests probably succeeded. As first haying began to occur in June rather than the second week of July and as the speed of haying increased, many clutches did not survive to fledging (Table 1). Accompanying the change in technology has been a change in extent: from a peak of around 100,000 acres of hayfield in the County during the third quarter of the 19th century, hayfields have diminished to around 30,000 acres today. As just noted, the combined result of these changes was that by the end of the 19th century, birders in the Northeast were noting steep declines of Bobolink and Eastern Meadowlark. In the 1930s, Ragged-fringed Orchid still was a common native plant in hayfields, and McVaugh (personal communication) attributed its drastic subsequent decline at least in part to the change in haying schedule.[21]

Later in the 20th century, some of these effects may have been offset somewhat in the County by the spread of 'estate' hayfields – hayfields that are cut once per year, often relatively late, by contracted farmers who invest little time and effort in improvement and are thus sometimes satisfied by a meager, late cut of hay. Whereas in 1910 only slightly more than 1% of the County hay was "wild" (i.e., not recently seeded), by 2007 nearly 20% was deemed wild. Yield (tons of hay per acre harvested) has also begun to drop from 2.6 tons per acre in 1987 to less than 2 tons per acres in 2007. There has been little effort to coordinate the cutting of these fields so as to protect grassland bird habitat, but late cuts may happen regularly in any case.

Butterflies also are affected by the timing of the hay cut. For those species whose eggs and caterpillars reside in the fields (for example, the so-called grass skippers), a cut that is made prior to when the adults take wing can destroy substantial numbers of individuals. Although many of the hayfields that we have surveyed ranked relatively high in butterfly diversity, we have been surprised at how low the diversity is in some fields. While there is concern about the long-term effects of early hay mowing, data from North American butterflies are sparse. Because the effects of mowing schedule will differ depending upon the distinct timing of each species' life cycle, mowing recommendations from the Midwest suggest breaking up the fields into management units and designating different mowing times for each set of units.[22]

	Fledging Period in New York State	
Species	Start	Stop
Bobolink	18 June	18 July
Eastern Meadowlark	9 June	9 July
Field Sparrow	16 June	16 July
Grasshopper Sparrow	27 June	27 July
Henslow Sparrow	17 June	17 July
Killdeer	21 May	-
Northern Harrier	4 July	-
Red-winged Blackbird	26 May	26 June
Savannah Sparrow	11 June	11 July
Song Sparrow	17 May	17 June
Upland Sandpiper	15 June	-
Vesper Sparrow	5 June	5 July

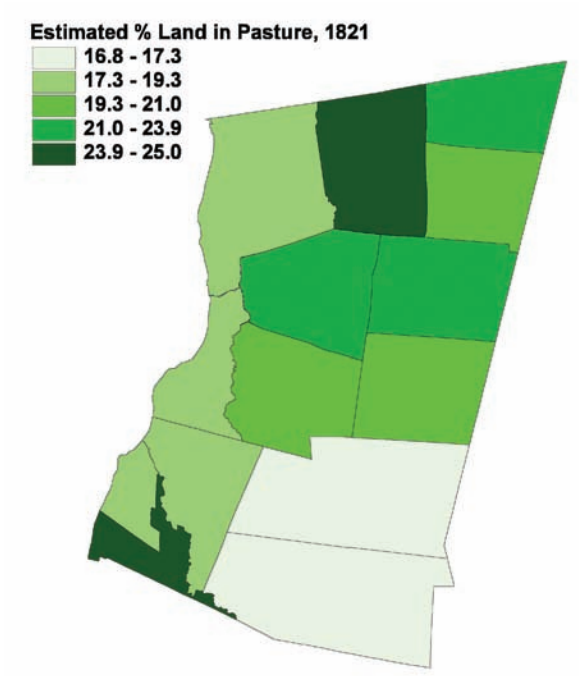
***Table 1**. One of the most ecologically important aspects of hayfield use is the timing of the hay cut relative to the date when resident grassland birds fledge (that is, leave the nest); if hay is cut prior to that date, most nests will be lost and the fields can form 'ecological traps.' Over the course of the last 300 years of agricultural evolution, the date of first hay cutting has moved from July to May, facilitated largely by the advent of mechanization. As the table of fledging dates suggests, cuts that occur before July may decimate the nests of grassland birds.* Fledging dates are derived from John Bull's *Birds of New York* (1974).

In sum, during the 19th century, there was an evolution of hayfields from providing analogies for beaver-meadow organisms towards providing analogies for prairie organisms. The plants and animals (largely insects, amphibians, and reptiles) of wet meadows saw their fortunes decline as those seeking prairies (e.g., grassland birds) benefitted. During the 20th century, however, changing harvest technology and substantial declines in habitat area battered the plants and animals of upland hay fields.

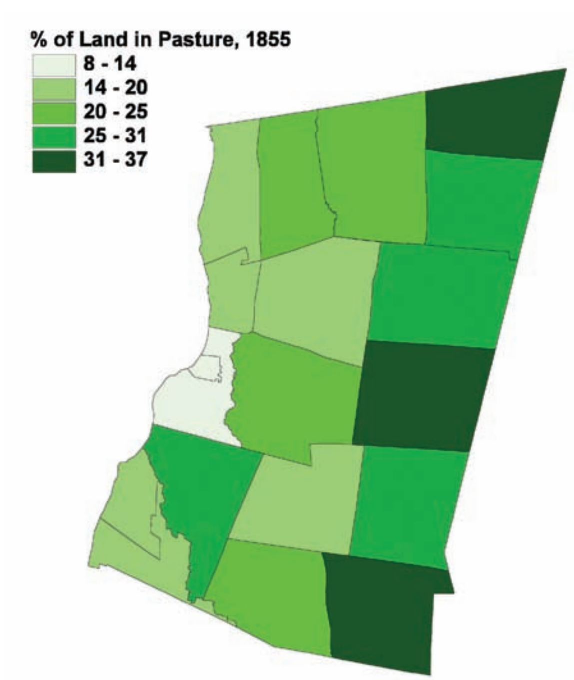
Early Pastures. "Pasture" refers to lands being grazed by animals; the nature of the pasture depends in part on the livestock being grazed and method of grazing. Early farmers commonly used not only open pasture but also woodland pasture where animals grazed beneath tree cover. However, this did not produce the fields which are this chapter's focus.

As with hayfields, where we described the gradual shift from wet meadows to uplands, a first step in understanding the historical ecology of our pastures is to understand what sort of land they were occupying. Were they, for example, on rich flatlands or thin-soiled hills? Our first direct information on pastures comes when they are tallied in the 1855 census. However, livestock were first surveyed in 1820, and we can use these numbers to create a rough map of estimated pasture area.

This earliest pasture map (Fig. 15) suggests that pasture was centered around Chatham, Ghent, Canaan and Austerlitz, but by 1855, when the first statistics on pasture area are available



(see Chap. 1, Fig. 12), the most extensive pastures in Columbia County were associated with the eastern towns, where pasture alone accounted for about a third of the entire surface area; in many western towns only 10-20% of the surface area was in pasture. Pasturing doubtless occurred in places other than the eastern hills, but was usually not as extensive. Early, largely self-sufficient farmers in the eastern part of the County may have cleared some lands for what was marginal grain production. Once cleared and as the market economy spread, that land invited pasturing not only as a practical alternative but one that was encouraged by the hill towns' relatively cooler, wetter clime which favored grass growth.



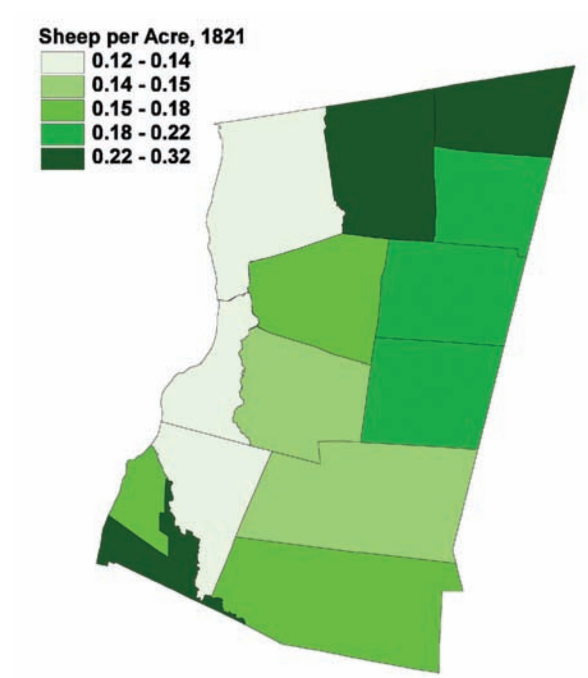


***Figure 15**. Unlike land in hay fields, land in pasture tended to be more common in the hill towns along the eastern margin of the County. These lands, far from the convenient transport of the river and too hilly to make good cropland, and yet fine for growing grass, may have been best suited for pasturing. These maps depict the estimated extent of pastures (proportion of town in pasture) in 1821 (top) based upon a census of livestock; pasture in 1855 when such lands were directly surveyed (lower left); and density of sheep in 1821 (lower right), the sheep boom of the first half of the 19th century may have spurred the spread of pastures, especially in the hillier eastern towns.*

Part of the pressure behind pasture creation in the first half of the 1800s was the sheep boom. In 1845, there were roughly 173,000 sheep in the County (and only about 43,000 people). Spurred by a tariff on European wool, sheep numbers had nearly doubled since 1820, and these animals may have been especially suited to extensive hill pasturing. Numbers were to drop as steeply as they had risen: the tariff was lifted and, after a slight resurgence during the Civil War, county sheep numbers fell to one third of their 1845 levels by 1875.[23] (See Chap.1, Fig. 13.)

Closely-cropped pastures are often too clean to provide strong analogies to natural grasslands for native vertebrates and plants, although scruffier pastures may have provided some analogies for the organisms of prairie grasslands and savannahs. Eaton, for example, provides a rather damning description of sheep pasture as bird habitat:

> *…the principal harm of pasturing, to bird life, is found in the destruction of ground cover ….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.*[24]

The lack of shrubbery and potential close-cropping of the pastures left room for few birds. Based on their current occurrence patterns, it does seem likely that a few sparrows (e.g., Savannah, Field) and other birds (e.g., Killdeer, Eastern Kingbird) used these lands, especially when there was scattered brush. Where vegetation crept in along fence rows, Northern Bobwhite, Yellow Warbler, Song Sparrow, Catbird and the like probably entered. When pastures occurred near denser, wetter vegetation, American Woodcocks may have used them as displaying grounds.

Intensively grazed but relatively fertile pasture land was probably not a haven for native plants. The flora of eastern North America does not include many species adapted to tolerate intensive grazing. Even the prairie plants that had co-evolved with grazing buffalo and were present in small populations in our region, usually did not compete well in fertile soil with European pasture plants. Once non-native grasses were widely introduced by the end of the 18th century, but while pasture soils were still relatively fertile and thick, native plants likely composed a very small proportion of the pasture vegetation. The native plant species that we know today from forest edges, field margins and even road-sides, probably found small niches along the edges of these early pastures. Some native insects were surely able to utilize the small habitat patches around the margins of the pastures, where native plants provided food and shelter. Plants and insects can settle in these small habitat patches and, through dispersal, 'glue' such patches together demographically.

The early soil richesse of pastures gave way to impoverishment. As Whitney put it, "Pastures were New England's stepchild," implying that they got only the attention and manure that was left for them after cropland and hayfields. The result, in New England at least, was a continuous decline in pasture quality (see Figs. 16 and 17 for regional hints of this decline). Indeed, in the botanical literature "hill pasture" seemed to become a shorthand for these nutrient-depleted, open lands. [25]

***Figure 16**. Pastures were mainly on rough ground, as suggested by this image (engraved by W.H. Bartlett in* American Scenery*, 1840), published near the height of the sheep boom, showing rough pastures on the hills near Hudson. Sheep could be grazed on pastures whose steepness or soil exhaustion made them unsuitable for cattle. The result was sometimes further soil erosion and degradation.*

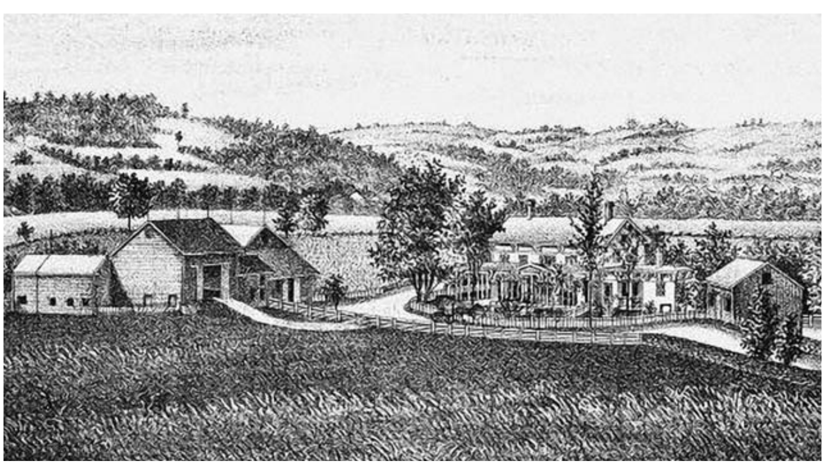


***Figure 17**. Another image from Ellis' 1878 history of the County. This farm was located in New Lebanon, and, while the artist had tried to create a neat, prosperous scene, the somewhat brushy looking hillsides suggest the incipient pasture abandonment that followed the decline of sheep and the restructuring of local agriculture that occurred as improved transport opened up new sources of livestock food. By the early 20th century, farmland was in steep decline.*

As the soil quality of pastures declined, native plants became more common. A 1929 study, nicely titled "Ecological factors determining the pasture flora in the northeastern United States," provides an explicit, regional description of this process (Table 2). Most of the introduced agronomic grasses outcompete native ones when nutrients are high, but are unable to maintain themselves as nutrients decline and are replaced by native grasses such as Poverty Oatgrass and Broom Sedge. Many of the native plants that come into these exhausted pastures found analogies to their original, thin-soiled habitats on ridge tops, steep hillsides, or other areas with thin layers of organic matter (e.g., sand barrens). Examples of native plants that were, according to John Torrey, common on "dry hillsides" or "sterile fields" in 1840 and are still found on those thin-soiled lands today, are: Pussytoe, Gray Goldenrod, Mountain-mint, Sweet Fern, Poverty Oatgrass, Little Bluestem, Pasture Rose, Dewberry, and Arrowhead Violet. Interestingly, again, there seems to have been a group of native plants that were able to take advantage of a certain stage of an evolving agricultural habitat and were listed as "not rare," "frequent," or even "common" in these poor habitats by Torrey, but have since become quite rare. These include Whorled Milkweed, Upland Boneset, Venus Looking-glass (Fig. 18), American Pennyroyal, Clammy Cuphea, Yellow Wild Indigo, Wild Sensitive Plant, Rattlebox, Downy Trailing Lespedeza, Virginia Yellow Flax, and Little Sundrops.[26]

Association	Warm to cool, relatively dry regions	Cool moist regions	Cold moist regions
1	Kentucky Bluegrass Canadian Bluegrass White Clover	Kentucky Bluegrass Canadian Bluegrass White Clover	Kentucky Bluegrass Canadian Bluegrass White Clover
2	Bluegrasses Red Top White Clover	Bluegrasses Rhode Island Bent White Clover	Bluegrasses Rhode Island Bent White Clover
3		Rhode Island Bent White Clover	Rhode Island Bent White Clover
4		Rhode Island Bent White Clover Sweet Vemal	Rhode Island Bent
5		Sweet Vemal	
6	Poverty Oatgrass	Sweet Vemal Poverty Oatgrass	Poverty Oatgrass
7	Poverty Oatgrass Goldenrod Broom Sedge Cinquefoil Trees	Poverty Oatgrass Goldenrod Broom Sedge Cinquefoil Trees Moss Ferns	Poverty Oatgrass Cinquefoil Trees Moss Ferns

Table 2. *A table from the 1929 work of Cooper and colleagues showing the plants associated with progressively degrading pastures under three climatic conditions. Soil impoverishment increases in associations 1-7. Introduced grasses and clovers dominate the nutrient rich pastures, but progressively give way to native species (in greeen) as pastures degrade. In our area, Little Bluestem replaces Broom Sedge, its sister grass.*

Going along with ecological change due to soil exhaustion were probably changes due to variation in grazing species as sheep gave way to cattle. Around 1910, total "neat cattle" (i.e., cows, steer and oxen) began to make up the majority of Columbia County livestock and sheep entered the minority. Sheep pasture and cattle pasture are distinct ecological habitats, because these animals have different grazing behavior. Specifically, some breeds of sheep browse much more intensively than most cattle. The result is that, unless they are regularly brush-hogged, cattle pastures are more apt to fill-in with unpalatable shrubs (Fig. 19).

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. The woody plants in such pastures are typically Grey Dogwood, Red Cedar, hawthorns, and, more recently, the introduced and highly invasive Multiflora Rose (Fig. 20; McVaugh's *Flora of the County*, which is based on field observations from the 1930s, does not yet mention this species). Some of the native herbs listed above can persist in the ground layer. The point here is that pasture was probably most ecologically valuable when it was marginal. Poor soil allowed both native plant species and native shrubland birds to find homes; obviously, in many cases these were the sorts of pastures that farmers didn't want. However, as certain European graziers have long practiced and as some North American grass-based cattle operations are beginning to experiment with,

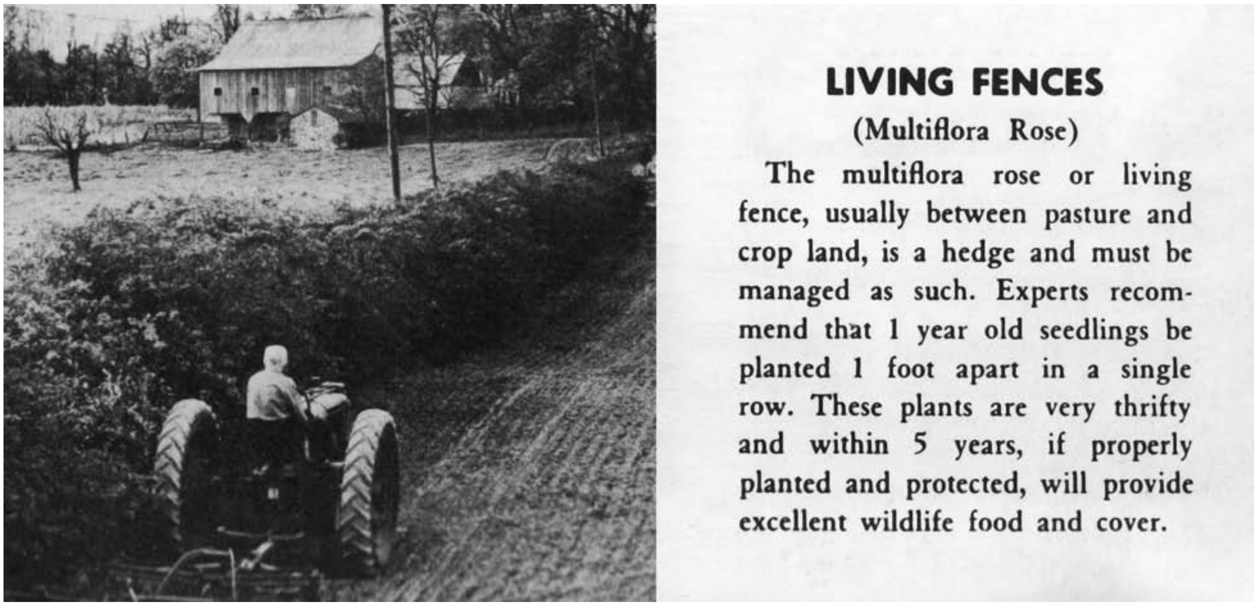
Figure 18. Though regarded as common by Torrey in the mid-19th century and by Rogers McVaugh in the 1930s, Venus Looking-glass is rarely seen today. One of the few places we did see it in abundance was a recently abandoned crop field.

Figure 19. A "shrubby pasture" on Hawthorne Valley Farm in Ghent. Dogwood and Multiflora Rose are invading this pasture, but the bronze fuzz is the native Little Bluestem. Pastures such as these, with their increased richness of native plants and shrubby shelter tend to be valuable wildlife habitat.

botanically diverse fields may have a role to play as medicinal leys, i.e., areas where cows can find resources to self-medicate. Whether such a potential benefit is high enough to justify keeping some pastures in nutritionally-marginal, botanically diverse pasture is unclear.[27]

Today, the shrubby pasture and "hill pasture" may be disappearing. Many of these have reverted to forest, and most farmers who are doing extensive grazing today will usually seed and fertilize their fields so as to insure adequate forage. Because of the price of land (a hindrance to those wishing to start an extensive farm; a temptation to those thinking of selling and getting out) and other aspects of farm economics, the medium-sized, moderately capitalized grazing-based farms are disappearing, and with them the productively-marginal, ecologically-richer pastures.

Fences are a modern component of pastures, and it is an interesting mind experiment to think about how various historical and modern fences have influenced the plant and animal life of fence rows (Fig. 21).



LIVING FENCES

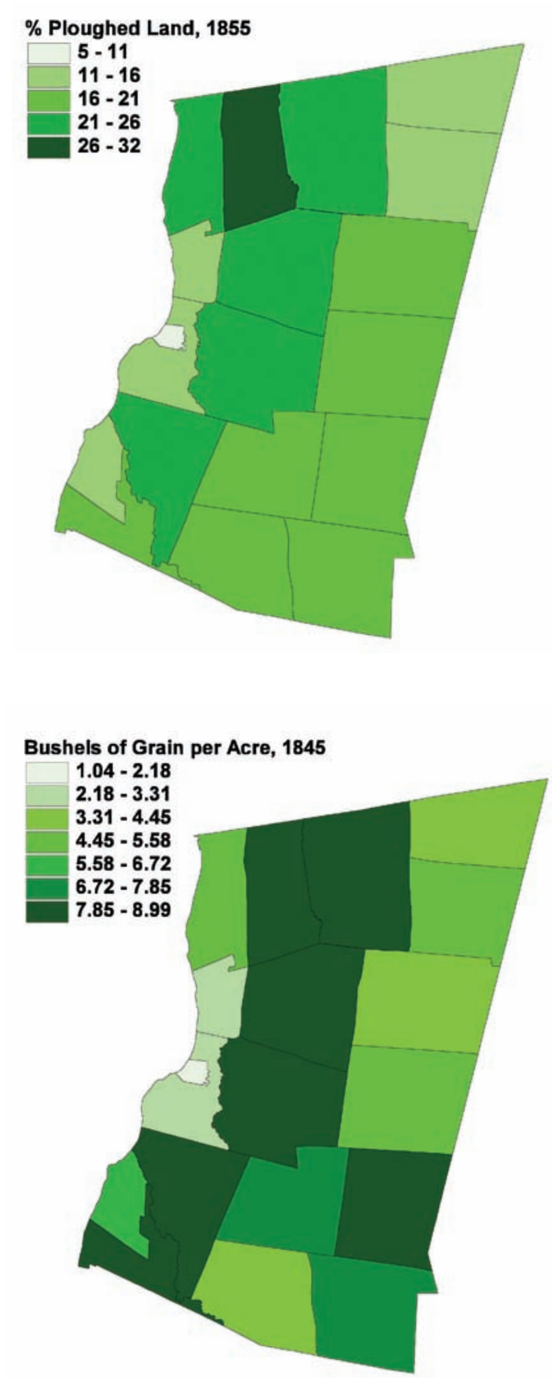
(Multiflora Rose)

The multiflora rose or living fence, usually between pasture and crop land, is a hedge and must be managed as such. Experts recommend that 1 year old seedlings be planted 1 foot apart in a single row. These plants are very thrifty and within 5 years, if properly planted and protected, will provide excellent wildlife food and cover.

***Figure 20**. Promotional material for Multiflora Rose from the Pennsylvania Game Commission's brochure* Food and Cover for Farm Wildlife *(1956). Unfortunately, by spreading aggressively into fields, the exotic Multiflora Rose has gone from boon to bane. The recent arrival of the Rose Rosette Virus has, however, begun to knock this species back.*

Early Croplands. Here, we define croplands as fields that provide a crop other than hay or haylage (see Chap. 1, Fig. 12.). Because some hayfields are plowed and seeded (think alfalfa fields, for example), they are considered as cropfields by some; we have included them with hayfields.

***Figure 21**. Rogers McVaughs' 1935 photographs of fence rows in and around Columbia County. Even the type of fencing can affect what our fields provide in terms of habitat for native plants and animals. The left photograph of a 'rail over rock' fence from just south of the Columbia County line hints at the habitat such fencing could provide to rock dwellers such as snakes and rodents. The clean wire fence in the right photograph of grazing cows in New Lebanon might provide a perch for passing birds, but little else.*



While early farm families did have vegetable gardens where they produced the likes of cabbage, turnip, and other foods, the most extensive plantings were field crops, often grains and sometimes potatoes. Early farmers in the County also planted flax for homespun linens. Cropland was always ploughed, and the niceties of this cover-type would be determined by the type of crop and the growing technique.

Grains (i.e., wheat, rye, oats, barley, and buckwheat) were probably the most desirable crops both because they fed the home (directly or indirectly via livestock) and because they were marketable or served as currency. In the 16th century through the 18th century, tenant farmers (living on manors or working the farms of smaller landlords) were often asked to settle their accounts with wheat. However, grains demanded the best soils. A modern map of "prime agricultural soils" (see Chapter 4, Fig. 6; admittedly probably differing somewhat from how a nineteenth century farmer might grade the soils), indicates the clustering of good farm soils in a band roughly 2 to 8 miles east of the Hudson and in the Harlem and Lebanon Valleys. These are relatively flat, well-draining soils.

Ploughed land dominated the landscape of the north-central townships: it accounted for almost one third of the landscape of Kinderhook, but only 1/10th – 1/20th of the land of Canaan and New Lebanon (Fig. 22). A "bird's eye view" map of Valatie in the town of Kinderhook gives one an impression of this landscape (Fig. 23).

Most croplands were probably so heavily managed that they provided shelter for few species. Some birds (e.g. Killdeer, Vesper Sparrow) may seek the open soils in these fields for nesting, although it is unclear how successful nests were. Killdeer, a shorebird that frequently strays inland, may have found analogy between such fields and the beaches it also used.

***Figure 22**. In 1855 ploughed land (top) was largely concentrated in the central townships located on the flat, fertile soils of the Hudson Valley. As indicated by the map of 1845 grain production (bottom), much of the ploughed land was used largely, although not entirely, for grain production (potato production, for example, was also quite high in Clermont).* Data entirely from New York censuses.

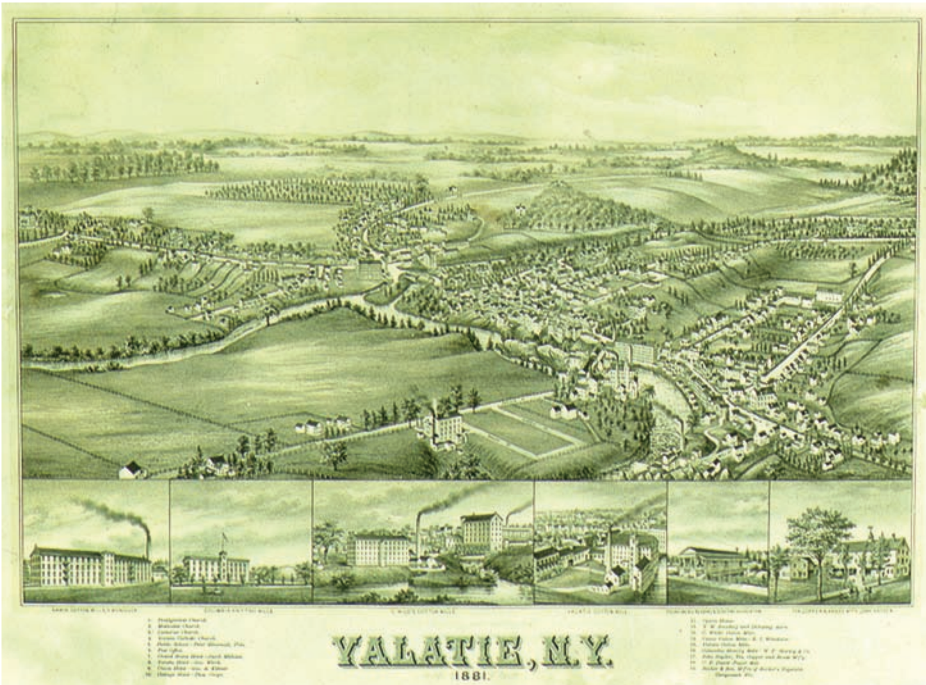


***Figure 23**. This 1881 "bird's eye view" of Valatie in the town of Kinderhook shows a patchwork of settlement and farmland punctuated by orchards and woodlots on the hillier terrain. Much cultivation occurred on these relatively flat lands, in some cases producing the rye that fed paper mills such as those visible along the stream.*
Image courtesy of the New York State Museum

More important than their role in providing structural habitat (and a premonition of the future role of cornfields), grainlands did provide food for wild animals. Early accounts suggest that Woodchucks quickly made themselves known, and a few native butterflies, such as the Black Swallowtail (whose caterpillars fed on the parsley and carrots) and our native Whites (on the brassicas; the Cabbage White which later outcompeted them was yet to be introduced) relished some crops. Needless to say, wildlife use was rarely the farmers' intent, and scarecrows, caterpillar squishing, and the shooting of 'varmints' were common. During the winter, as they do today, passing flocks of boreal migrants such as Horned Larks and Snow Buntings gleaned amongst the stubble and around the farmyard.[28]

During the breeding season, most breeding birds are insectivorous, and, if tolerated, can repay the compliment by helping to control crop pests. Early observers, such as seventeenth-century Peter Kalm, quickly noted that the killing of song birds appeared to be resulting in more severe pest outbreaks, and early ornithological works heralded the agro-economical value of bird life; a focus that persisted until pesticides made biological control appear superfluous.[29]

A handful of native plants that thrive on bare soil adopted cultivated fields and gardens as suitable habitat and joined the league of introduced weeds which had co-evolved with European agriculture for millennia. Common Ragweed (in wheat), Bur-cucumber and Devil's Beggartick (in gardens and corn fields), Milk Purslane and Witch-grass (in corn fields), and Pennsylvania Smartweed (in barn yards) were common enough to be listed as weeds of cultivated grounds by Torrey (1840) and Darlington (1859). Today, Common Ragweed and some smartweeds are among the native cropland weeds.[30]

Cornfields. As our pre-eminent field crop for much of the last 150 years, if not longer, cornfields deserve their own consideration. So-called "Indian Corn" (to distinguish it from what the English termed "corn," which meant any grain) was quickly adopted by colonists and appears to have been widely planted in the County by 1800, mostly for use as cornmeal. Widow's allotments from this period list an average of 4 bushels of corn as annual staple (for humans and livestock), and Alexander Coventry's late 18th century Claverack diary mentions both its domestic use and its retailing. More than 28,000 acres of corn were recorded as planted in 1845 (see Chapter 1, Fig. 13). This extent dwindled over the next century until corn took on wide use as fodder for cattle, and dairy farming became a mainstay of the County economy. Corn peaked again around 1970 at almost 30,000 acres. Because of new corn types and farming styles, much more corn was produced from this land than in 1845 (early yields were around 80 bushels per acre, modern yields exceed 400 bushels/acre). We focus our consideration of corn on this later period because pre-1845 agriculture was diverse and corn was but one field crop among many. By the 1970s, no other crop, not even hay, competed with corn for extent in the County. [31]

As do most grains, corn prefers deep, rich soil. It is one of the most demanding field crops currently grown in the County. Much corn is raised on or near floodplains, in valley soils which are relatively deep and flat, and this means its cultivation supplanted particular natural habitats. During our study of 15 floodplain forests in the County, we found current or former cornfields adjacent to nine of them. The cornfields were usually located on slightly elevated floodplain terraces; however, their proximity to the waterway was illustrated by the common occurrence of corn stalks or cobs in flood flotsam, and, as will be described in Chapter 5, water studies have shown the significant presence of cornfield agro-chemicals in the waters of some creeks. The cornfield's proximity to and substitution for floodplain forests affects those organisms which occur in floodplain forests but might wander into adjacent cornfields. A major cause of mortality in Wood Turtles, for example, is farm machinery. Wood Turtles hibernate in streams and spend the summer months roaming nearby lands. There is a set of native plants and animals that is nearly confined to floodplain forests, and another set that frequents wet meadows. Cornfields, which have increasingly replaced such lands, offer habitat for fewer organisms. Recent trends towards heavier summer rains in the County, associated with significant bottomland flooding in 2008, 2009 and 2011, is leading some farmers to re-think their use of floodplain soils; the native species may, in the long term, be better able to accommodate changes in flood regimes than the farmers.[32]

Few organisms find direct analogies between cornfields and the native habitats that they have experienced for millennia. However, in terms of nutrition, a 'neighborhood' cornfield might be somewhat equivalent to the food resources that wildlife found in masting forests – chestnuts, acorns, hickory nuts, and beech nuts are all produced irregularly but in large quantities. Such "mast years" have long been recognized as important nutritional bonanzas for native wildlife. Indeed, it appears that the Passenger Pigeon's natural history, which included huge flocks that wandered over vast areas, was predicated on taking advantage of such 'blooms.' Other birds and mammals such as American Turkey, Black Bear, Raccoon, squirrels, rabbits, White-tailed Deer, and various mice have reproductive strategies that can result in quick increases in fertility when food is flush. As a source of highly localized and concentrated potential food, cornfields might offer certain analogies to masting forests. In fact, aside from following tree masting, Passenger Pigeons were also known as cornfield pests (Fig. 24).[33]

***Figure 24**. Passenger Pigeon, as illustrated in* Johnson's Natural History *(1874). These pigeons apparently sought out stands of masting trees; farm fields could provide similar bonanzas.*

A walk through and around many cornfields indicates the extent to which wildlife makes use of these fields as food sources, although not necessarily as habitat. Researchers in Illinois reported that small mammal biomass in fence rows separating crop fields (mainly corn and soy bean) was four times the levels found in forests; populations in the fields themselves were, however, below forest densities. The use of cornfields by birds (e.g., blackbirds and crows) is also well known. Such uses are not necessarily desiderata of the farmers, yet several we have spoken with in the County recognize the importance of their fields for wildlife and reported consciously planting 'a bit more' corn to accommodate wildlife use. In conjunction with the increase in corn-consumers that such fields facilitate, predators such as Long- or Short-tailed Weasels, Bobcat and Eastern Coyote may take advantage of the increase in prey. In addition to a feeding ground, the adaptable coyote has also been reported to use cornfields as daytime shelter.[34]

Lawns. The American lawn may have at least two roots: the English manor with its extensive, verdant gardens and grounds, and the backyard pasture that fed the family horse or cow and got things reasonably open around the house. The English aristocracy developed a penchant for lawns, perhaps because of the vistas they afforded and the wealth they emanated (i.e., the owner had enough land that cultivating it all for food was not necessary and had enough money to pay the groundskeepers needed for maintenance). This fashion was copied by the North American upper class during the first half of the 19th century; President Jefferson was apparently a booster. The lawn's identification as a status symbol prompted emulation by aspirants, and Alexander Downing, an influential New York landscape architect of the mid 19th century, promoted the beauty of lawns in his widely read books describing middle-class homes. Hand lawn mowers began to be produced during the 1860s.

Early in the 20th century, the USDA and the American Golf Association teamed up to find the best mix of grasses for US lawn; they focused on imported species of grass, in part because so many of our grasses are warm-season grasses that show little lushness until mid to late summer. Some have suggested that televising of the Masters Golf Tournament, begun in 1967, made a large contribution to making lawns a desired staple of suburbia. Gardening and fashion magazines of the mid 20th century espoused the role of green lawn. The ideal, suburban home was ringed by a relatively small, but closely-kept swath of grass – an anachronistic green moat against the wildness that had already been driven out.

A recent publication estimated that, nationwide, lawn area increased by more than 350,000 acres per year between 1982 and 1997. More than 40,000,000 acres are estimated to be covered by lawn in the continental US. Very closely cut, frequently doused with lawn chemicals, predominantly populated by non-native plants, most lawns offer ecological analogies for few native organisms. The concept of gardening with native species has gained popularity, but the lawn is still a dominant and yet biologically impoverished field type.[35]

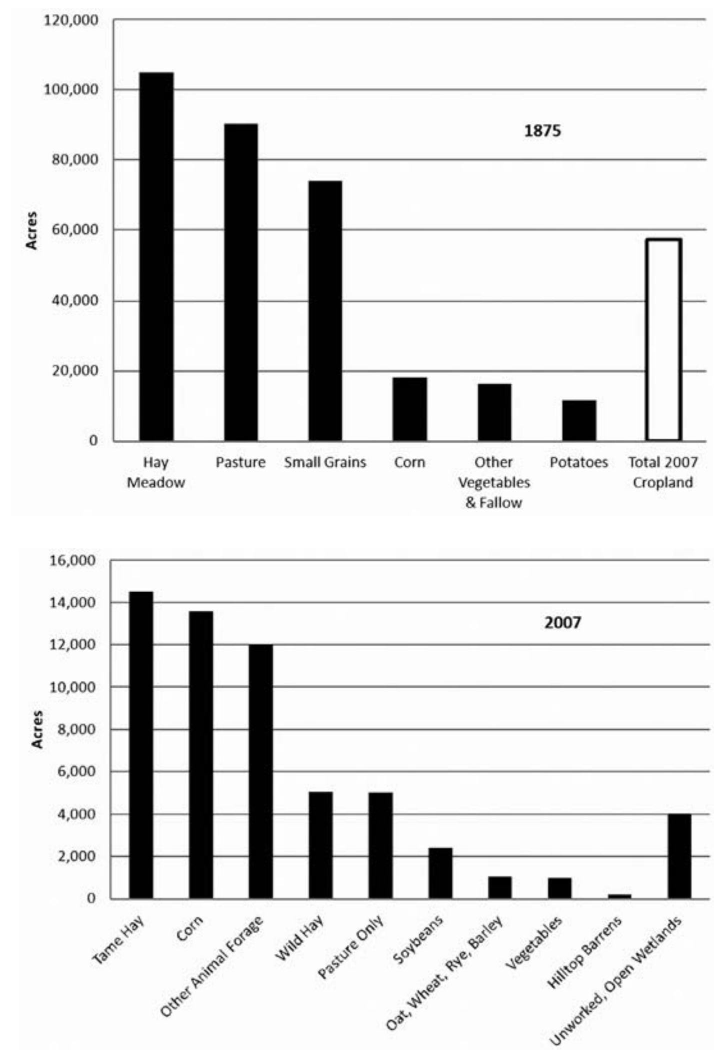


***Figure 25**. These graphs depict the estimated extent of certain Columbia County field types in 1875 (top) and 2007 (bottom) based on census reports. Fields have declined substantially – the total area of worked fields (including pastures and hay fields) in 2007 is less than what was devoted to grain production alone 130 years earlier. Hay has remained the largest single component of the fields, but pasture extent has fallen dramatically. The estimated extent of hilltop barrens and open wetland are also indicated in the 2007 graph; clearly, agriculture is the primary current source of our fields.*

Summation of field history

A 2002 estimate from the work of Amielle Dewan put openlands in Columbia County at around 102,500 acres (or roughly 25% of the County, compared to 63% forested). According to the 2007 agricultural census, approximately 54,560 acres of this were being pastured or harvested for a variety of crops including hay. In addition, there were roughly 4,000 acres of open wetlands. This would leave around 37,150 acres of lawns or old fields. This compares to a our pre-European settlement guestimate of no more 25,000 acres in fields, most of which would have been wet meadows, and some of which may have been used for indigenous farming. At the peak of agricultural extent around 1875, some 315,000 acres (or 75% of the County) were openland, of which about 105,000 acres were in hay, 90,500 acres in pasture, and around 74,000 acres in small grains. In other words, the amount of hay land in 1875 is roughly equal to the total of all openlands (agricultural or not) today, and the total amount of worked farmland today is less than what was devoted to small grains in 1875 (Fig. 25).

As we have tried to describe above, these marked changes in the landscape have meant profound demographic changes for many of our field organisms.

The Future

An Aside on our Ability to Know Where We Are. Our fields continue to change. Fields arise from disturbance, human-caused or otherwise. In our time and place, human-related factors predominate, and agriculture continues to be foremost amongst those. As a result, because of the regional decline in farming, one of the most dramatic changes in our fields is that there are many fewer of them.

Will that dramatic decline continue? Where are we now? Grasslands in the County have certainly declined dramatically over the past 125 years, even if, for example, the area of hay meadow in 1865 was not, as the census reports, exactly 96,806.25 acres. Not only do we have the statistical information but inspection of old images and a walk through woods laced with stone walls confirm this general trend. However, as the purported changes become more subtle, as they have in recent years, the chance of being misled by the statistics grows. There are several causes for this, and they are worth describing because they apply to many of our efforts to understand land use, not just the extent of grasslands.

First, as any of us who have filled out more complex census forms know, there is almost always room for interpretation when answering questions. In addition, the questions change – those who design the censuses develop interests in new aspects of agriculture and lose old interests. For example, for many decades, the agricultural census provided town by town statistics on what they called “improved” and “unimproved” farmland. Recent censuses have dropped the town as a unit of sampling and do not explicitly report “improved” and “unimproved” acreage (although one can estimate those acreages from what is reported). Further, some farmers deeply mistrust government and may not describe their farms in detail. All these factors add ‘slop,’ which means those numbers which appear so reassuringly concrete, may in fact be somewhat nebulous.

There are other approaches to looking at trends in land use. Ever since aircraft and then satellites, circled the Earth, it has been possible to take aerial photographs of the land and use those to assess change. The advantages seem obvious – no longer must one depend on respondents to understand and truthfully answer census questions and on census designers to show constancy in their questions, one can see for oneself. Alas, it is not so easy. There are two major stumbling blocks in the use of aerial imagery: it takes a great deal of work and it also involves a level of interpretation.

For example, suppose I want to assemble information on county-wide change in the extent of lawn cover since the 1940s. At a minimum, I would need to inspect photographs of 412,000 acres of land twice (once with the historical and once with the current aerial photographs). I would need to make parcel-by-parcel determinations of what was lawn and what was not. The comparability of my mapping of each era would be hampered by the facts that the 1940s photographs are black and white and of relatively low resolution while at least some of the modern images are color and of higher resolution. Additionally, while I can ground-check the modern images, I have few means of doing so for historical images (for example, in a 1940s image, how do I know what areas were true lawn and which areas were grazed by the family cow or horse, or even graded into hayfield?). Even modern images present challenges. On former farms which have become non-farmer estates, can I always tell which land is hayed by the farmer down the road and what is mowed weekly by a groundskeeper?

Recent efforts to describe land use have tried to avoid these subjective choices by using computers to mathematically analyze the texture and color of each part of a photograph and, based on that, categorizing the land use. However, such equations are just derived from somebody else's approximation, albeit one that is applied with rigid consistency. Furthermore, these assessments usually break the landscape up into 'bite-sized' blocks and assign each block to its predominant landcover. The minimum size of such blocks is often 30m x 30m (about 180 ft x 180 ft). This is a size that encompasses the entire lot of many homes – lawn, driveway, houses, garage and all. Again, this means there is 'slop' and inaccuracy.

One can envision the ideal – cruising the landscape with aerial photograph in hand, outlining true lawn on the image and eventually summarizing those outlines. One can also envision the cost of such an approach….The point of this digression is to suggest humility as we try to consider future trends: not only can we not predict the future but, in some very real ways, we don't know where we are right now and may have even fuzzier knowledge of the historical patterns indicative of land use momentum. With those caveats, we'll proceed to speculate.

Columbia County & Westchester County – Before & After?

Located on the east side of the Hudson and of somewhat similar size, one can look to Westchester County as a potential example of what Columbia County might look like if sub- or ex-urbanization spreads into it to the same degree as in Westchester. There are reasons why this comparison has flaws (slight differences in climate, distinct differences in history), but in terms of potential landscape change in Columbia County, the comparison might bring insight, especially given the similarities between the two counties some 150 years ago.[36]

In 1855, Columbia County was roughly 69% improved farmland, including 23% of its total in pasture and 15% in hay meadow; at the same time, Westchester County was roughly 62% improved farmland, including 25% of its total in pasture and 19% in hay meadow (Table 3).

				Percent of County's Total Surface Area					
County	area (sq mi)	Population Density (people/sq mi) 1850	Population Density (people/sq mi) 2010	Improved Farmland 1855	Pasture 1855	Hayfield 1855	Forest 2000	Hayfield & Pasture 2000	Lawn 2000
Westchester	500	117	1,898	62%	25%	19%	52%	4%	9%
Columbia	648	66	97	69%	23%	15%	59%	19%	1%

Table 3*. Current and historical descriptors of Columbia County and Westchester County land use and demographics. Increased population has been accompanied by increased lawns, and the pesticides to maintain those lawns (see text).* Recent figures are derived from the National Land Cover Database (NCLD, www.mrlc.gov/nlcd06_data.php).

In 1855, Westchester had twice the human density of Columbia County with about one person for every four acres of land; today, the population density of Westchester County is 20 times that of Columbia County, and Columbia has yet to reach the densities that Westchester experienced in 1855. This large demographic divergence has meant a large divergence of land use (Fig. 26).

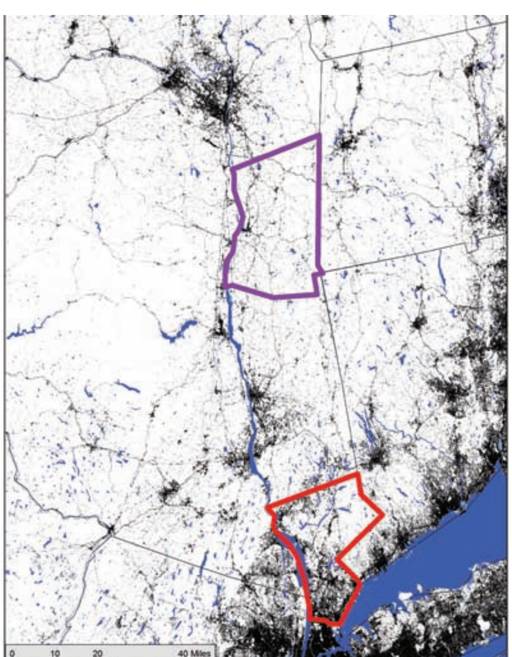


Figure 26*. Outlines of Columbia (purple) and Westchester (red) Counties overlain on the National Atlas' impervious surfaces layer (see also Chap. 2, Fig. 20). Relative to much of the surrounding land, Columbia County is lightly developed; Albany (northwest), Pittsfield (northeast), and Poughkeepsie (south) are the closest major cities.*

Using one of those crude land use assessment tools that we mentioned above (mathematical land use classification based on aerial images), we can try to describe how the fields of these two counties differ today and what that might mean about the future of Columbia County's fields. Westchester County has about 9% of its surface area in lawn (this would include household lawns, golf courses, cemeteries, mown parks, etc) and about 4% in hayfield and pasture (with about 52% in forest and, thanks partially to reservoir construction, nearly 23% of its surface covered by water). Columbia County has more field: about 19% is hayfield and pasture, with only about 1% in lawn. Interestingly, the two counties differ little in forested area according to this analysis: Westchester is about 52% forested, Columbia about 59%. One could argue about the relative ecological integrity of the forests, but the main point here is that the two counties differ most substantially in their field habitats.

If lawn and pasture/meadow were of equal ecological value, one might say the difference was relatively slight. However, lawn is the most ecologically barren type of grassland in our landscape. From the perspective of potential habitat for field organisms, it's probably accurate to say that going from essential equality in 1855, Columbia County now has about 5 times more ecologically useful grassland habitat than Westchester. This difference has consequences for the animals who depend on such habitat. In the recent NYS breeding bird atlas, about 10% of the Westchester County blocks reported Bobolinks and 8% reported Eastern Meadowlarks (both grassland nesting birds); in Columbia County, the values were roughly 82% and 68% respectively. Likewise, Jeffery Glassberg, reporting on Westchester County butterfly counts in the Fall/Winter 2013 edition of *American Butterflies*, noted widespread decline, including the apparent local extinction of at least a couple of species still present in Columbia County.

These differences in field habitat extent have even profounder implications. In 2005 (unfortunately, the most recent year for which there are data), about 20,000 gallons and 36,000 pounds of pesticides were applied in Columbia County; in Westchester County during the same year, about 579,000 gallons and 2,303,960 lbs of pesticides were applied. The pesticides utilized in Columbia County were apparently used on farms, lawns and in apple orchards; in Westchester County, the vast majority of the chemicals used were for 'turf care.' The figures are staggering, especially if one realizes that there were only around 30,000 acres of lawn or turf in Westchester County.[37]

The aquatic consequences of these chemicals and other suburban impacts (e.g., nutrient influx and sedimentation) for aquatic organisms is evident in NYS DEC's assessments of aquatic invertebrates (something we'll explore more in Chapter 5). As a way of assessing water quality, the State carries out spot studies on various waterways and then compares the communities of insects and other invertebrates to reference communities from sites with various levels of impact. Based on these comparisons, they then classify each sampling site in terms of relative degree of impact. Of roughly 32 Columbia County sites, 62% were classified as non-impacted, 28% as slightly impacted and 9% as moderately impacted. Of 44 sites in and around Westchester County, only 14% were deemed non-impacted, 61% were slightly impacted, 20% were moderately impacted and 5% qualified as severely impacted.[38]

Westchester County is one possible approximation of the future of Columbia County. However, rather than being seen as a likely eventuality, perhaps it is best seen as a pole towards which certain pressures are likely to push Columbia County and its fields. Current change is relatively modest. The US census bureau estimates that human population in Columbia County has been more or less stable since the last census, and although remote sensing suggests that lawns and developed area other than lawns have increased in the County while forests have declined between 2001 and 2005, the changes have been slight (increases of 78 and 83 acres, and a decrease of 229 acres, respectively). However, as the agricultural indices show, dramatic changes have occurred during the past 150 years. Even since 1950, Columbia County's population has increased around 50% and farmland decreased by nearly 60%.[39]

The consequences of development for our field habitats will depend upon at least three factors: the type and extent of farming in our landscape, the economy and fashion driving the landscaping of large country estates (often derived from former farms) and of more modest homes (whose land use is individually less, but whose sum effect is also large), and housing patterns. In the northwest portion of the County, for example, a study of sequential aerial photographs (Fig. 27) suggests that housing developments first supplanted orchards and now are taking up former fields. These are generally small-lot developments designed for Capital District commuters. Unless they are clustered and stacked, such development will likely destroy field habitat. Houses in these developments are usually surrounded by lawn.[40]

If the larger estates which are now replacing some farms maintain their current tendency for irregular hay cutting, then fields of a certain ilk will survive. However, the type of farmers who use such medium quality hay are declining (horses demand better hay), and, in the future, land owners may need to pay to have their fields cut and the hay removed. They may decide to abandon such fields (which will eventually revert to shrubland and then forest) or to manage them more intensively for horses or by regular lawn-mowing.

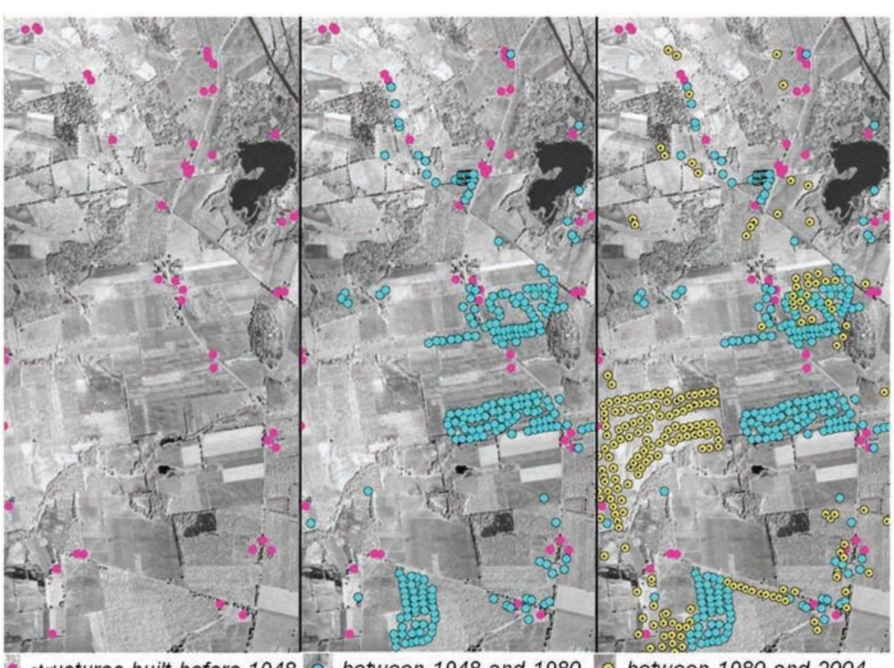


***Figure 27**. The chronological sequence of housing development along the Route 9 corridor in Kinderhook. Between 1948 and 1980, many houses were built on former orchards. Since then, crop fields have begun to be developed. The declining extent of fields has ecological as well as agronomic implications – some grassland birds, for example, will only nest on relatively broad grassland expanses. Such large, contiguous areas of field were readily available in 1948, but are scarcer today.*

The shape of future agriculture will play a large role in determining our landscape cover. If relatively intense, small scale vegetable farms become the agricultural mainstay (perhaps the only type of new farming that will be practical given high land prices), then extensive agricultural fields – pastures, upland hay fields, wet meadows – will largely disappear and the landscape will "Westchesterize" at least in this respect (Fig. 28). Horse pastures may be less ecologically valuable than pasture of other livestock, because they are often seeded and are kept closely cropped. If grass-fed meat and dairy maintains a foothold or even expands (as it has over the past 10 years), then we may see the creation of new grasslands from former corn fields (as corn-based dairy declines). Because of the high land prices, most grass-based meat and dairy operations in the County today are backed by non-farming investment; it remains to be seen whether those farms will become established in the long-term or just be shorter term investments.

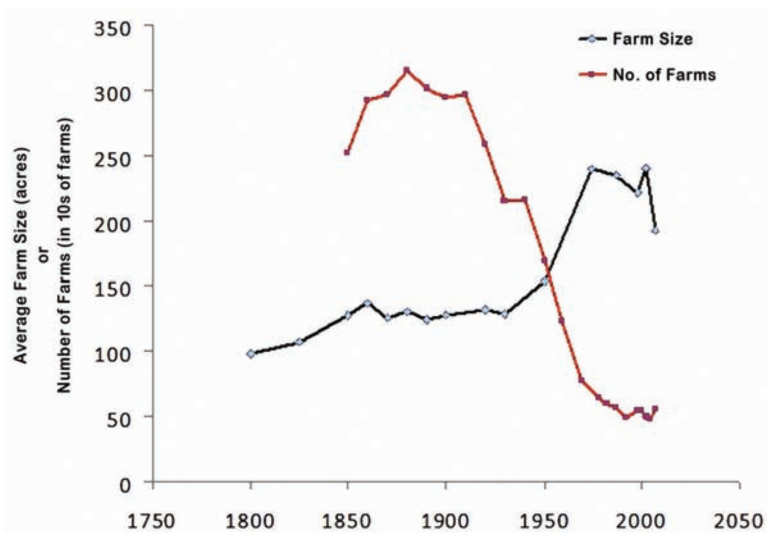


***Figure 28**. The number of farms in Columbia County has declined steeply since 1900. As farms consolidated, farm size rose. However, it has recently begun to drop while farm numbers appear to have stabilized. This may reflect the increased viability of market vegetable gardens. This development has led to a partial revival of agriculture in the County, but such farming requires substantially less land than the fruit orchards and dairy farms that predominated during much of the 20th century.* Data from federal and state censuses.

The fields of Columbia County still exist, and there is even still room for their expansion. We have yet to burn many bridges, and current rates of change (i.e., the last 10 years) appear to be relatively slow. We still have a natural resource to conserve and the theoretical ability to do so. Fields occupy an intersection of production and conservation. They are home to our food production and home to a variety of native species. In some cases this may represent competition, but in other cases (such as the hay meadows which provide homes to grassland birds or the wet pastures which support unusual butterflies) there are compromises where agricultural production and conservation are compatible or even synergistic. Land use for both local food production and nature conservation is, in turn, largely influenced by land use for residential and commercial (non-agricultural) development. We have yet to enunciate and pursue a collective county-wide vision that integrates development with agriculture and conservation. The survival of the local biological riches described in this chapter may depend on such a vision.

In the sections that follow, we explore the ecology of field plants and animals in a bit more detail, so that we can reach beyond the numbers and graphs to the cast of characters to be found in the fields around us.

Natural History Profiles: Field Plants

There is a history written in weeds – a history of humanity's different uses for plants and of how some of these plants have trickled out of field and garden and left their imprints on the ecology of our current world. It is also a story of empty ecological nooks and crannies, of spaces where native openland species, ill-adapted to compete on, literally, a level playing field, found room to survive. We will follow these two contrasting scenarios by focusing on some of the leading botanical characters of our fields.[41]

Introduced plants are in our fields because they somehow arrived and, once on site, have been able to survive and often prosper (see Table 4 for the introduction history of some species). That many have flourished can simplistically be explained by the ecologies of the plants that Europeans tended

	Ornamental	Medicinal	Spices & Other Uses	Domestic Food	Pasture/Hay	Incidental
1600s	Butter & Eggs Dame's Rocket	Catnip Celandine Chicory Common Plantain Common Speedwell Common St. Johnswort Curly Dock Shepherd's Purse Tansy Wormwood	Shepherd's Purse Wild Marjoram	Barberry Chicory Dandelion Purslane Stinging Nettle (?) Watercress (?)	Kentucky Bluegrass White Clover White Sweet Clover	Cocklebur Common Chickweed Non-native Knotweeds Quack Grass Stitchwort Velvet Grass
1700s	Bouncing Bet Gill-over-the-Ground (?) Johnny Jump-up Oxeye Daisy Scarlet Pimpernel	Bouncing Bet Common Mullin English Plantain Hedge Mustard Johnny Jump-up Lemon Balm Moth Mullein? Queen Anne's Lace Thyme Viper's Bugloss	Peppermint Spearmint Thyme Wild Madder	Asparagus Queen Anne's Lace	Alfalfa Black Medick Field Garlic Orchard Grass Red Clover	Canada Thistle Cheat Common Teasel Field Bindweed Lamb's Quarters Penny Field Cress Soft Chess Sweet Vernal Grass Tall Fescue Viper's Bugloss Wild Mustard Yard Grass
1800s	Bladder Campion Hawkweeds Japanese Knotweed Moneywort Multiflora Rose	Garlic Mustard		Garlic Mustard	Multiflora Rose (as living fence) Tall Fescue	Barnyard Grass Black Bindweed Bull Thistle Downy Chess Hemp Nettle Sow Thistle Spotted Knapweed Wild Radish Yellow Foxtail
1900s	Galinsoga Purple Loosestrife				Cow Vetch (?)	Giant Foxtail Velvet Leaf Wild Madder

***Table 4**. A partial summary of the introduction history of some of our non-native plants. All dates are approximate and some of the reasons for introduction are uncertain. In addition, some plants were brought here for more than one reason. The primary cause of introductions varied over time with medicine, food and animal forage uses accounting for many of the earlier introductions, while ornamental uses became more important subsequently.* See note 41 for sources.

to bring with them. Most of these were plants adapted to a broadly cultivated landscape. In the 'old country,' millennia of European-style farming meant a pre-selected cohort of plants adapted to agricultural field conditions. As European-style farming spread in North America, few native plants 'felt at home' whereas the imports were on familiar ground and so took hold. Different species, however, arrived in different ways and at different times. While some plants arrived accidentally, others were brought over intentionally. How and why these latter plants arrived is perhaps the most interesting question because it reveals a history of intentions still growing in the landscape around us, even after those intentions have disappeared from current minds.

Before delving into the biographies of some of the intentionally introduced plants, it's worth briefly thinking about the sly stowaways. Many European field weeds had been shaped by generations of living with Old World agriculture before they arrived here; these species (such as Wild Oats, Rye Brome, and various sorrels) snuck around the countryside in part because their seeds often mimicked those of certain grains and other cultivated grasses and hence were difficult to separate when those crop seeds were collected for planting. These inveterate stowaways came to North America as infiltrators of crop-seed batches or in harvests from 'weed-enriched' fields such as hay (and hence manure) or packing materials. Some incidentals probably also arrived as ballast waste, perhaps together with earthworms. Early transport boats used dirt as ballast and dumped their weight when they loaded up at ports such as Hudson (later, when boats began using water for ballast, this also became a route for aquatic invaders such as Zebra Mussel). The seeds sometimes also arrived in packing material or other freight, and one pastime of ardent botanists in the late 1800s was to visit train yards, where they were often able to substantially augment their plant lists. Agronomic tastes change and early farmers experimented, so some plants listed as early incidentals may have, in fact, been intentionally introduced as part of the seed mixes that early farmers used to start their fields.[42]

Intentional introductions for agriculture, medicine, food/spice, or ornamental gardening were probably the most common routes of arrival. If we look at non-woody, wild-growing plants in Columbia County, work done by one of our interns, Tara Morgan, shows that, compared to the native species, the introduced plant species are less likely to be directly toxic and perhaps more likely to be truly edible. In other words, the introduced plants that we find around us were, broadly speaking, originally put here for a purpose.

First Arrivals

When Europeans first settled in the Northeast during the seventeenth century, they brought the seeds they needed for food and medicine. The colonial seed lists that have survived include crops, spices, and medicinal plants. Ornamental flower gardens were probably not the first thing on people's minds when they went to settle in the 'wilderness.' While it is difficult to know exactly when any of these early plants first went wild, several familiar field plants were probably amongst the first 'graduating classes,' these include Common Plantain and White Clover.

Common Plantain (Fig. 29) and the similar **Narrowleaf Plantain** have spikes of inconspicuous flowers supported by rosettes of leaves lying nearly flat on the ground. If you find a cluster of broad, low, non-grass leaves in your lawn, then you've probably spotted one of these species. Those flat leaves help it evade the lawnmower.

Plantains arrived so early that at least one 18th century botanist was unsure whether they were native or exotic. According to what is perhaps an apocryphal tale, the Common Plantain was called 'white man's footprint' by Native Americans because it sprung up so quickly in the wake of European settlement. Like so many of our weeds, Plantain not only may have stuck to our shoes, so to speak, it also prospered on the trampled ground we left behind; we provided both inocula and habitat. As Chester Dewey, of Berkshire County, wrote in reference to this species, "where he [mankind] rears a hut or tills the soil, it appears to cheer him on his way." Indeed, some suggest that this plant was originally called "plantain" because it followed the foot paths of the Roman legions (the "plant" of both plantain and plant is thought to derive from the Latin for foot, the latter derivation perhaps due to the use of the foot in planting). Whatever the case, early accounts suppose that it was introduced to the New World because it was favored to wrap wounds or blisters. As one early flora summed it up: "This vegetable, which grows at every one's door, and not the less for being trampled underfoot, is in considerable repute among many people as a refrigerant external application [sic]." It is, in some ways, a Band-Aid escaped from the first-aid box.[43]

Figure 29. *Common Plantain may have first been brought to this continent as a medicinal herb; it seemed to have a range of applications, including use as a diuretic and antiseptic.*

By the mid 19th century, it seems to have been considered more weed than remedy although New Lebanon Shakers were selling its dried leaves. Its seeds apparently resemble those of Red Clover, and so it was accidentally mixed into clover seed stock. It was thus a constant weed of upland clover meadows. Although farmers seemed to generally disparage it (or, as Torrey gently put it, only "lightly esteemed" it), sheep were apparently not so discriminating, and it made a functional pasture plant. Despite its exotic status, it is one of the novelties that seems to be experiencing some ecological acceptance: the caterpillars of Baltimore Checkerspot, a handsome native butterfly, apparently are beginning to accept Narrow-leaf Plantain as food in the wild, together with their traditional fare of the more wet-meadow loving, native Turtlehead. By doing so, they might dramatically expand their larval habitat.

Other plants that were apparently favored for their medicinal properties and arrived in the seventeenth century included Chicory (Fig. 30), Celandine, Common St. Johnswort, Heal-All, and Curly Dock. All of these now occur in our fields, a reflection, at least in part, of their early utility.

Interestingly, based on Tara Morgan's study of modern and historical herbals, introduced plants are not more likely to be medicinal than native plants, although the curing of certain ailments, such as heart problems, is more readily associated with the new species than with the native ones. This difference in reported curative properties may have less to do with differing plant chemistries and more to do with the differing diseases that afflicted native and European cultures (and hence shaped the respective medicine chests that have been handed down to us). Heart disease, for example, may have been relatively uncommon amongst American Indians, and so there was little motivation to find botanical cures for it.

Figure 30 *Chicory and friend. Chicory was introduced relatively early, probably for its medicinal value.*

White Clover (Fig. 31) is a plant from the farmer's field kit: it was probably carried here for its on-farm value. This is one of the most common plants in lawns and in many close-cut (or grazed) fields. If you find a smooth-leaved (i.e., not fuzzy) clover on a lawn, then you've probably found this species. It is a member of the pea family, and like all plants of that sort, it fixes nitrogen. Nitrogen fixation means that nitrogenous gases are plucked from the air and converted, with the help of some collaborative bacteria, to more solid forms that all plants can then incorporate into their growth. Aside from the ways that this benefits the soils, the relatively high protein content (proteins are among the most common organic compounds that contain nitrogen) makes clover a valued cattle forage. While the intricacies of crop rotation and green manures were probably not fully realized during the earliest stages of colonial agriculture, this Old World regular of the farmyard was quickly introduced to the Colonies. Alexander Coventry of Claverack recounts buying clover seeds in his 18th century diary. During the 19th century, one of the first forages cut by the New Lebanon Shakers during the growing season was their clover.

The idea that the name "Claverack" translates into "Clover-Reach" and hence demonstrates the original presence of clover on our hills is erroneous: "claver" in this case refers to the clay banks or bluffs that marked this stretch of the Hudson River. However, the fact that this notion has long been held indicates how quickly clover came to be a regular. Two luminaries of botany in the 1800s, Asa Gray and John Torrey, both thought it native; Torrey stating, "This species must be native, for it springs spontaneously from the soil, even when turned up from considerable depths, where its seeds have probably lain dormant for ages." Eighteenth-century Swedish visitor Peter Kalm, describing his visit to Albany, ponders, "The hills near the river abound with Red and White Clover. We found both these kinds plentiful in the woods. It is therefore difficult to determine whether they were brought over by the Europeans, as some people think, or whether they were originally in America, which the Indians deny." Perhaps reflecting its early association with farmers from Holland, one 19th century book calls it "Dutch Clover."

Once on the ground, White Clover probably spread, intentionally or not, in the manure of grazing animals (this is a form of propagation that was clearly recognized and utilized by early farmers) or through the spreading of pasture seed mixes. White Clover was later joined by Red Clover and, more recently, Alsike Clover (Fig. 31). Numerous 'English grasses' also arrived to our landscape as tools for enriching pastures and hayfields.[44]

Figure 31 *Red, Alsike and White Clovers. These European imports were probably intentionally introduced because of their value as forage and cover crop.*

Several spices seem to have been introduced fairly early. **Thyme**, **Wild Marjoram**, **Spearmint** and **Peppermint**, for example, were probably brought over to spice the pot. While Thyme has a somewhat patchy distribution in Columbia County, it abounds in the northeast corner where I grew up. This assured that I returned home from many a boyhood romp on the Canaan hillsides smelling better, or at least no worse, than when I left. McVaugh found Thyme wild-growing and abundant only in New Lebanon and Canaan, and it has been suggested that our local populations of Thyme may represent escapees from Shaker spice gardens near Mount Lebanon. While the Shakers did commercialize it, the Thyme of our back fields more likely fled the herb gardens of many now-nameless settlers in the region. It is recorded from New England gardens as early as 1623. Wild Marjoram appears to have been a seventeenth-century arrival and may have escaped into woods as early as 1634; it was apparently not only used as a spice but also a dye. Eights, describing the landscape around Albany on the 28th of August 1835, writes that the Marjoram "is beautifully in bloom, along stony fields and edges of wood." Spearmint was also recorded from New England gardens as early as 1623, although it may not have 'gone wild' until later. Planted around houses and gardens, Spearmint apparently had a rather risqué reputation in the nineteenth century, thanks to mint juleps. In the early 19th century, Peppermint was reportedly cultivated in parts of Berkshire County, whence it escaped into the countryside. Peppermint doesn't seem to be recorded from as early in colonization as the others, although this may reflect the spottiness of the historical record I perused.[45]

The Second Wave

It was probably only after the colonists established themselves that they began to think of their flower gardens. Many of the introduced plant species that became common after 1700 are escaped garden flowers. Perhaps one of the earliest such species was **Butter and Eggs** (Fig. 32, also known as Snapdragon or Toadflax). While this flower is still sprinkled across our drier fields and is relatively easy to find, it was once much more common regionally if not locally. Together with St. Johnswort, it was perhaps one of our earliest 'invasives'; the historian Richard Mack summarizes accounts from the nineteenth century bemoaning its abundance, especially in Pennsylvania. Bartram (in 1758) describes it in almost 'vampirian' tones: "It is the most hurtful plant to our pastures that can grow in our northern climate. Neither the spade, plough, nor hoe, can eradicate it, when it is spread in a pasture. Every little fibre that is left, will soon increase prodigiously; nay, some people have rolled great heaps of logs upon it, and burnt them to ashes, whereby the earth was burnt half a foot deep, yet it put up again, as fresh as ever, covering the ground so close as not to let any grass grow among it." In the 19th century, it was described as very common around Boston in 1824 and wild-growing along roadsides around Troy in 1836; Torrey called it a "pernicious weed," and Dewey, while recording it along roads in Berkshire County in 1829, describes it as "a very troublesome weed" in some states. Darlington, in his 1826 flora of Chester County, Pennsylvania, was even more specific "This is a foreigner, but very extensively naturalized; and a most unwelcome intruder upon our farms;—being utterly worthless, and monopolizing much ground."

Figure 32. *Butter and Eggs was one of the earliest introduced plants to 'make it big.' It was apparently a widespread and despised weed in the 18th and 19th century. It is now just an occasional member of our field flora.*

Darlington in his more general book of farm weeds (1859) decries it as "a vile nuisance." It's in the 1836 flora of Troy and on the 1840s list of plants near Kinderhook Academy. Interestingly, by 1875, Hoysradt is observing that around Pine Plains (Dutchess County, while still "very abundant," it is "not as common as 20 years ago." In 1910, in Connecticut, it still qualifies as "a troublesome weed, difficult to eradicate." By 1915, a botany of the lower Hudson Valley simply states that it is a common weed in the mid to southern Hudson Valley, as does McVaugh based on his mid-1930s fieldwork in the County. Whether cultivation, climate, pests or other changes account for the path of Butter and Eggs from demonic weed to occasional sighting is not known.[46]

Dandelion was also an early arrival – aside from being a garden flower, this multipurpose plant was used as medicine, herb and salad green. Gill-Over-the-Ground was probably another quick escapee from the flower bed and, in wetter areas, Moneywort also became established at this time.

Ragged Robin (Fig. 33), Bladder Campion, and Hawkweed are apparently all showy plants which expanded from flower gardens in the 18th or early 19th centuries. Historians recount the 19th century advent of international markets in seeds and ornamentals and the concomitant boom in new botanical arrivals. An entire suite of plants also came in as pasture or hayfield stock, although it is often difficult to know when such introductions were intentional and when they were incidental.[47]

Our table of introduced plants and their uses should not suggest that native North American plants are without value to humans nor that Native Americans did not bring some of these species to Columbia County for their own use. However, given our distance from that history and the fact that their utilitarian plants were native, detecting indigenous propagation is much harder and so we won't try to determine which native North American plant species arrived to the County via human agency. Those interested in the uses of native plants should consult compendia of both indigenous and colonial botany and recall that settlers learned from the Native Americans around them and vice-versa.

Figure 33. *The showy flowers of Ragged Robin are illustrative of the displays which first brought plants like this to American flower gardens. From there, they escaped into the 'wild' world.*

20th Century

The *de facto* 'organic' approach to agriculture went out of favor for much of the 20th century as synthetic fertilizers, herbicides and pesticides became available and appeared to offer improved yields; however, "green mulches" and cover crops gained new strength during the century's last quarter. Cow Vetch may indicate a new weed derived from this renewed interest in soil-building cover crops. The newest arrivals also include a smattering of ornamentals (e.g., Purple Loosestrife, Japanese Knotweed) and a continuous wave of incidental invaders who arrived along with various seeds and/or were encouraged by modern farming techniques.

A renewed interest in herbal medicine may enrich our flora even more. Lemon Balm, for example, while reportedly grown by the Shakers in the 19th century and listed in early floras (such as Eaton's work from the 1830s), is not listed in McVaugh's *Flora* of the County. Today, it shows up occasionally in our grasslands. This may be an example of a currently favored garden herb/medicine making a new break for it.

Thus, one way to view our fields is as a partial reflection of ourselves. For good or bad, our fields can be read as a chronology of our changing needs, sensibilities, and technologies (not just of agriculture but also of transport). They are truly a cultural landscape.

The Home Team

As we described earlier, most of our native plants were not particularly well-suited for life in a European-style farm field. However, our fields are hardly without native plants, although they are commonly less abundant than the imports.

Figure 34. *Ragged Fringed Orchid, one of our delicate, inconspicuous and increasingly rare native orchids.*

Figure 35. *Nodding Lady's Tresses are modest spikes found in our wetter fields.*

At least one group of field plants deserves a special mention, not because it is conspicuous but because it is inconspicuous. About 30 species of **native orchids** occur in our fields (and forests), but most are short spikes of delicate, inconspicuously-colored flowers that are easily overlooked (not all of our orchids are humble; Pink and Showy Lady Slippers, for instance, are prominent woodland orchids). In our fields, we have, for example, occasionally found Ragged Fringed Orchid (Fig. 34) and Nodding Lady's Tresses (Fig. 35) in moister areas. Intriguingly, Dr. McVaugh reported both species as "frequent," hardly appellations that we would apply today. Furthermore, he cites a third openland species of somewhat drier areas, Slender Lady's Tresses, as "common" in our area, but we have only seen it once. Torrey, almost 100 years earlier, presaged his assessments. New Lebanon resident and future professor of landscape design, Arthur Harrison made sure to mention the array of orchid colors and shapes in the woods and meadows of the New York/ Massachusetts border around 1890. Although numbers are lacking, one gets the distinct impression that orchids were more of a presence in our landscape 100 years or more ago. As written in a book by W. Hamilton Gibson (a rarely sung but highly talented naturalist and illustrator of Northwest Connecticut) and Helena Jeliffe, "When Indian summer warms the brown meadows and swamps, and those second adventists, the violets and clover, reappear to mortals before the summer dies, the Nodding Lady's Tresses shine like slim white ghosts between the grass and sedges, and shed a faint, sweet almond perfume through the air." Today, with rare exception, orchids seem to be but seasonal passersby, lost and inconspicuous in the modern field.[48]

The reason for their increasing rarity is not completely clear. Orchids have naturally patchy populations, perhaps in part because of their known complex relationships with soil fungi. Orchids collaborate with a specialized group, known as mycorrhizal fungi, to create fine roots that collect nutrients for the plants. Fungi are even important for the germination of the orchids' minute, dust-like seeds which carry no nutrient stores on-board. Orchids also often have quite specialized relationships with their pollinators. Perhaps these intricacies make orchids especially sensitive to the changes being wrought on their landscape in the same general way that the intricacies of amphibian metamorphosis seem to make that group of animals sensitive indicators of aquatic habitat quality. On top of this, deer appear to enjoy orchids – Rogers McVaugh guessed that the burgeoning deer population was one factor in orchid decline, a supposition our own incidental browsing observations would support.[49]

Figure 36. Two native lilies with differing habitats: the Wood Lily (top) is more apt to be found on drier ground, including forest edges, whereas the Canada Lily prefers wetter, often somewhat shadier, areas.

Unlike most field orchids, **Wood** and **Canada Lilies** (Fig. 36) are not easy flowers to miss. While differing in finer aspects of shape and hue, they are generally similar to the Day Lilies which make such a splash in our flower gardens. These are best described as flowers of wooded glades, but they sometimes venture at least to the edges of old fields, with Canada Lily favoring moist situations, especially in the Hudson Valley, and the Wood Lily, something of a Prairie species, favoring the drier domains of the eastern hills. In keeping with their gaudy colors, these lilies are apparently pollinated by swallowtail butterflies and hummingbirds. These are, again, flowers which McVaugh and contemporaries considered to be common in the proper habitats and which, today, are a rare pleasure. A sense of their historical abundance can be felt in Eight's 14th of July 1835 entry from near Albany, Canada Lily making "a most superb show in the low meadows and in the light woods… I frequently counted from ten to sixteen flowers on a single plant." Some ten years earlier, a Boston-based botanist wrote of the same species, "A great portion of our meadows are embellished with the flowers of this lily in the first part of summer." Speaking of the Canada or the similar Turk's Cap Lily, one botanist, writing in 1900, states, "Travellers by rail between New York and Boston know how gorgeous are the low meadows and marshes in July or August, when its clusters of deep yellow, orange, or flame-colored lilies tower above the surrounding vegetation." The decline of these species can, again, probably be credited to deer browsing, together with habitat loss (the conversion of field to forest or the intensification of field use).[50]

Goldenrods are the main exception to the generalizations that, at least on relatively deep-soiled fields, exotic plants predominate and that, overall, native field plants are declining: in some old fields, Goldenrods spread far and wide, covering the meadows with a delicate yellow come autumn. Indeed, some have suggested that Goldenrods can become abundant enough to stunt old field succession by outcompeting other species for light and through allelopathy (the secretion into the soil of chemicals which stunt the growth of other species), thereby holding fields in something of a suspended state of Goldenrod exuberance. At least one species, Canada Goldenrod, is considered an invasive in parts of Europe. We have recorded about 17 species of *Solidago* (the goldenrod genus) from the County, although a few are forest dwellers and one, Silverrod, is not even yellow. This diversity clouds historical work, because identification of particular species has been in an almost constant flux.[51]

The mystery here is, perhaps, whence the Goldenrod field? If, as we have hinted earlier, natural fields were unusual in the Northeast for the millennia preceding European settlement, then where did this splay of species come from? The most common Goldenrods in today's old farm fields are the Wrinkle-Leaved (Fig. 37), Canada, and Grass-leaved (Fig. 38) Goldenrods, with wetter fields harboring Smooth Goldenrod, and drier fields home to Early, Grey (Fig. 39), and Showy Goldenrods. The white 'goldenrod,' Silverrod, also comes in on drier fields. It seems likely that some of these species originally found habitats in or around wetland openings, perhaps even in late beaver meadows. Other species were probably more fond of the openings created by thin soil, such as on hilltops or rock ledges; perhaps some species benefited from periodic fires. However, where Canada Goldenrod and its cohort came from is less clear – at least as far back as the 18th century, their habitat was fence rows and field edges, from where they spread as fields were abandoned. Prior to that, perhaps they were tree-gap colonizers, although Peter Marks, a respected Cornell historical ecologist, concluded that most old-field species, including Canada Goldenrod, were in fact invaders from semi-permanent openings (such as those wetlands and rocky hilltops) in the historical landscape, and that their role in succession was new-found.[52]

As hinted at in our earlier review of Cooper's old pasture paper, a few native grasses, such as Little Bluestem, have also been able to hang on where conditions are right for them (or, at least, sufficiently bad for everybody else). Little Bluestem meadows are, for example, found on the drier, thinner soils where the more demanding European grasses have trouble making it.

Figure 37 (top). *Wrinkle-leaved Goldenrod*
Figure 38 (center). *Grass-leaved Goldenrod*
Figure 39 (bottom). *Grey Goldenrod*
Three of our 17 or so goldenrod species, which grow in fields where, together with several other species, they provide a late-summer splash of native flower power.

Natural History Profiles: Butterflies

We touched on the ecology of 'grassland birds' earlier in this chapter. As we mentioned, many of these species reached novel abundances as they spread east from the Prairies or up out of small, local habitat pockets. They have come to be flagships of grassland conservation even though many of them are relative new-comers. Perhaps as deserving of flagship status in our area are some of the field butterflies. Like some of their avian colleagues, they may have been favored by early farming practices – the opening up of extensive wet hay meadows or the spread of poor pastures, for example, probably favored these species. Below, we provide biographies for some of our butterflies. Keep your eyes peeled, most of them are still around.[53]

I am never sure whether the **Painted Lady**'s (Fig. 40) name is intended as a compliment or not. Nineteenth century books also list it as the Thistle Butterfly, Cynthia of the Thistle, or Cosmopolite, all of which are more descriptive of its ecology than is its modern nomenclature. It is, however, a beautifully painted butterfly – like the related Tortoiseshells, Commas, and the American Lady, this medium-sized butterfly can hide its explosion of colors behind the subtle beauty of its lower wing. When alighted but cautious, these butterflies close their wings, thus snuffing out the bold orange and black markings of their upper wing. As a result, a butterfly that may have been conspicuous as it flew by, can disappear on the ground.

The common name 'Cosmopolite' or Cosmopolitan Butterfly refers to the fact that this is the world's most widely distributed butterfly, reportedly breeding on all continents save Antarctica. This widespread distribution might help account for its abundance of common names. However, until early in the 20th century, this species had a well-kept secret: lepidopterists

Figure 40. *The Painted Lady is our most geographically widespread butterfly and is reportedly native to all continents except Antarctica. As is true of a number of other butterfly species, it can hide its startlingly bright upper wing (above) behind an intricate camouflage when it closes its wings (below). The resulting 'now you see me, now you don't' possibilities may be important in predator avoidance and communication.*

were baffled because of its 'eruptive' populations and its tattered state upon first notice. Samuel Scudder, one of the most diligent butterfly observers ever born, concluded that this species probably hibernated and its varying populations were due to variation in parasite load. Certainly, some of its close relatives overwinter as adults and, although the hibernators were not actually found, such a pattern seemed the most believable. Reality was less believable.

Like the better known Monarch, Painted Ladies migrate. The butterflies that reach the Northeast apparently arise from individuals who overwintered in Mexico or, at least, the Southwest; Africa is the source for at least some of the Painted Ladies who visit Europe in the summer. Butterfly and bird migration have important differences: the Painted Lady that might flit by your window in June did not necessarily strike out from Mexico itself. Rather, the butterfly which you see is the child (or grandchild or, perhaps, even great-grandchild) of a butterfly which left Mexico months ago when Spring first reached the more southerly realm. These ancestors came partway north, bred and deposited their eggs. The hatchlings from those eggs eventually metamorphosed into butterflies which continued the northerly journey. If their travel plans are similar to those of the Monarch, then the last autumn generation apparently does make the full trip back to Mexico, where they hibernate before initiating the next migratory cycle the following Spring. Weather conditions and other flukes probably affect overwintering populations and each leg of the journey, the result being that in some years almost none arrive to us while, in other years, they are more abundant.[54]

As its nearly world-wide distribution suggests, its caterpillars feed on a variety of plants. Not only is its diet rather liberal, but the plants it does feed upon are widespread: thistles and a variety of other composits and mallows seem to be preferred. Many of the plants they feed on in the Northeast are introduced weeds, thus they tend to breed on our weed-rich hayfields, lawns, and cropfield edges. This is also the species that is often chosen by those who raise butterflies for mass releases at weddings and other events. The easy-going dietary habits of the caterpillars, the strong flight of the adults, and the ubiquity of the species apparently make them apt butterfly bouquets.

The **Mulberry Wing** (Fig. 41) is a so-called 'skipper' and a much pickier creature than the Painted Lady. "Skippers" are where the artificial dichotomy of moths and butterflies becomes most apparent: their stocky bodies and somewhat subdued colors often lead newcomers to ask why they're not moths. The veteran is no wiser and can say little more than, "well, that's what lepidopterists have decided." There are, however, a few distinctions between moths and butterflies that, while not necessarily reflective of deep evolutionary divergence, help one abide by convention.

Figure 41. *The Mulberry Wing is a moth-like skipper. Its swollen antennal tips (characteristic of most butterflies) help to distinguish it from a moth. The Mulberry Wing has a strangely disjunct distribution – a narrow band across the northern Midwest and a relatively small area of southern New England and the Mid-Atlantic States.*

Butterflies are day fliers – their bright coloration and even the expanded optic areas of their brain indicate that they are visual creatures. Unlike moths, attraction between the sexes is primarily visual rather than chemical (although male skippers have large pheromone glands on their wings). While none of our butterflies are night fliers, some of our moths are day fliers (the elegant orange-shouldered, blue-caped Ctenuchids being among the most conspicuous of these). Butterflies have clubbed antennae (meaning the tip of the antennae are bulbous) whereas those of moths are either slim and hairlike or feathery (the better to smell with). Finally, although moths and butterflies both have two pairs of wings, the fore and hind wings of moths hitch on to each other via a patch of Velcro-like material; the fore and hind wings of butterflies are not hooked together. This may sound like an esoteric distinction, but apparently it has aerodynamic significance and may explain why, unlike butterflies, most moths make such clumsy landings. In the field, one can often distinguish moth from butterfly by how they land – the butterfly alighting daintily on the stems; the moth often demonstrating an unceremonious arrival reminiscent of my less successful kite-flying attempts.

Mulberry Wings themselves are relatively dark, small (about the length of a penny), wetland skippers, distinguished by a light cross with drooping arms which appears on the underwing. Whereas the Painted Lady's conspicuousness and global distribution has insured that it has been amply documented, literature on the Mulberry Wing, whose distribution is restricted to a swath across the Northeast and part of the Midwest, is strikingly brief. Those 19th century scientists who even noted its existence, bemoaned our lack of knowledge concerning its behavior and life stages; modern accounts add little more. We do know (or at least think we know) that the caterpillars feed on sedges, perhaps only Tussock Sedge, and that its flight-time is July and August. ("Flight-time" refers to the period of the year when the adult butterflies can be found. As focused as we are on the winged butterflies, it is sometimes difficult to appreciate that many of these species spend the vast majority of their lives, say 90-95% of it, as eggs or caterpillars; for many species, the butterfly stage, or "flight-time," is just the last flare of color intended to insure there is a next generation.)

One rarely encounters Mulberry Wings far afield from a marshy wetland, although I was once surprised to find an individual nectaring in a particularly exuberant flower garden. This species is not favored by our penchant towards tidiness. If we take a marsh and drain it or, as often happens, convert it to an open, well-manicured pond, then we are ridding the Mulberry Wing of its home. Unlike the Painted Lady, this butterfly tends to spend its entire life in a single area, passing the winter, reportedly, as a caterpillar. Obviously, some dispersal amongst marshes has gone on, but as such habitats become fewer and farther between, the sources for new migration to colonize new places or replenish depleted populations become scarcer. It is difficult for us to picture the demographic connections that tie together the animal populations of distinct marshes, but they are there or, at least, were there. Importantly, we simply don't know what, in terms of wetland distribution and the survival of this species, is 'too few and far between.'

I have never seen the **Regal Fritillary** (Fig. 42) in the wild. I have seen drawers of specimens at the Carnegie Museum, I have seen a mounted individual in an old Ward's Scientific butterfly collection assembled for schools, I have looked at hand-colored images in a late 19th century book of New England butterflies, and I have read a concurrent account of it being "tolerably abundant" in neighboring Berkshire County, but this large and beautifully patterned butterfly is now long gone from our region. "Long" not so much in a temporal sense – had I had the urge, perhaps I could have still found some as a boy (there are historic collections from Columbia County) – but "long" in a geographic sense. The nearest known populations are now in southcentral Pennsylvania. Having once spread throughout much of the Northeast from North Carolina to Maine, only a single populated site, in Pennsylvania, remains in the East. More Midwestern populations persist, but even their numbers are diminishing, and it is considered vulnerable, imperiled or extirpated in all but one of the Midwestern states that form the core of its range.[55]

"Regal" is an apt name. With a wingspan of almost 3 ¼ inches, it is slightly larger than our largest currently-resident Fritillary (the Great Spangled). In the Regal, the standard Fritillary black and orange patterned forewing is contrasted with a deep, blue-black hindwing to dramatic effect. Like other Fritillaries, this species' caterpillars feed on violets. As is also reported for the Great Spangled Fritillary, it appears that females mate relatively early in the summer, but then do not actually deposit their eggs until up to three months later.

It is still not known why this species vanished from the Northeast. Most believe that, like some of our grassland birds, suitable habitat became too rare. In our area, this was a butterfly of damp fields maintained by seasonal hay cutting or by pasturing. Because such habitats were largely the result of agriculture in our region, it seems likely that the populations of this species expanded during the first half of the 19th century as European-style farming also spread throughout the State. There are suggestions that there was a distinct eastern race, and it may be that there were eastern populations that colonized beaver meadows and the like. However, the demographic core is and probably was the Tallgrass Prairies of the Midwest.

Figure 42. *The Regal Fritillary, as portrayed in Maynard's 19th century guide to New England butterflies. Once a regular member of the Northeast butterfly fauna, this conspicuous species has become nearly extinct here over the past 30-50 years. The reasons for this decline are uncertain, although habitat loss is one likely cause.*

According to this theory, it is not that suitable habitat completely disappeared from the Northeast but rather that, as discussed for the Mulberry Wing, some threshold was crossed at which point suitable habitat patches were too few and far between. At that point, adults dispersing from habitat patches in search of a mate were unlikely to be successful and individual patches that were decimated by some localized event (for example, a fire, severe storm, or human development) were unlikely to be re-populated. The demographics fall apart in an apparently sudden collapse despite the fact that seemingly suitable habitat patches may persist. Picture a landscape of human houses prior to the age of cars. If houses winked out, some point would be reached at which young men and women would be unlikely to succeed if they set off on horseback through inhospitable land to find a consort. That point would likely be pretty abrupt and correspond to some function of the time periods humans and horses can go without supplies and the amount of land they can search during that period.

In addition to habitat loss, other explanations for this species' decline include disease and the use of insecticides for mosquitoes, Gypsy Moths, and agricultural pest control. This butterfly is very sensitive, for example, to Bt sprays. Finally, new insect predators or parasitoids, sometimes introduced as biocontrol alternatives to chemical sprays, stray from their intended hosts, and prey on wild, non-pest insects. Such mortality is thought to be a major cause of the disappearance of many of our large moths.

In all likelihood, "the explanation" is less a single cause and rather the result of a suite of stresses that, together, are proving to be too much. Picture again our human population with scattered houses – if a plague were to sweep through or hostile armies invade, the decline that the low density was already precipitating would occur even faster. Similar, multi-stress causes may explain such well-marked recent declines as those of frogs, bees, and bats. True, you can sometimes pinpoint a proximate cause that was the 'last straw,' but often that only became the 'last straw' because populations were already on the brink of collapse. These are unsatisfying explanations because they preach prevention rather than cure. We can treat (some) 'diseases' with medicine, we can stop applying specific pesticides, for example. However, it is much more difficult to change our lifestyles in ways that mitigate all the many stresses we are applying to the environment; "difficult" both because the changes required run so deep, and because there is no 'smoking gun' that pushes political and social action.

Figure 43. *This is a breeding pair of Peck's Skippers, one of our most common grassland butterflies. Its caterpillars can feed upon an array of native and non-native grasses.*

From the rare to the common. **Peck's Skipper** (Fig. 43) has been and continues to be common. During the middle of the summer these small, but distinctively marked orange and black skippers can be found in many old fields around the County. According to our observations, it is the most common skipper in those habitats. Its caterpillars can survive both on native grasses such as Little Bluestem and Rice Cutgrass and on common, introduced lawn grasses such as Kentucky Bluegrass. As a result, it can be found on lawns and prairies and on most field types in between (except perhaps wet meadows). While its populations may have increased as farm fields were opened, it has remained relatively common even as such habitats have shrunk, perhaps because of its ability to use lawns.

Hunting for grassland skippers is a somewhat different sport from hunting for other butterflies. Your best bet is to catch a glimpse of a skipper as it rests upon a leaf. Their flight is so fast and their size so small, that you only rarely detect them on the wing. To walk into a field with numerous skippers is a bit like being out just as a rain is starting – you know something new is happening, but your mind has yet to catalogue and make explicit the evidence. Out of the corner of your eye you see a flurry or perhaps a small speck pops up where, moments before, there had been only an empty leaf.

Despite its being our most common skipper, we do not know all the details of its life. For example, apparently no one is certain where the pupae are located in the wild, some suggest that sedges might be included in its diet, and it has been proposed that, while most individuals overwinter as caterpillars, some may pass the winter as pupae. Much of our knowledge of butterfly natural history was assembled by late 19th and early 20th century observers. Since then, with notable exception, butterfly natural history study appears to have become somewhat passé, the perceived frontier of mystery has moved elsewhere. As a result, we will probably continue to be surprised when butterflies react in unforeseen ways to our manipulation of their habitats.

Figure 44. *The Common Ringlet was first recorded in the Hudson Valley around 1990. This grassland species may have followed the open verges of our north/south interstates.*

Common Ringlet (Fig. 44) is a novelty. While inspection of antique butterfly books leads one to bemoan the once common species which we rarely see today, it is also true that those records lack some species which we do frequently observe at present. Prior to about 1968, the Common Ringlet was unknown in the eastern United States. At that time, it stretched through Alaska and Canada (it also occurs in Europe). It then began pushing south. By 1974, it had inched into the northernmost counties of New York, and it reportedly reached the southern Hudson Valley around 1990. It is now a common sight throughout the County, especially in mature hayfields and woody pastures. Why this species decided to venture south during the last quarter of the 20th century is unclear. The general pattern associated with possible warming trends is for northerly species to retreat farther north. One suggestion, reminiscent of the 19th century grassland bridge from the Prairies to New England, is that this species came south as the grassy verges of north/south interstates linked tundra-like grasslands to the lawns and agricultural fields further south. One other butterfly, the northern race of the Silvery Blue, apparently has exhibited a similar southward progression, reportedly following roadside plantings of vetches southward. We have not yet observed that species in Columbia County.

In some ways, the Common Ringlet is our butterfly world's equivalent of a polar bear. It has an array of adaptations that make it especially suited to a boreal life. Its body, for example, is thickly haired (as are the bodies of some moths which fly during the night when it is cooler). Butterflies and moths don't have an internal thermostat and a furnace that maintain body temperatures the way we and most other mammals and birds do. However, they can accumulate heat by moving their muscles and by basking; 'fur coats' can then help them retain that heat. Warmth is important because bodies tend to work better at relatively warm temperatures – digestion, growth, reproduction, movement can all happen more quickly. Even when conditions are too cold to allow these processes to happen rapidly, the Common Ringlet has another strategy: some northern European populations require two years to complete a generation! That means a butterfly hatched one summer might lay an egg that overwinters, the following summer that egg hatches and develops into a caterpillar that begins feeding. The individual overwinters a second time as a late-stage caterpillar or a pupa, and the adult only emerges the following year.

Common Ringlets remind one of autumn, even if they do first fly early in the summer. The auburn/rusty orange hue is reminiscent of fallen oak leaves, and their bouncing, irregular flight makes one think of a dried leaf skipping across a surface. Color and flight pattern are good field characters for this species. If you spot a 1.5" fleck that flashes a subdued, sandy orange as it flits over a field as if suspended from string by a puppeteer, then you have probably sighted a Common Ringlet.

This species appears to have an even broader diet than the Peck's Skipper. Aside from feeding on grasses native to both North America and Europe, the caterpillars of some populations also feed on sedges thereby opening up wet meadows to its potential range of habitats.

Meadow Fritillary (Fig. 45) is a distant relative of the Regal Fritillary. It is our most common local representative of what are called the "lesser fritillaries," a group of smaller fritillaries which tend to be a northerly bunch that rely on wild or semi-wild habitats. The Meadow Fritillary is apparently the more 'daring' of the set, straying into lawns and agricultural fields from its native, wet-meadow haunts.

This species sports the classic black and orange coloration of our fritillaries, but is noticeably smaller than our other common species and has more elongate wings. It is potentially confused with the very abundant Pearl Crescent, although the latter is a slightly smaller creature with more rounded wings that tend to appear black-margined. The Silver-bordered Fritillary, a rarer, more strictly wetland species that others have recorded from the County, is even more similar in size, shape and color. However, its underwings sport prominent, silvery spots that are entirely absent on the Meadow Fritillary.

The Meadow Fritillary seems, in some ways, to be a species that is not as common as it should be. Like other fritillaries, its caterpillars feed on a variety of violets, and, not surprisingly given the propensities of violets, it is found around moist fields. And yet, although we have seen 'blossomings,' Meadow Fritillaries are seldom as abundant as some other butterfly species, and during certain years they seem almost rare. This species is non-migratory, so the flukes affecting migratory air travel are not relevant. Furthermore, the range of this species is declining. It was common in and around Boston and other parts of eastern Massachusetts at the turn of the 19th century. Today, it is basically absent east of the Connecticut River. Likewise, it has been vanishing from its haunts around New York City; Connecticut and perhaps New Jersey are also reporting declines. A patchy local distribution and news of retracting populations mean it may be one of those species which, like some of our grassland birds, quietly fades from the County. As Sharon Stichter notes, the regional demise of the Regal Fritillary should be a clarion call prompting us to watch our other Fritillaries closely.

Figure 45. *Caterpillars of the Meadow Fritillary feed upon violets, but the adults seek out field flowers as a nectar source. This species seems to be declining in suburbanized areas.*

The most obvious cause for the Meadow Fritilliaries decline is habitat loss. As outlined earlier, farm fields are currently tending to follow various trajectories: they have become more intensively managed cropland, have been abandoned to forest, or have been lost through development. None of these alternatives 'works' for the Meadow Fritillary. It is an openland species but, unlike the Peck's Skipper, can apparently not adapt to the lawns of suburbia. On the bright side, it is conceivable that Columbia County, with its continuation of small-scale agriculture, might become a refuge of sorts for this species in the Hudson Valley.

The **Cabbage White** (Fig. 46) is probably our most common field butterfly. It can be seen fluttering over our fields from April to October. While we do have a few native 'whites,' they are now quite rare, and the most likely source of confusion when identifying a Cabbage White is the white-ish female form of our more yellowish Clouded and Orange Sulfurs. Look for the 'eye' on the hindwing of these Sulfurs when their wings are closed; the Cabbage White has no such marking. When seen from above, the thick, black wing rims of Sulfurs are distinctive compared to the wing-tip darkening of the Cabbage White. The

Cabbage White is one of our few larger butterflies with distinct sexual dimorphism: when the wings are opened, the male sports one black dot on the forewing and the female two.

Not surprisingly, given the fact that most of our field plants are not native, the Cabbage White itself is not native. The story of its 19th century introduction and spread is intriguing. It apparently first established itself on the North American continent around the port city of Quebec in 1859. The amateur but observant entomologists who first encountered them were apparently excited to think they had discovered some here-to-fore unknown native species. Consultation with more widely experienced colleagues soon disillusioned them. Asa Fitch's (New York's first state entomologist) account of its arrival is graphic if speculative,

"It was brought to this country in some vessel which discharged its cargo at Quebec. Mr. Riley [a noted Midwestern entomologist]… suggests it was probably introduced into this country in its egg state, upon a batch of refuse cabbage leaves which were thrown from some vessel…But the insect does not remain in its egg state the length of time required for such a voyage. The eggs, however, hatching on shipboard, the worms from them would readily sustain themselves on the leaves, and on reaching port where fresh vegetables could be obtained, the few wilted and decaying [not to mention chewn!] cabbages remaining would be thrown away, with some of these worms lurking among their leaves, whereby their race was probably started on this continent."[56]

Figure 46. *The Cabbage White is a European species that arrived in North America in the late 1800s. It is now one of the most conspicuous butterflies over our fields. It feeds upon plants in the mustard family; this female is pictured on another non-native, the invasive Garlic Mustard.*

Asa Fitch's description of the Cabbage White's eventual arrival to New York State in 1870 is interesting for an additional reason: he precedes it with an account of the Mustard White. This is one of our native whites which, as he notes, had switched diets from some of our native mustards, such as toothworts, to some crop brassicas such as cabbage, kale, and turnip. In his piece on the Mustard White, which he wrote prior to the Cabbage White's *en masse* arrival in the State, he remarks, "…these plants [cabbage and turnip] being grown so extensively in all our gardens furnish it an abundant supply of nourishment, whereby its [i.e., the Mustard White's] numbers are now greatly increased. I think … these butterflies are tenfold more numerous than they were forty years ago. … they are threatening to become a formidable evil." Little could he know. By the first decades of the 20th century, entomologists were describing the Mustard White in New York State as "formerly common and widespread, now replaced by rapae [the Cabbage White] except in out-of-the way places and open woods." This trend has only continued, with the Cabbage White still abundant and the Mustard White apparently ever rarer. In fact, the latter species is unreported from Columbia County, although the most sightings reported in Massachusetts' butterfly atlas were from just across the state border near Pittsfield in Berkshire County. Fitch's account also hints that widespread cultivation of cabbage and turnips may have made North America particularly welcoming to the Cabbage White during that era.[57]

The decline of our native whites, while roughly coinciding with the arrival of the Cabbage White (and the parasites introduced to fight it), may also be linked to the introduction of non-native mustards such as Garlic Mustard and Common Winter Cress. These mustards attract egg-laying females of our native whites, but apparently the caterpillars are unable to survive on them, and the plants thus function as ecological traps. Garlic Mustard is now much more common in our forests than any native mustard, and it is easy to imagine that the Mustard White could waste much reproductive effort on this plant. Perhaps one day Mustard White evolution, which apparently allowed it to spread to crop plants from its original, native food plants in the 19th century, will 'invent' a way of letting it survive on these introduced mustards in the 21st century. Recent research suggests that Cabbage Whites are able to utilize Garlic Mustard.

Figure 47. *The Bronze Copper is a regionally rare butterfly which is found relatively frequently on moist farm fields around the County. After years of decline, it is, perhaps, just perhaps, rebounding.*

The **Bronze Copper** (Fig. 47) is a Halloween pumpkin decked out in royal blue velvet. While neither the size nor the texture of a pumpkin might really compare to the Bronze Copper, the bright, clear orange contrasting with a deep, shifting blue describes this butterfly's color combination (at least for the male; the female lacks the blue). This butterfly has a wingspan about equal to the diameter of a plastic milk jug's top and is found singly or in small groups around wet pastures. I have a soft spot for the Bronze Copper. My butterfly guides reported it as rare (thus making a sighting a rewarding event for the treasure hunter in me) and yet, early on, I found it fluttering about the edges of cattle ponds, an apt illustration of the idea that farms provide important habitat. It is worth quoting a portion of a popular field guide's description of this species:

> *This heart-stopping species has declined drastically over the past twenty years. It may be that the Bronze Copper is basically an invasive species that does best in freshly created habitat (newly wet due to flooding, or fresh wet soil exposed by the receding water line of a pond). Man's penchant for stability may be in conflict with this species' survival."*[58]

This is a general theme that we shall return to in the water chapter. (Note that here, "invasive" is used to mean "pioneer," i.e., a native species that prefers transient, recently disturbed habitats; more frequently, ecologists use this term in a different way to refer to an introduced species that is invading natural habitats – the native Bronze Copper is not invasive in that sense). The authors of another favorite guide reported having seen this species only twice during the decade of preparing their guide; the Connecticut Butterfly Atlas reported it from only six of its 116 survey blocks; the Massachusetts Atlas reported the collection of only 9 specimens during that atlas' five-year run (it seems somewhat more common in Vermont, although even there it is described as declining). What greater thrill then to the novice butterfly hunter than to find this species; not only once but at numerous different farms or former farmlands around Columbia County? When I asked David Wagner, a Connecticut entomologist with ample experience, why there was this discrepancy between what I was seeing and what the guides reported, he told me that was because so few butterfly biologists thought of farms as fruitful butterflying grounds and so rarely visited farmland.

Despite these thrills of being a regular acquaintance of the 'rare and famous,' in reality my observations may also reflect a resurgence of this species. More recent work from Massachusetts, summarized by Sharon Stichter, suggests that this species may be increasing (or may have been undersampled during the official Atlas period). Time will tell if the seeming resurgence reflects new observational diligence in the right habitats or an actual upswing of population.

It is apparent however that, even on farms in Columbia County, the Bronze Copper is not currently as common as some other wetland butterflies. A review of the literature suggests that, while it declined during most of the 20th century, there is little record of it ever being particularly common, at least in the Northeast (the species ranges into the Midwest and there is a reference to its increase in that area). Even 100-year-old guide books use terms like "rare" and "scattered." We have found it solely on the wet edges of pastures or old fields, often in the transition between dry land and open water. What determines the apparent spottiness of their distribution is unclear. Its host plants, docks (*Rumex*) and knotweeds (*Polygonum*), are more generally distributed in moist habitats. Why aren't more sites occupied? Why aren't sites more densely populated? As with the Mulberry Wing, at which point are populations too far and few between to survive in the long term? If it actually is increasing, then why? This elegant butterfly is something of a banner species for farmland butterflies in the Northeast, and yet, as with so many butterflies, it seems as if a piece of its natural history puzzle is missing.

It is appropriate to end this chapter with the Bronze Copper, whose uncertain fate perhaps typifies that of much of our field ecology. Much of that ecology remains hidden by the more prosaic uses we assign to our fields and by the shallowness of our historic 'depth of field.' Agriculture, of course, is central to our own survival, yet there is some room for tweaking that use, and much room for altering our less utilitarian uses of openland. If we can strengthen the ecology in our openland aesthetics, perhaps we will have the motivation both to learn more about the life of our fields and to then act on that knowledge.

The Nature of the Place ~ Four

THE SOIL AS HABITAT WITH HISTORY

The definition of soil is a bit muddied. It is worded in different ways by different people and runs the gamut from the physical/geological definition as basically a collection of rubble at the earth's surface to the agronomist's definition of it as a matrix for plant growth. For our purposes, we'll borrow from the middle ground and define a soil as 'a particular collection of sediments that is located at the Earth's surface and that has evolved/is evolving because of its interactions with climate and life.' This definition embodies at least two important, intrinsic properties of soil: it is dynamic (that is, it "evolves"), and life is part of soil. In other words, it has a meaningful history and it is habitat for life.[1]

This chapter is divided into two sections. The first explores the post-glacial origins of our soils, and the second looks at the history of our regional soils over the last 250 years or so, both how we have manipulated them and how our conception of them has evolved. Much of the second section is devoted to the human history of agriculture and agronomy in and around the County, because historical information on the natural history of soils is so scant. Although the focus of the agricultural history in this chapter is its consequences for the soils, such land use also clearly affected the fields, forests, and waters, which are considered elsewhere in this book.

Section 1: Ancient History

The Ground Work

The history of our soils is not as 'ancient' as that of some other parts of the world where the clock was not reset by a relatively recent period of glaciations. The surface of our land was largely scraped clean by repeated glaciations, but then relatively quickly 're-soiled' as glaciers melted and deposited debris and as life and weather began to convert rock to soil. The County's geological foundations are summarized in Chapter 1.[2]

Soil time is an intermediary between the seemingly vast scale of geological time (except for some dramatic, short-term events like volcanism) and the very personal scale of biological time. To a certain degree, this is because you can think of soil as the product of rocks and life. Simple chemical and physical weathering can convert rocks to dust; but much of what makes the dust into true soil is life – the glue that sticks bits of earth together (courtesy of worms, fungi, and other organisms), much of its color (dark soil is high in 'organic matter'), a great deal of its chemistry (various microorganisms take the relatively 'inert' chemicals of the raw soil and convert them to forms that are accessible to plants and hence animals), and even the earthy smell (courtesy of a certain group of fungus-like bacteria).

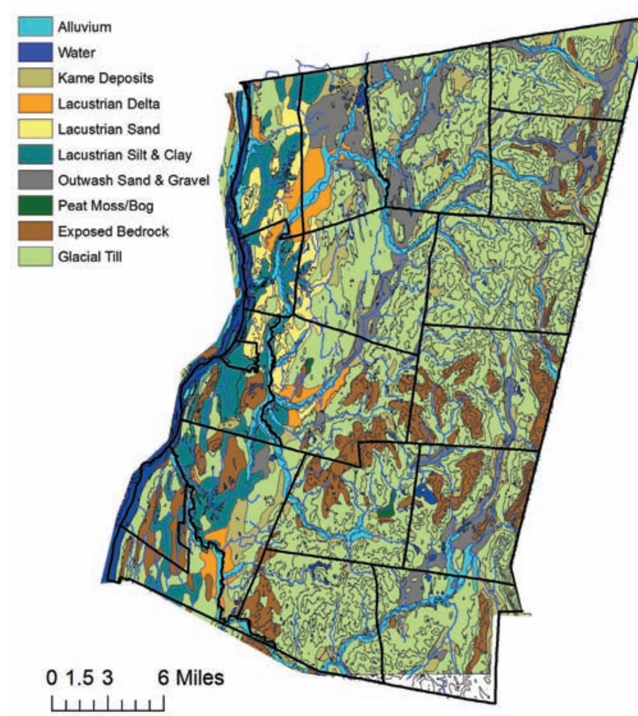


Figure 1. Map of Columbia County surficial geology. The majority of the County is covered by glacial till (green), but water-deposited materials, some derived from glacial Lake Albany, are common along the western edge. The edge of that lake can more or less be traced as the eastward extent of lacustrine deposits. Data from New York State Museum.

The basic post-glacial starting point of our soils can be understood with the help of what is called a 'surficial geology' map (Fig. 1). Such a map shows neither the bedrock of a conventional geological map nor the precise earth types of a soil map. Instead, it shows you a bit of the history of the soil's prima materia. For example, in the associated map, most of the landscape is the pea-soup green which indicates "glacial till." Glacial till is the ice-swallowed soil of the pre-glacial landscape, together with ground bedrock. It is the material that a healthy glacier picked up during its life, and that was then deposited directly onto the land surface as the ice melted. Sometimes, this till was apparently shaped into long 'slugs' by the overlying ice and formed structures known as drumlins. Some of the clearest examples of drumlins in the County are east of Valatie (Fig. 2). In the hillier eastern part of the County, exposed bedrock pokes up through the till carpet; except on the steepest slopes, these lands do have soil, but it formed from post-glacial action on the bedrock without any contribution from a deposit of till.[3]

The other basic type of parent material, in addition to bedrock or ice-deposited debris, is that which was processed and distributed by the action of water either as the glaciers melted or since then. It can be much the same material as till, but it has been carried and sorted by water. Picture the small fans of mud or sand that may, for example, be left behind when mud puddles dry. Those materials were transported to that spot by water, and the texture of any particular part of the fan will have been

Figure 2a (left). *Drumlin fields east of Valatie. The glacier moved in a south-southeast direction (indicated by the white arrow) leaving these sculptured mounds of glacial till.* ***Figure 2b (right).*** *Some of the same drumlins as seen from the ground. Fill is regularly removed from these low hills because they are formed of loose geological debris rather than bedrock.*

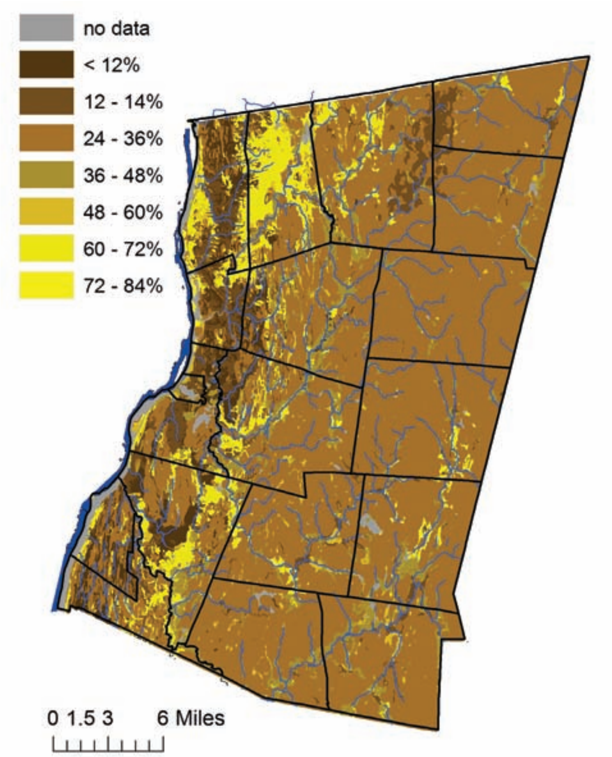
determined not only by the texture of the material the water picked up but also by the force of the water at any particular spot. Coarse material settles out of water sooner (i.e., at a higher water velocity) than finer materials. This differentiation in texture due to differences in water speed produces 'sorting.' In the surficial geology map, the water-borne soil starters are indicated in tan, grey and shades of blue. Some were apparently deposited by glacial meltwater ponds and streams; those along the Hudson were left on the shores of Glacial Lake Albany, a late glacial lake that occupied much of the Hudson Valley. Not all of these materials are of glacial age – anybody who lives along an existing stream knows that modern floods can deposit layers of new soil.

Implicit in the above descriptions of soil formation is the definition of soil that was given in the first paragraph. Under that definition, dust, dirt or debris is not soil until it has settled somewhere long enough to begin taking on a particular 'personality' due to its interaction with weathering and biology. Thus, bedrock that has been freshly broken up and ground by a glacier is not a soil until it has been deposited and has begun to evolve *in situ*. Likewise, for our purposes, old soil that a glacier picks up, effectively sterilizes, washes and remixes is not soil again until it is laid down and begins to evolve a particular character beyond just its geological ingredients. Put another way, soil doesn't exist without place, time and life.

The Ramifications of Ancient History The processes associated with the glacial facelift help us understand our soils in at least two ways. First, as alluded to in the mud puddle analogy, how a soil was laid down influences its texture. The maps of soil texture make clear some of the sorting that was caused by water. While the glacial till soils tend to be mixtures of clay, silt, and sand, soils deposited by water are more frequently dominated by clay or sand. Picture a drying mud puddle and a little rill that runs from it. Kneeling down to inspect it more closely, you'd find portions of relatively fine materials (where standing water evaporated leaving behind the fine solids that had been in suspension) together with coarser grained areas, where heavier materials were dropped as water speed slowed and yet was still fast enough to carry finer particles away. Our primary clay and sand deposits are in the western parts of the County, where the shores of Glacial Lake Albany and adjacent deltas left sandy stretches in some cases and clayey deposits in others (Figs. 3 and 4).[4]

The variation in soil texture and chemistry resulting from differing starting points has had profound importance for plant species and, less directly perhaps, for animals.

Soil texture affects drainage, with sands tending to drain easily and clay tending to block water movement. In addition, because of their chemical and physical structure, most clays have a relatively high 'cation exchange capacity' or CEC. Basically, the higher this capacity, the more plant nutrients can be held in the soil, and, under the right conditions, made available to the plants themselves. The ideal soil texture for farming will depend on the crops and techniques; however, in general, a relatively mixed soil possessing ample but not dominating amounts of sand and clay (together with silt)



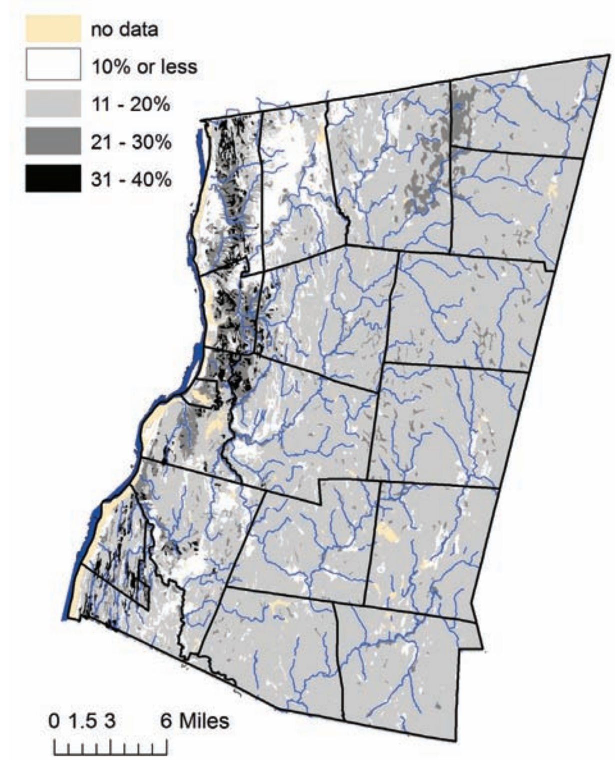


***Figure 3 (left)**. Map of Columbia County soil texture expressed as percent sand (from USDA data). Most of the sandiest soils are located in the western half of the County and mark the former beaches of Glacial Lake Albany. The much less sandy soils to the west mark the claying lake bottom, as shown in the **Figure 4 (right)** map of Columbia County soil texture expressed as percent clay (from USDA data). Most of the clayiest soils are located near the Hudson and presumably reflect the settling out of fine sediments along the margins of Glacial Lake Albany.*

is considered best. Such soils are termed 'loams.' Organic matter, which can also serve as a nutrient sponge, can help ameliorate the nutrient-leaking tendencies of sandier soils. One of the clearest examples of soil-texture's effect on our local vegetation was the Kinderhook Pine Plains described in Chapter 2, p. 71.

Soil chemistry is complex. Aside from the components of the air and water trapped in the ground, the most common ingredients of soil include iron, silica, aluminum, potassium, and calcium. Various other nutrients and micronutrients are usually also present. Almost all of these elements and related compounds can influence plant growth, because they are, to greater or lesser degrees, required by life. Locally, one of the clearest examples of soil chemistry influencing soil suitability is the relation between soil pH and plant growth. While most of us realize that extreme soil pHs can directly damage plants and associated soil microbes, most of the interaction of plant health and soil pH is probably due to the fact that soil pH has a profound effect on the solubility of soil minerals. Within the limits of common soil pHs, most nutrients become more available to plants as soil pH rises. Limestone serves to raise soil pH (reduce its acidity) and so increase the availability of soil nutrients. For this reason, farmers will lime their fields if pH is low, and limestone-derived soils, such as those around rock outcrops in the Harlem and New Lebanon Valleys and on Becraft Mountain, tend to have a surprising diversity of wild plants (Fig. 5).

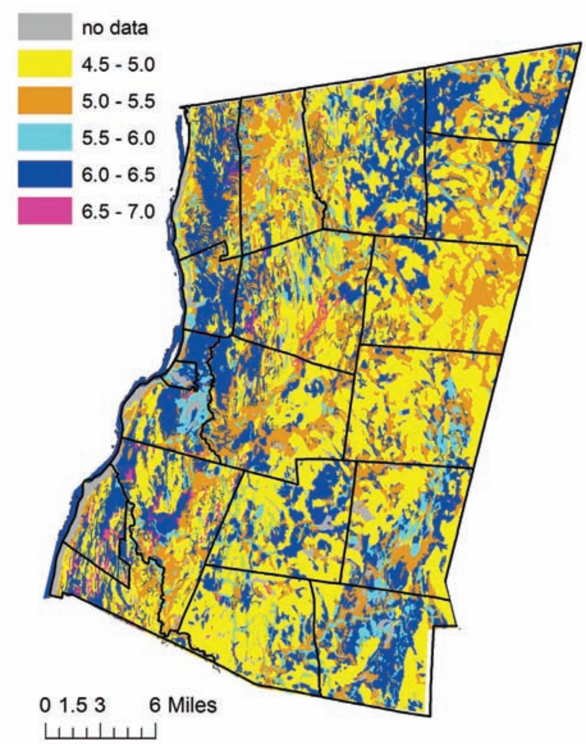
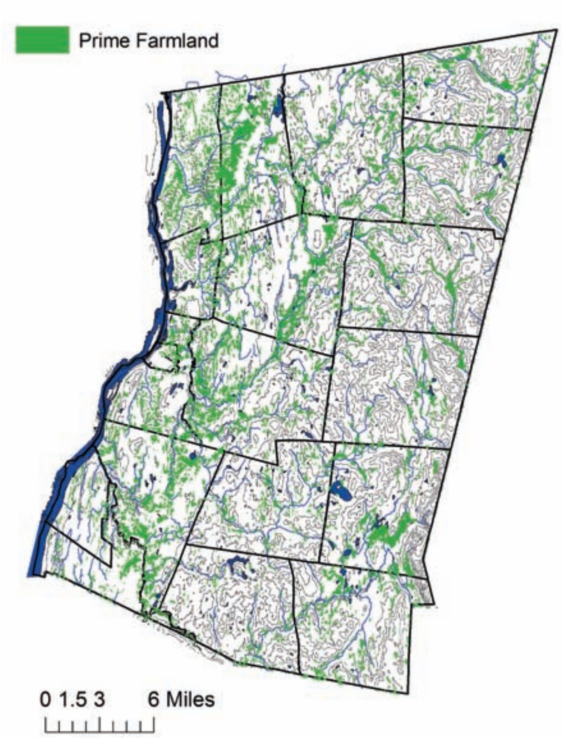


Figure 5. Map of Columbia County soil pH (from USDA data). The least acidic soils – highest pH – are found overlaying limestone in the northeast and southeast corners of the County and along a band adjacent to the Hudson River. Soil pH can have a profound effect on the suitability of a soil for farming.

The interaction between soil conditions and animal life is more subtle. Soil texture influences the distribution of burrowing organisms. For example, certain native bees make their solitary nests in holes which they dig in the ground. The easiest soils for them to dig into are sandy ones. One April afternoon, we watched a collection of busy bees burrowing into a sandy bank of Kinderhook Creek, just west of Valatie. Tiger Beetles prowled nearby, probably searching for the ants which also favor such soils. Soil chemistry affects animal nutrition. Mineral licks are better known in the West than in the Northeast. Deer, Caribou, Elk and other ungulates come to such spots in search of the salts demanded by their bodies. Various studies have, for example, found correlations between deer antler weights and calcium concentrations of the soil. Alexander Coventry, an 18th century Columbia County doctor whose diary we'll shortly explore in more detail, reported a mud spot where passenger pigeons congregated. Snails and millipedes, which bioaccumulate calcium, tend to be most common on limestone soils. We found startling numbers of large millipedes on a limestone slope above Shaker Swamp in New Lebanon.[5]

The most direct representation of soil quality for plant growth, at least in terms of crop plants, is the map of prime farmland produced by the USDA. "Prime" is defined relative to conventional farming of the 20th century, but at least represents soil quality from that perspective. "Prime soils" tend to be loams located on the County's well-drained flatlands (Fig. 6). Proximity to limestone bedrock is, for the reasons already mentioned, a plus. The early settlement patterns of colonists were shaped by a variety of factors, but one was certainly the fine farmland soils near the Hudson (Fig. 7). But we are getting ahead of ourselves.[6]



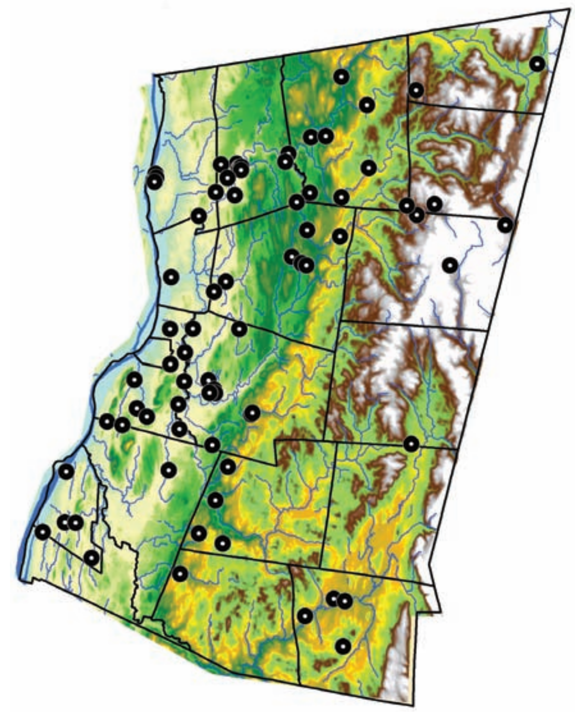


***Figure 6 (left)**. The distribution of prime farmland in Columbia County, together with topolines and major streams. Most of the prime soils are found on the Hudson Valley plateau along the western margin of the County and in the Harlem Valley. **Figure 7 (right)**. The location of early colonial settlement in the County as indicated by the location of extant houses built no later than 1750. (Many more houses were built, but these are the modern survivors.) The map doesn't indicate the absolute number of houses built, but it does indicate the approximate distribution of construction. Europeans first settled the good farming soils of the Hudson Valley portion of the County. Settlement of the prime soils of the Harlem Valley (southeast corner of the County) was probably discouraged by the fact that distance and surrounding hills made transport and agricultural commerce difficult prior to the arrival of the railroad.* Data from USDA Soil Survey and NYS Department of Taxation and Finance

Section 2: Recent Soil History – Asking the Soil to Work for Us

The section which follows uses regional agricultural and agronomic history as a backdrop for considering the history of our soils. While the previous chapter on fields outlined production aspects of the last 200 years of Columbia County agriculture, this section, in searching for soil-relevant information, takes a complementary tack: we survey soil-relevant themes and generalities for the period of farming prior to that period and then, for the last two hundred years, we focus more particularly on regional soil science as illustrated by published works from in and around Columbia County. Our goal is not only to describe how the soils were likely being treated and why, but also to describe how they were being envisioned. Human concepts can be just as important as human actions, because they are often behind the intent which guides our ubiquitous hand.

Farming of the Late Pre-Colonial Period

Our image of Mahican agriculture at the time of contact is shaped as much by what we don't have records of as by what we do have records of. Both historical accounts and archeological evidence are quite sparse. We can paint a picture based upon what little direct evidence there is, supplemented by some extrapolation. For additional background information on the Mahicans, see Chapter 1, pp. 18-21. Based upon archeological studies, squash is first recorded from in or around the Hudson Valley (i.e., including the Mohawk and Susquehanna watersheds) about 3,000 years ago, and corn from about 1,600 years ago. Beans apparently only arrived roughly 700 years ago. The 'three sisters' is thus a relatively recent constellation (and even when all were present, may not have always been grown together). The first record of corn from the Hudson River Valley itself comes from a Columbia County site along the Roeliff Jansen Kill and has been dated at around 1,000 years ago. Agriculture's arrival in our region was probably 'soft.' The gathering of edible wild plants graded into their semi-cultivation or, at least, encouragement (e.g., by spreading their seeds or discouraging disfavored competitors). For much of the pre-European period, squash and corn were simply components of this broader Eastern Agricultural Complex, which also included Lambsquarter, Sunflowers, and certain Knotweeds. The early indigenous residents were probably also consuming, and may well have been encouraging, nuts, fruits, berries, and wild rice. Evidence of substantial social restructuring around agriculture is not seen in our area until ca. 700-800 years ago, although even then some communities maintained more semi-nomadic patterns.[7]

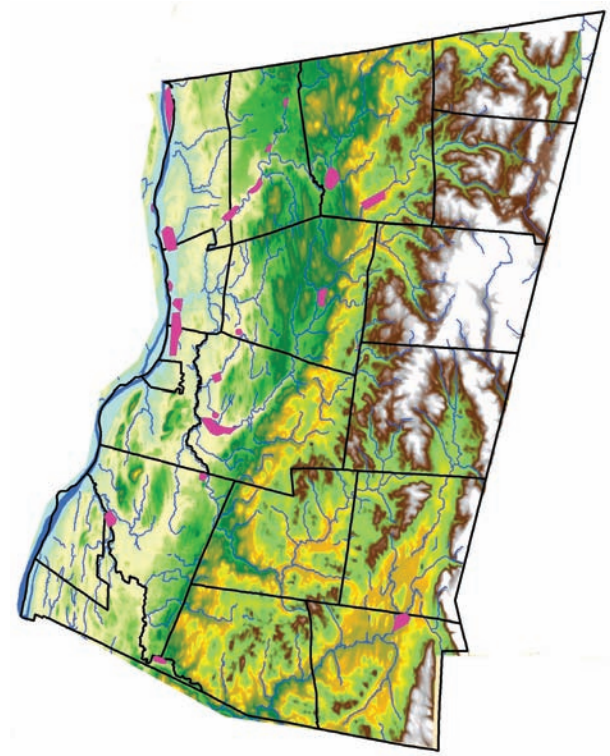


Figure 8. *Very approximate locations (shown in pink) of some pre-colonial Native American sites in Columbia County, based largely upon deed or historical records mentioning meadows, flats, or other openings at the time of colonization. Size and location are extremely rough and this map is only meant as a general perspective. Worked areas were evidently clustered along lowland waterways, as was true throughout most of the region (see for example the maps in Mulholland, 'Territoriality and horticulture,' pp. 137-166 of* Holocene Human Ecology in Northeastern North America, *1988, Nicholas, ed.). Compare with Figure 6.*

Mahican farmland was probably largely confined to strips along the Hudson or, farther inland, in rich-soiled stream valleys, the so-called "intervales" (Fig. 8). Because of their regular replenishment by flooding (an event made less damaging to crops and soil by the minimal indigenous tillage), floodplains were and are some of the most fertile agricultural land; many modern cornfields still dot such land in the County today. This location also meant that water for consumption and travel was handy, and fish may have been easy to obtain. Accounts of European settlement in Columbia County regularly reference the acquisition or observation of floodplain lands worked by the Indians. These include corn land on many of the Hudson islands and along the river's shores (such as van Rensselaer's description of more than 2,000 acres of open land along the east side of the Hudson in Rensselaer County), "plains" along the Roeliff Jansen Kill, "three hundred acres of meadow" in Taghkanic, Squampamock Flats along Claverack Creek in Ghent, a glade in Gallatin, bushland along the west side of Kinderhook Creek, bushland in Claverack where Indians grew corn, and "rich alluvial lands and Indian fields along the water courses of Chatham." It seems the earliest settlers often found that the best valley ground evidenced prior Indian use; an observation supported by the regular finding of Indian artifacts on waterside grounds in the County, (although at least some of these sites may date from before corn-based agriculture).[8]

It is unlikely that corn growing extended far into the Taconics: historians believe that Native American corn cultivation was most reliable where a growing season exceeding 180 days could be counted upon. Currently, western Columbia County seems well within this zone, but growing seasons in the eastern hills appear to be a week or two less than that limit.[9]

The most detailed, and practically the only, contact-period Mahican archeological location known is the Goldkrest site located along the Hudson in southwest Rensselaer County. At this site, the remains of Corn and Lamb's Quarters mix with the relicts of hunter-gatherer lifestyle including the bones of White-tailed Deer and various fish and Butternut, Hickory, Raspberry, Grape and Elderberry seeds. Buttercup remains, perhaps used for medicinal purposes, were also found. Whether the rarity of such sites indicates their actual rarity in the historical landscape or, instead, inconspicuousness combined with the fact that, as we have noted, European settlement frequently arrived atop them, we don't know. As with indigenous peoples throughout the Northeast, there is no evidence of pre-contact livestock.[10]

The consensus among modern authors seems to be that, at the time of European arrival, Mahican agriculture was not at the scale of the Iroquois' large fields in central and western New York. These authors describe, with varying emphases, relatively small groups of people, at least some of whom moved seasonally, pursuing their hunting, gathering and fishing in conjunction with their riverside and intervale farming. Based upon work in southern New England, field size may have averaged less than 2.5 acres. The Columbia County settlement accounts listed above would suggest, however, that at least some larger patches of our floodplain soils were regularly worked.[11]

Aside from apparent topographic location, we have little direct, specific information on the agronomics of Mahican cultivation. When Hendrick Aupaumut, a Mahican at the Stockbridge Mission, described his people's agriculture in the mid 1700s, he wrote (in phrasing that may seem awkward to us today),

> *As our fathers had no art of manufacturing any sort of metal, they had no implements of husbandry; therefore were not able to cultivate their lands but little, that of planting shammonon, or Indian corn, beans, and little squashes, which was chiefly left under the management of women, and old men who are incapable of hunting, and little boys.*
>
> *They made use of bone, either moose, bears, deer's shoulder plate instead of hoe, to hoe their corn with tie it fast to one end of a stick or helve made for that purpose.*
>
> *Their way of clearing lands was not so difficult as we should imagine, and that without using an axe. When they find that their fields will fail, they are to prepare another piece of land. In the first place they do make fire around the foot of every tree, as many trees standing on the ground which they intended to clear, until the barks of the trees burnt through; for trees are killed very easy in this manner. They planted while trees are standing, after they are killed. And as soon as trees is fell, they burnt it off such length that they might roll the logs together, and burnt them up to ashes. Thus they do till they get it quite clear. An industrious woman, when great many dry trees are fallen, could burnt off as many logs in one day as a smart man could chop in two or three days time with an axe.*[12]

According to the few other primary accounts that pertain directly to the Mahicans, they probably grew corn together with beans in mounds at least partially formed (judging by Van der Donck's description of early Dutch corn farming in this region, which may have followed indigenous patterns) by the heaping up of weeds and other plant debris around the growing plants; such fertilizing organic matter is today termed 'green manure.' At least corn and beans were grown together, the latter growing around and up the former. Squash or pumpkins may have been grown in between. The use of fish as fertilizer amongst northeastern Native Americans has been debated, but seems evident, if rare, amongst at least some coastal people. I know of no documentation of its use amongst the Mahicans. There are also reports from elsewhere of the use of ash, and it's conceivable that refuse midden soil was used as a plant fertilizer, but we have no clear indication of how frequent such practices were.[13]

Pesticides or herbicides were rare or absent. There are scattered reports of northeastern Indians using "corn medicine" and similar herbal seed soaks as a way to deter pests, especially birds. Elder, Hellebore, and Common Reed were among the plants used in these preparations. The apparently localized application of such 'medicines' and their organic nature would suggest that they had minimal ecological effects on soil ecology. It seems very unlikely that any living soil amendments, other than the introduction of new crops, were used.[14]

Aupaumut's account together with those southern New England descriptions suggest some sort of a rotation or, at the least, a limited period of cultivation. Likewise, van der Donck describes fallowing as the form of field rejuvenation amongst early Dutch corn farmers, and recounts a discussion with a Native American in which a field that had been fallow for about 25 years was recommended for corn planting, indicating that normal fallows weren't necessarily longer than that, and may have been shorter. It has been suggested that, at least in southern New England, there may have been both short (every other year) and long (8-10 year) fallow rotations. Perhaps even the occurrence of fallowing was dependent on the land: regularly flooded lands may have needed no (or at least less) fallowing, the silt being, as van der Donck said, as "good as manure." Fallowing allowed natural vegetation to return some of the soil nutrients that cropping removed (Fig. 9).[15]

Fire was probably a tool in both clearing and forest management, although it may have been patchy in both time and space. It was probably most regularly used on the drier, sandier soils nearest the Hudson. Indeed, van der Donck speaks of it explicitly and mentions ground fires occasionally taking in the pine forests typical of such sites. Mahican-set fires likely had had a noticeable effect on ecologies in the western portions of the County at the time of European settlement, and the colonial Dutch evidently continued at least some aspects of Native American burning practices. In fact, although there is some uncertainty about the

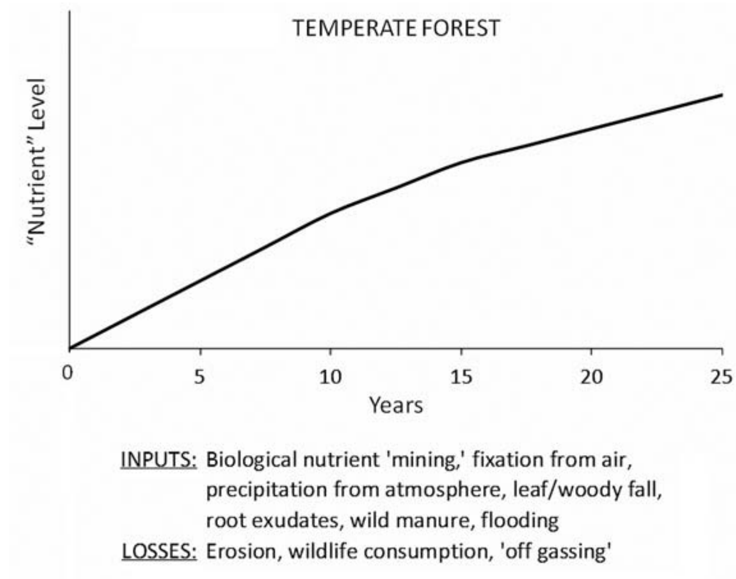
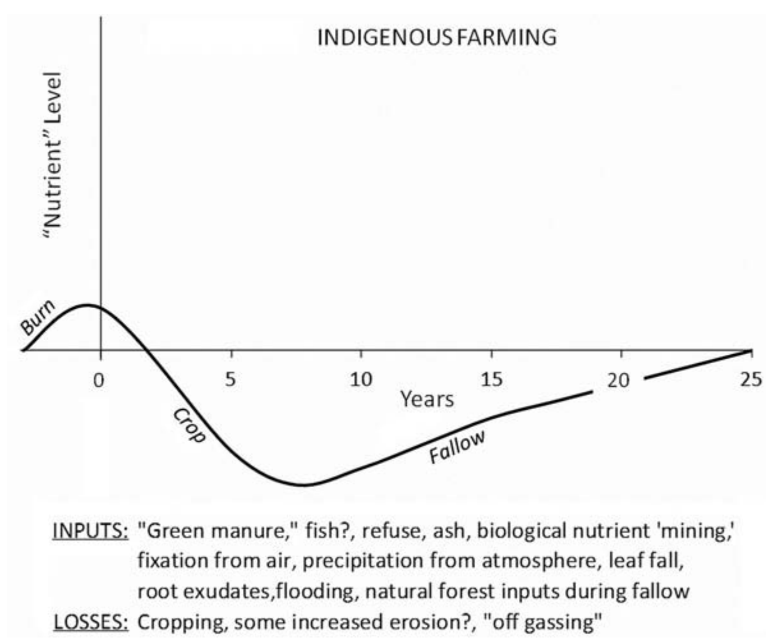


Figure 9a (above)*. Hypothetical sketch diagram illustrating the course of generalized nutrient dynamics under established forest.* ***Figure 9b (below)****. Hypothetical sketch diagram illustrating the course of generalized nutrient dynamics under Native American farming. Nutrients tend to accumulate under forests, while Native American farming probably caused minor depletion during the cropping period followed by recovery during the long fallow.*



earlier sediment records, a study of sediments near the mouth of Stockport Creek indicates at least a localized (in time and space) peak in burning shortly post colonization. Work at the Albany Pine Bush, a habitat somewhat similar to the Kinderhook 'pine plains,' has shown how important fire was in maintaining the ecological habitats that were initially described for the Bush. At the same time, natural causes may have been the primary spark for fires on higher ground in the eastern part of the County, where agricultural objectives might have been less pressing (although hunting and blueberry management may have also motivated some burns) and human densities lower. That forest fires could occur here naturally is documented by the fire-cause records of the early 19th century. Between 1912 and 1936, Columbia County averaged about 32 wildfires per year, including a 12,000 acre blaze in the southeastern region. Lightning-caused fires probably averaged about one every five years.[16]

In sum, indigenous farming in our area was not without impacts on the soil – no agriculture can be – but it may have left substantial parts of the soil life intact because it was limited in both extent and intensity. Changes in temperature and humidity due to exposure of the ground probably resulted in direct changes in soil life and resultant biochemical processes; likewise, changes in the plant cover and associated root exudates and leaf litter no doubt also altered soil chemistry. Ecologically, at least some of the soil and ground-surface life that occurred in native agricultural openings was probably the same as in natural breaks in the forest such as might be created by fire, windfall or flooding. In some ways, indigenous agricultural openings, with their crop/fallow cycles, simulated such events. Such similarity was enhanced by the apparent absence of significant external soil additives such as fertilizers or pesticides/herbicides. Without the ubiquitous non-native plants and invertebrates that now characterize much disturbed lands (most of our so-called weeds are European plants that arrived with the colonists), if we were to travel back in time and root around in an Indian vegetable plot, we would likely find many organisms typical of natural forest openings. Even today, a subset of the wild plants and animals found in gardens and farm fields are native species typical of natural disturbances.

The First Colonial Farmers: The Dutch

In some ways, writing about the impacts of Native American farming on soils is easy – there are so few real data points that one can easily craft a story that fits with what little we know. As we enter the next periods and move towards the present, however, the data points become more numerous and, in some ways, more confounding.

We won't try to present a complete agricultural history of the County; instead, for this next period, we will take a view that is both more specific and more general. More specific in that we will retain our focus on the changing soil habitat, giving relatively short shrift to the larger context; more general in that this focus on soils sometimes requires us to include areas outside of the County in order to find applicable data. Despite the presence of more detail, 'circumstantial evidence' will still be a large part of our soil detective work: how was the soil apparently managed, and so how might its health have evolved? To aid us, we do have written words now – the accounts left behind by witnesses to the 17th, 18th and 19th centuries along the Hudson Valley. We'll let those who were actually there speak for themselves when possible. These words are the closest we get to snapshots of Northeastern farming during this era which, in turn, is the nearest we can approach historical soil tests.

Descriptive writers never make up more than a small percentage of any population and so, not surprisingly, in the early days of European settlement, when total colonists were relatively few, authors were scarce indeed. Aside from a limited pool, even those who did write often had 'ulterior motives.' Many early accounts of colonial agriculture and soils were written with the purpose of attracting companions or new settlers, rather than of providing objective descriptions; their accounts thus need to be taken with a grain of salt.

One of the most descriptive early witnesses to the Hudson Valley was the aforementioned Adriaen van der Donck. He first came to the "New World" in 1641 as the 21-year-old legal assistant (some translations say 'lawyer'; others, 'sheriff') to Kiliaen van Rensselaer – that 'stay-at-home' Dutch lord of the Rensselaer Manor who was quoted earlier. Van der Donck retained his post, based in Albany, for four years before his broad interests and connections with the Native Americans apparently brought him into conflict with van Rensselaer. He then moved south to what was then "New Amsterdam," where he helped negotiate a peace with the Indians and continued to develop his own political ideas and aspirations. He made proposals for the proper running of the Colony, specifically suggesting more local autonomy and an end to the Dutch West Indies Company's governing role. Not surprisingly, the then-governor of the Colony, who had been hand-picked by the Dutch West Indies Company, disagreed with his ideas. In an attempt to plead his case, van der Donck and two other members of his group went to the Netherlands in 1649. His pleas were initially accepted, but then war broke out in Europe, delaying his return and leading the Dutch Government to revoke its decision in his favor. He was allowed to return to New Netherlands in 1653, after promising to retire from politics. He apparently died less than two years later at the age of 35.

His descriptions of the Hudson Valley were written in the early 1650s as part of his efforts to convince the Dutch Government that the New Netherlands Colony had a *raison d'être* aside from that of being a business venture of the Dutch West Indies Company. As such, his words were meant to paint the picture of land that would be welcoming to yeoman settlers. Despite his apparent political aspirations, there is no doubt that he was intimately familiar with the land and peoples he described. A careful re-translation of his work by Goedhuys (edited by Gehring and Starna) was recently published in 2010, and the quotes below come from that work. Van der Donck was also the central figure in Russell Shorto's popular book *Island at the Center of the World*.[17]

Early in his description, van der Donck summarizes his case for settlement in the Hudson Valley, "This river system and the many rich, fertile fields served by it are well suited for establishing sizable settlements, villages, and towns. … it would be sad to see such a gem stripped from our hands by foreigners" (Fig. 10). Van der Donck feared that misrule would discourage Dutch settlement, weaken the Colony, and so open it to other powers. About 10 years after his death, New Netherlands was indeed ceded to the English.

Figure 10. *A map of New Netherlands attributed to Vinkeboons, ca. 1639. Many of the villages that are mapped lie along what we now call the Hudson River; the river was thoroughfare and natural soil replenisher. The area of today's Columbia County seems relatively well settled with Claverack and Kinderhook already appearing, together with two now-lost names, Hinhoeck and Backers Rack.* From the Library of Congress.

He continues and provides our most detailed account of local agriculture during this period,

> *Farther inland as in the colony of Rensselaerswijck [which included Columbia County]…. low-lying land may be flooded once or twice a year…but to those who prepare and provide for it this causes no damage. Sometimes a little stand of corn here and there is washed away, though the silt left behind as good as manures the land. …[aside from some mountains] there are also so many beautiful flats with meadows and pastures of great length and breadth… The soil normally consists of black earth mixed with clay down to about a foot or a foot and a half, and sometimes a bit more or less … Amid the mountains [which he describes as tree-covered]…and by the rivers and shores, lie great and wide plains … which are very suitable for establishing villages, settlements, farms, and plantations… I can say that in the nine years or so I lived in that country, I never saw the land being fertilized; it is certainly seldom done. Soil quality is maintained more often by leaving land fallow… People whom I regard as quite competent sow their land with peas when it becomes weedy and they reckon it needs to be rested, because this is said to make the soil soft, rich, and clean… While it [corn and beans] is growing, two weedings are enough. Nor is the weeding very hard work, for the soil is not turned but merely cleared of weeds on top with a broad mattock. The first time, the weeds are piled up between the rows; the second time is easier as only the new growth is killed and the first lot is raked into small heaps around the cornstalks.*

After recounting the stories of farmers who harvested crops from a single field for 11 years or who grew barley higher than men's heads, he concludes, "Therefore all expert interested persons judge that New Netherland is as fertile and fit for growing all kinds of grain as any part of the world thus far known to or possessed by Netherlanders."

Although these comments are not particularly detailed, they present an image of an agriculture with similarities to both the Native American agriculture that it rubbed shoulders with and eventually supplanted, and to the developing "alternative" agriculture of Europe. The results for the soils may have been, in some ways, the worst of both worlds: like Native Americans, the Dutch provided little manure to their soils; like their 'homeland' counterparts, they may have aspired to more permanence, perhaps eschewing the rotating fallows of the Native Americans. As with the Native Americans (and probably in part because of the preceding farming of those peoples), most Dutch colonists settled the river's edge, intervales and flats first. Evidently, they tolerated periodic floods as nutrient-bearing events. Unlike Native Americans, however, at least some of these early settlers had livestock, and the lowest, most-frequently flooding patches were sometimes made into pasture and hayland. [18]

Despite the presence of cattle, the descriptions of van der Donck and, later, Coventry suggest that manuring was relatively rare. Writing from Manhattan in 1628, a priest who lost his wife and then found few provisions awaiting him bemoaned the fact that, "The ground is fertile enough to reward labor, but they must clear it well, and manure and cultivate it the same as our lands require. It has hitherto happened much worse, because many of the people are not very laborious or could not obtain their proper necessaries for want of bread."[19]

Nonetheless, records from Rensselaerwyck and Albany County (then including Columbia and Rensselaer Counties) include mention of the sale of manure, and manuring was a requisite in some tenant agreements. Even from afar, Kiliaen van Rensselear seemed to keep a close eye on his business in New Netherlands. One result of this distance paired with close attention is that his letters of instruction to his colony are often quite explicit, containing details that might have been unrecorded had he been on hand to deliver them directly. Manuring and fallowing were hardly 'lost arts,' as van Rensselaer makes clear in this 1634 set of instructions regarding how to manage a particular farm:

> *Since the land is overworked and poor, I have proposed to the lords commissioners to let it lie fallow for some years, leaving there some foals and calves, which by that time will attain their growth, and in the meantime to pay the rent as before and to deliver as much of my grain at the market price as my neighbors do. They found this not unreasonable, but said that the manure must stay on the farm, to which I replied that it was better for the land to lie fallow than to put the manure on and take it out twice over by farming, but that the young beasts should stay on it.*

Clearly, van Rensselaer, like his contemporary European colleagues, recognized the importance of manuring and fallowing; it is also clear that, even this soon into colonial agriculture, some farms were already "overworked."[20]

We can encompass both van der Donck's observations and van Rensselear's orders if we assume that the rules, as established in Amsterdam, were only rarely followed on the ground in New Netherlands. In the 1600s, farmers in Holland were practicing manuring, cover crops and fallowing. The lack of their widespread application in the "New World" was perhaps not the result of complete ignorance, but rather of reduced motivation. All these practices require effort and planning; while land was plentiful, few farmers may have seen a reason to invest in them. It may also have been that the most successful farmers – the ones most experienced with the benefits of these relatively new techniques – had little reason to weather the risks of the sea crossing and of establishing a farm in a novel land. Finally, during the very initial stages of the colony, livestock (and their dung) and cover crop seeds may have been relatively scarce, discouraging manuring and cover cropping even by those who wished to do so. The result may have been a tendency for field soils to gradually degrade over time (Fig. 11), something which, as we will see in the next section, may have been commonly evidencing itself by the third quarter of the 1700s.

From Wilderness to Farm: Soil-Relevant Themes in Early Federal Agriculture

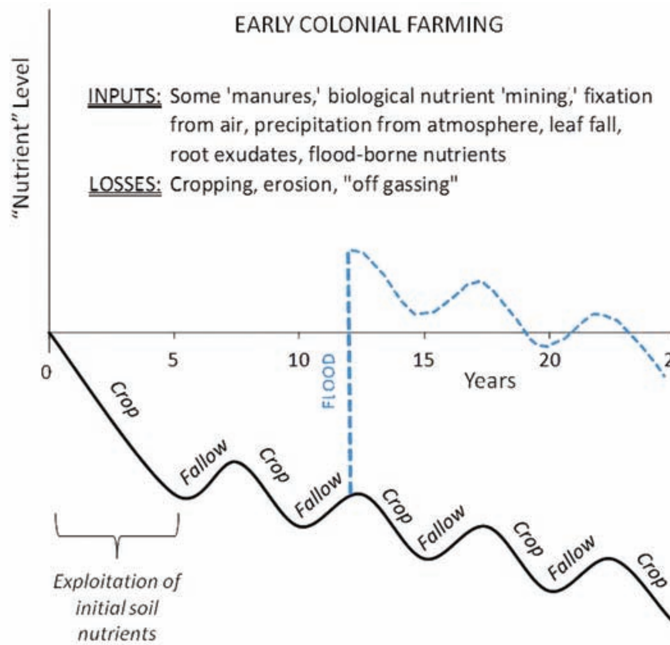


***Figure 11**. A sketch diagram illustrating the hypothetical course of generalized nutrient dynamics under stereotypical colonial agriculture. In many cases, such agriculture apparently resulted in the progressive depletion of soil nutrients despite some periodical recovery during periods of fallow.*

The 18th century formed a bridge between the farming of the earliest settlers and the agriculture we know today. As such, it has tinges of both eras, harkening back to themes we've already discussed while presaging questions or trends that are still with us today.[21]

This expanded section is organized around four inter-related themes: 1) the balance of land vs. labor, and what that meant for the style of farming and hence for the soil; 2) land tenure and the unit of farming, and how that might have affected soil treatment; 3) integration into commercial markets, and the consequences for crop and hence soil diversity; and finally, 4) agricultural innovation, and farmers' increasing efforts to free themselves from the limitations of their land. While each of these themes had much earlier origins and persisted into later periods, this era will be used to introduce and explore them, conscious that we are but dipping into what are much larger issues.

Structured around these themes, the pages that follow provide a local illustration of late 18th and early 19th century agriculture through excerpts from the writings of two County residents of that period: Dr. Alexander Coventry and Robert R. Livingston (the "Chancellor"). The first was a Scotch immigrant, who came to his father's lands along the south bank of Stockport Creek. A medical doctor, farm manager and some-time farmer, he kept a detailed diary during his residence in the County from 1786 to 1791. Because of his extensive diary, he will be our primary source. Robert Livingston was a more prominent figure, owner of the Clermont estate, co-author (but not signer) of the Declaration of Independence, oath-giver to President Washington, holder of various state and federal positions, and founder and president of New York's Society for the Promotion of Agriculture, Arts and Manufactures, antecedent to the New York State Board of Agriculture.

Both of these men were exceptional: both were landlords, although Alexander Coventry's domain was much smaller (ca. 1,000 acres shared with his brother) versus Robert Livingston's 12,000+ acres.

The Coventry land was worked by three to five tenant families; Robert Livingston's by about 100. Alexander Coventry was closely involved in managing the day-to-day use of his lands, and he was also an acute observer of what was happening around him. As such, while his lifestyle was not that of an independent family farmer, his diary can be used to indicate the general practices of the time. Robert Livingston's writings are interesting because of their experimental nature. Inspired in part by the 'progressive' experimental farms of people like Thomas Coke in England and Charles Read in New Jersey, Robert Livingston turned his attention to exploring and promoting the methods of farming that he felt would be most advantageous to regional farming and hence, echoing his early political aspirations, to the new nation. His work therefore helped highlight and explore some of the cutting-edge agronomic issues of his day in a local, Columbia County context, something that Alexander Coventry was in no position to pursue.[22]

Below, we provide background on each theme, illustrate them with direct quotes from both of these residents, and then hazard conclusions about the related consequences for our soils.

1. The Balance of Land and Labor

Historical and modern critiques of early American farming often point to its low yields relative to European fields of the same period and conclude that such farming was backward and/or degraded the soils; however, as astute observers noted even then, the situation was more complex.

In 1790, average population density in the United States, as then proscribed, was 4.5 people/mi^2; at the same time, the estimated population density in England exceeded 150 people/mi^2. As a result, relative to England, land in the Colonies was cheap and labor expensive. Thus, North American farmers felt less pressure to wring every last harvest from a given acre of land and more pressure to get the most production from a given hour of labor. One farmer might be able to harvest more from lightly working 100 acres of farmland than from intensively working 25 acres, even if the per acre yield were higher in the latter. Lower yields are sometimes taken to indicate that North American farmers were poorer at their trade than European ones, when, in fact, both groups were farming in ways appropriate to the divergent resources available to them.[23]

> – Alexander Coventry, 21 August 1786
> *Dutch farming.…they raise large crops of wheat (Fig. 12), plowing sometimes 200 acres, using no manure, which, until of late they rode out to the river, in the winter, so that it might go off in the spring, with the ice. The quantity of land plowed, makes up for the present poverty of the soil, which, however, after frequent plowing, becomes incapable of producing more. This obliges them to move, and they not being compelled to raise their own bread must sell. Often the purchaser is a New England man, who, being used to employ every known art to make his native barren soil produce a good subsistence, generally gets rich, lives well.…*[24]

***Figure 12**. Wheat was central to Hudson Valley agriculture from the 17th to early 19th century. These and the following sequence of images are woodcuts from the notebooks of Alexander Anderson (1775-1870), a New York- and New Jersey-based illustrator. Undoubtedly, as was commonly accepted practice, he copied the illustrations of others. However, he also was witness to farming in and around New York, and, presumably, this direct experience was also reflected in his work.* Image courtesy of the New York Public Library.

***Figure 13**. Although clearing new land for farms was hard work, it also paid back in terms of fresh soil and forest resources such as potash, firewood or, as probably shown here, fence rails.* Image courtesy of the New York Public Library.

This is one of Coventry's most detailed assessments of local agronomy. Coming relatively early in his residence in the US, it is surely tainted with preconceptions of what made for good farming. In this excerpt, Coventry provides quite a detailed description of an extensive form of crop management: low investment (in terms of manure) in each acre being compensated for by the quantity of land being plowed. It is difficult to believe that neighboring farmers were quite as profligate with their resources as Coventry suggests, however soil exhaustion was apparently occurring – an observation supported by the Hudson Valley observations of contemporaries. The last portion of his longer commentary is particularly interesting. Coventry was living in a multicultural world. He makes frequent reference to the Dutch, English, Irish, German, and Yankee farmers he encounters. The "extensive" Dutch farmer was replaced by the more "intensive" New England farmer, as the soil was worn out and population density built. It is not hard to believe that farmers who had experience with New England's hard-scrabble farming and higher population densities might relish a chance to work even 'worn-out' Hudson Valley farms, and might bring with them a tool box for soil renewal.[25]

NEW LAND A key component of extensive farming was the availability of new land 'over the next hill.' While Coventry's everyday life seems to take place in a well-settled land, his trips make clear that much of the 'matrix' was still unsettled if not unclaimed lands. There were still 'internal frontiers' in the region, but Coventry lived in the County for part of the period when forest clearing was at a peak, and the location of new land was fast moving west, fueled not only by the search for fresh ground, but also by the immediate payback land clearers could get for forest resources (Fig. 13). Some six years later, Coventry himself was to move to new land in central New York.

> – Alexander Coventry, 1 February 1788 [during a visit to the area of Greene County]
> *About two years ago I was in this place, and except Dudley's, there was not a house to be seen for three miles, and now every lot of 100 trees, and almost every 50 acre lot, has a settler with a house and small clearing around it, so that it is thicker settled than any place on the east side of the river, excepting the towns. The inhabitants are very poor but seem industrious.*

> – Alexander Coventry, 2 February 1788 [during the same visit]
> *Mr. Hine has lived here about 2 years: has his second crop in the ground, and provision to last until the harvests the coming season, last year he had 40 bushels, from one and a half bushels of sowing. The method he followed was this: he cleared his land completely, leaving scarce a tree standing in the autumn; early next spring, he burnt it over, letting it lie to the sun all summer. Then he dragged in his wheat in good season in the autumn. The piece was a stony ridge, and he could stand anywhere in it, and put the wheat heads cross his head, although I suppose he is about 5 feet 10 inches high. … He is an excellent manager, a good man, but as his wife says, "not handsome, but clever."*

> – Alexander Coventry, 17 April 1790 [in or about Ancram/Copake]
> *…stony, hilly, rough country, almost entirely wood, oak and hickory. This track, Livingston to whom it belongs, reserves for the use of his furnace and forges.*

Mr Hine's tremendous wheat yields would suggest that some virgin soils had not yet been stripped of their initial wealth. It is hard to believe that he was able to continue his impressive wheat harvests for long into the future. The southeast corner of Columbia County was settled relatively late (and is still one of the least densely settled portions of the County), due in part to its rough terrain and border disputes with adjacent states. Coventry's account suggests that this slow growth also occurred because the Livingstons (albeit not "the Chancellor," whose estate did not extend so far east) actively sought to maintain the forests that could fuel their iron processing.

DEAR LABOR Much of Coventry's diary is composed of discussions of labor issues. He was to become a slave owner and recounts his difficulties with various laborers and tenants. His socio-economic rationalization for slavery is apparent in the first excerpt below, while the second describes just one

***Figure 14**. Slavery was common in New York State, including parts of Columbia County, in the late 1700s. Slaves were both farmworkers and household servants.* Image courtesy of the New York Public Library.

of his agreements with a sharecropper (who soon left to work on another farm). Through specific references to other slaves, and through his own slave's participation in societal events such as the celebration of Pinxter and attendance at a funeral, his diary makes it clear that there was a community of African-Americans in the region. Other entries record the escape of one slave and the flight of a mixed-race couple. While never as widespread as farther south, slavery was very much a part of Hudson Valley agriculture. In 1790, slightly over 5% of Columbia County's population were slaves (Fig. 14).[26]

> – Alexander Coventry, 14 February 1787
> *There are few portions of my life that I survey with more pleasure than the few days spent among the respectable Dutch families, farmers, on the Cocksacie neighborhood [near Albany]. …Their farms produced all the means. I have never met with any portion of the human family who lived so independently. In the first place their farms were large, of the richest soil, and within two miles of the Hudson river. Within 24 hours sail of New York. …. Each individual family had more or less black slaves who did all the work on the farm; this saved the masters and mistresses from the insolence of what is called hired help, who must be humored like spoiled children, or they will leave you at their own will.*

> – Alexander Coventry, 28 March 1787
> *Agreed today with James White to work my farm on shares, to have half the produce, I finding the team and tackling; he doing all the work, mowing excepted, during which I find one man, and take 2/3 of hay. Term 3 years.*

Livingston and his colleagues also provide insight into the transition from extensive to intensive agriculture. The excerpts below come from the first volumes of the *Transactions of the Society for* *the Promotion of Agriculture, Arts and Manufactures, Instituted in the State of New York* (the title of later incarnations was thankfully shortened to *Transactions of the Society for the Promotion of the Useful Arts*).

As context for Livingston's remarks to the Society, the following words, presented by Dr. Samuel Mitchell of New York City in 1792, provide an overview of the justification for the Society and an interpretation of the current state of affairs, at least in the eyes of certain (elite) members of society at large. While the narrative is nominally about soil exhaustion due to what are connoted to be bad farming practices, one can also view this as a description of the changing context of farming, one in which the preeminent citizens of long-established eastern colonies were beginning to believe that the future of the nation as a whole and of their leadership within it was going to depend on a more conscious approach to farming, herein dubbed 'systematic agriculture.'

> *Hitherto, the American husbandman has cultivated a soil, enriched for ages by the yearly addition of a fresh stratum of mould. From the first existence of vegetation upon the dry land, decayed plants have continually furnished a supply of manure, which the winds and rain have liberally spread abroad. As the supply was annually greater than the consumption, the earth, unexhausted by it productions, increased in fertility. The thick layer of vegetable mould which covered the face of the earth was a store-house of food for plants, and this quantity was greatly increased by the conversion of wood into ashes by clearing. It is not wonderful then, that for some years newly-cleared settlements should abound in produce, and require little more labour than that of ploughing and reaping; for during this period the provision is wasting, which for centuries had been accumulating. But the time will come, and indeed in many places now is, when the land, repeatedly wounded by the plough-share, and exhausted of its richness, shall be too weak, of itself, to make plants grow with their former luxuriance. This may be called the era of systematic agriculture, when man, taking the earth from nature's hand, bare of manure, is so to manage and dispose it artificially, that it shall yield him first a subsistence, and then an overplus to grow wealthy upon.*

In an address some two years later, Livingston directly compares North American and English agriculture and is much more explicit in pointing out the labor-related motivations that led English and North American farmers to approach their lands differently.

> – Robert Livingston, 1794
> *All these natural advantages being in favour of the American farmer, I shall be asked how it happens that the lands in Britain are more productive… the answer would be found in the low price of labour, and in the high price of land. More labour is therefore expended*

> *upon less land there, and the product is always in proportion to the labour, the soil and the climate. But does it yield more profit to the cultivator? —No man need be told that a garden where one man is constantly employed upon half an acre of ground, will produce more pulse [i.e., the like of peas, lentils, black beans] than the same quantity of ground cultivated with a plough, in which way one man can tend ten acres; but does it follow the one half acre is more profitable than the ten acres, even though the additional rent should be superadded?*

NET BENEFITS OF EXTENSIVE FARMING We can use another of Livingston's essays to help describe farmers' incomes and to put some comparative numbers into our accounts of North American and English agriculture. In this essay, Livingston presents an economic comparison between the theoretical profits of two 100-acre farms, one of which does not raise vetch and one of which follows Livingston's ideal with vetch-inclusive rotations. Livingston goes on to show how the use of vetches could enhance farmer profit, but here we will focus on his 'control' farm, the farm he presents as the conservative norm. It is evidently a tenant farm (it pays rent) and is described as using "common agriculture."

Based on this and others of his accounts, we can describe a 'typical' (but not necessarily average) Columbia County farm of the late 18th century as containing about 130 acres, of which perhaps 40 acres was actually tilled with only about 2/3rd of that actually in crops during any given year, the remainder being in fallow. The 90 acres that were not tilled would be divided between hay meadow, pasture and woodlands, together with smaller allotments for house, barn and yard. There might have been four horses and as many oxen, perhaps 5-10 cows, and a scattering of sheep and wide-ranging hogs. These livestock were probably fed both from the farm's own land and, as discussed later, from lands grazed in common. The woodlands provided fuel and construction material for home and market. Wood was also processed into charcoal and potash for sale.

Using Livingston's calculations, and with corroboration from other sources, we can estimate that, in a decent year, such farmers had about 50-70£ of profit. If modern British pounds are a remote enough concept for most of us, then eighteenth-century New York pounds are nearly incomprehensible. However, we can use information from Coventry's diary to translate this into more comprehensible units. An acre of land was selling for about .5 to 5£, with the lower prices usually referring to uncleared lands in western NY, and the higher prices applying to local, clear lands, often with some infrastructure in place. A year's wages for a farm worker were around 20-40£ and that of a priest around 150£; while a modest horse might be valued at 5£, a cow at 6-7£, a restaurant meal at about .15£ and a doctor's visit at 1-1.5£.[27]

With this as context, we can explore the question of the relative success of North American farmers

– were they poor farmers whose ignorance led them to mistreat their land, or were they economically (in the broadest sense) astute farmers who balanced investment with output to maximize total gain? *American Husbandry*, a mysteriously anonymous book published in 1775 (talk about bad timing: its publication was easily eclipsed by colonial events more dramatic than wheat cultivation!), provides some additional context. This work tried to assess which British economic groups would most benefit by immigration to North America. The author concludes that it was the small to medium sized land holder who had the most to gain; more affluent British farmers had much to lose and little to gain by crossing the Atlantic.

A comparison of the production of modest colonial and British farmers from this era seems to support the author's conclusion: in England, the common farm seemed to have higher yields than its colonial counterpart (20 vs 10 bu of wheat/acre; 32 vs 20 bu of oats/acre), but was smaller (10-20 acres vs. more than 100 acres). From a farmer's perspective, the key number was not yield per acre but net per farm. Given that landholders in our area appeared to have farms at least five times larger than their British counterparts (although proportional area in cultivation may have been lower) while their yields were about one-half to two-thirds of their English contemporaries, their total productive capabilities were probably greater, suggesting that, at the least, a farm family's ability to produce food for its own subsistence was easier in the colonies.[28]

As our anonymous author of *American Husbandry* puts it,

> *I do not think a more miserable set of men are to be found than the little farmers in Britain; they work harder, fare worse, and are in fact poorer than the day labourers they employ, wheras in New England [and the same would likely have been said of the Hudson Valley, which he generally deems to be better land], the little freeholders and farmers live in the midst of plenty of all the necessaries of life; they do not acquire wealth but they have comforts in abundance.*

CONSEQUENCES FOR THE SOIL As we have discussed above, relative to English farmers, eighteenth-century farmers in Columbia County both asked less of their land and gave less to their land on a per acre basis. In other words, they probably did not push their soils as hard in terms of expected yields, but they probably also gave each acre less care (in terms of manure, gypsum, and rotational management). Both approaches may have led to soil exhaustion, but, one might suppose that the North American model was more apt to do so, albeit at a slower rate and over a longer time period. The initial response of North American farmers to reduced yields was often to seek new land; this was feasible because land degradation was slow enough to pay back the investment of establishing a farm before soil yields ran out, new land was relatively cheap, and land clearing itself could be profitable (via timber and potash sales and subsequent land speculation). Conversely, British farmers probably had to be more 'on top of' their soil conditions and sensitive to short-term declines in yields.

Yet the times they were a-changing, and it is apparent that the motivation for more conscious soil management was rising in the long-cultivated regions of the Northeast, including Columbia County.

2. Evolving Land Tenure and Work Units

We have come to think of the compact, independent 'family farm' as the natural, if sometimes thwarted, unit of agriculture. However, during the Middle Ages of Europe and the early colonial period of North America it was uncommon. For example, as van Rensselaer's earlier comments suggest, much of early Dutch farming was on 'company farms,' administered by the Dutch West Indies Company or the lords of large manors (for more on the manorial system, see Chapter 1, pp. 22-24). In Europe, lords and abbeys controlled large tracts. What private land existed, other than what was in estates, was scattered as small parcels among relatively large, common fields. (The use of "commons" in this sense is somewhat misleading: while a great many people worked in these large common fields and while labor-bartering surely occurred, there were still distinct, often individually worked beds within them, in much the same way that many modern "community gardens" are in fact a patchwork of privately-worked plots).[29]

Aspects of this system were transferred to the colonies, and early settlements sometimes repeated the pattern of a centralized core village with distributed small, private holdings throughout larger fields. Supplementing these "common fields" was the commons at large – this was true common land in the sense that a variety of townsfolk could make use of it for gathering wood, hunting and, perhaps most important, for pasturing livestock. In this way, even people who owned no land were able to raise at least a few animals. Such land may have been owned by the town, or it may have been privately owned, but its shared use was part of 'common practice.' In part, such centralized colonial villages reflected the need for a fortified core village in the face of hostilities with the Native Americans. However, as that danger waned and as enclosure and associated agricultural techniques spread in Europe, the consolidated, independent family farm became the norm.

The transition from shared fields to consolidated farms should not be confused with that from tenant to freeholder. Tenant farmers work land owned by somebody else, usually in return for a payment to the landowner. Freeholders work land that they own. Shared field and consolidated farm agricultural systems do not dictate whether the farmers are tenants or freeholders. While shared fields may have typified some medieval feudal situations (in which case the lots were owned not by the farmer himself but rather by the lord), many early European colonists in North America (together with many European farmers of that time period) worked personally owned plots in shared fields. Conversely, many early Columbia County farmers worked consolidated farms that they did not own. Such an arrangement occurred not only in those portions of the County found within the Manors of Livingston and Rensselaerwyck, but also beyond the bounds of those manors where other multi-farm land owners (such as the Coventrys) made agreements with tenant farmers. (Many modern farmers continue to work land that they do not own.)[30]

***Figure 15**. It wasn't only the bull who got into the corn. In a landscape with evolving tenure, livestock were perceived to have a right to the commons. Those who wanted to keep them out of crops, built walls and fences around their cultivated fields.* Image courtesy of the New York Public Library.

GLIMPSES OF THE COMMONS Perhaps one of the least familiar (to modern eyes) aspects of farming in Coventry's day was the free-ranging livestock: an arrangement that benefited the landless, but frustrated crop growers and discouraged those recommending more conscious management of manure (Fig. 15).[31]

> – Alexander Coventry, 21 August 1786
> *The horses have broken several times into the meadow, and destroyed an excellent aftermath ["aftermath" meant a hay harvest that occurred after the primary cut]. Oh, that there was not a horse in Claverack.*
>
> – Alexander Coventry, 3 October 1786
> *The hogs amongst the wheat, a great part of which they rooted out. Hunted them with Chloe the bulldog, who fought nobly and would not fly from the whole of them. A hog that has been always accustomed to the woods, will fight wickedly.*
>
> – Alexander Coventry, 9 May 1787
> *Mr. Van Alstine's cattle, 18 in number, have got into my wheat and destroyed it, and injured my meadow, so that I shall neither have wheat nor hay.*

As these and ample other entries make clear, keeping livestock out of crops was largely the responsibility of the crop-owner (rather than the livestock owner), and fences were designed to keep livestock out rather than in. This didn't always work: horses, cattle, pigs and perhaps sheep seemed to be regularly robbing hay, rooting up young orchards, and destroying crops in and around Coventry's farm.

Figure 16. *Fishing and hunting grounds were often also considered part of the commons, although that didn't prevent bad feelings.* Images courtesy of the New York Public Library.

As the following excerpts illustrate, the commons was also hunting and fishing ground (a persistent, if now vanishing, arrangement). It is important to remember that hunting and fishing was probably an important part of the 18th century food system, and may have even lessened demands for domestic animal protein (Fig. 16).[32]

> – Alexander Coventry, 18 September 1787
> *Went with Ludlow over the creek, to what they call Salt Lick, a marshy, springy piece of low clay ground, where the pigeons frequent often, supposed on account of the saltish quality in the clay. We found Delemaitre and Kettle there, they had killed 20 pigeons each.*

> – Alexander Coventry, 2 May 1790
> *They have caught a good many fish at Primar Hook, taking about 100 at one haul, a party from our neighborhood, the Martins, went to fish the Schermerhorn's fish, the latter cut their ropes.*

Coventry mentions local hunting of various birds, of squirrels, and of pests such as wolves and foxes. Wildlife had no doubt already declined substantially by Coventry's period. He makes no mention of other small game (such as rabbits) or of deer. He does recount deer hunting during his trip to western New York, suggesting that deer may have been scarce in the County during his time. The "pigeons" referred to are clearly the now-extinct Passenger Pigeons, and Coventry reports hunting them several times. It was apparently a group affair, and, at one point, he recounts firing into a flock of at least 1,000. Suckers, Striped Bass, and Shad were among the fish he described seeing caught. Catches, evidently, could be large: one year prior to his fish report of 1790, he describes catches totaling 7,000 Shad in the same location. His diary suggests that hunting and fishing were frequent activities, providing sport and subsistence.

CONSEQUENCES FOR THE SOIL The decline of the commons and the rise of the consolidated family farm had a variety of consequences from cultural to economic to agronomic, and it is difficult to isolate its effects on the soil. One can conceive of both positive and negative soil impacts. One impetus, amongst several, for consolidation and enclosure in Europe was that it gave farmers (or farm owners) the ability to more closely manage blocks of land without being tied to synchrony with the other farmers in the common field. For example, pasturing of livestock in the stubble of a crop field could bring manure nutrients into the field, but on a shared field, no pasturing could occur until all holders had gathered their crops. Some agricultural historians thus argue that consolidation and enclosure was necessary for the modernization of agriculture and the improvement of soil management through more complex crop rotations. But agricultural benefits may have also been lost: tight communities, held together by the need to coordinate the use of shared fields, may have allowed for more efficient use of the landscape than dispersed individual farms. The careful, community-planned sharing of seasonally-flooded meadows is a case in point. This arrangement may have enabled a wider geographic sharing of wet meadow nutrients than would have occurred under sole ownership of the meadows.[33]

Logic suggests that tenant farmers, who did not own their land and who, as in the case of the Livingston Manor at least, had no right to sell or pass on their farms to their offspring, would have had less motivation for careful soil management than freeholders, who could expect to benefit themselves or their offspring by improving the land's value (Fig. 17). The well-known generalization described as 'the tragedy of the commons' implies that personal gain trumps community benefits as a motive for sound land management. Spafford in 1813 describes farming in the Livingston-owned portion of the County as notably backward compared to the rest of the County, concluding "The lands are held by leases, of various duration, but principally for a single life, and its agriculture indicates the tenure of title." Our own small analysis (Fig. 18), comparing our earliest county-wide wheat yield results (1845) with our latest information on tenancy prior to the manor system's slow dissolution (1822), suggests that wheat yields in high tenancy towns may have been lower than at least some of the

***Figure 17**. Although perhaps not always as uncomfortable as portrayed, tenant farming was widespread in the Hudson Valley, and widely questioned.* Image courtesy of the New York Public Library.

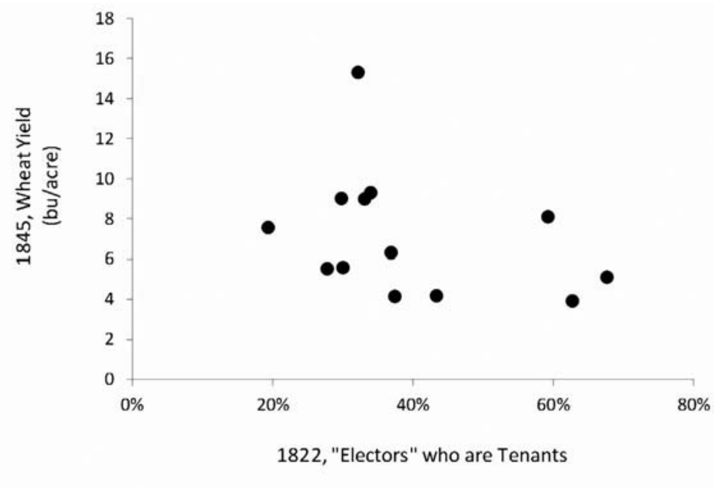


Figure 18. Tenancy vs. wheat yield as reflected in census data. Each dot represents one town in Columbia County. Higher tenancy may have been associated with somewhat lower wheat yields; but this may not reflect cause and effect: both tenancy and wheat yield may have been correlated with soil quality.

towns with fewer tenant farmers. However, inherent soil quality may well have interacted with tenancy during this period when large landlords were selling off parcels: plots with better, more prosperous soils (and hence higher wheat yields) may have been more readily purchased and hence home to fewer tenant farmers.

3. Markets: Local/Global, In-kind/Monetary

Many farmers during this period were farming primarily (although not solely) for family or, at least, community subsistence, rather than for broader markets. There is an on-going academic debate regarding the degree to which farmers were part of the market system during different time periods. We can skirt that by saying local farmers were definitely part of an economy beyond their farms (with wheat as one of the primary currencies), and yet most farms were diversified and had, as a primary goal, the direct production of family staples.[34]

Coventry lived in a money-based economic system that was largely without money. Coventry's diary is replete with annotations on trades and barters. The value of trade items was often converted to currency, but no money actually exchanged hands. Instead, services (such as Dr. Coventry's care of a patient) were usually paid back in goods and other services (Fig. 19). In part, this was because of a post-revolutionary collapse in the value of colonial paper money and the scarcity of alternatives.

> – Alexander Coventry, 15 December 1785
> *Money is extremely scarce; no silver or gold, or no bank notes. What money exists, is in the hands of a few rich men… and they take exorbitant interest: there are no banks, confidence, or credit.*

> – Alexander Coventry, 7 August 1786 [in Albany]
> *The streets full of people, who have come from all parts of the state, to get some of the new paper money, for which they mortgage real estate to double the amount, and pay annually*

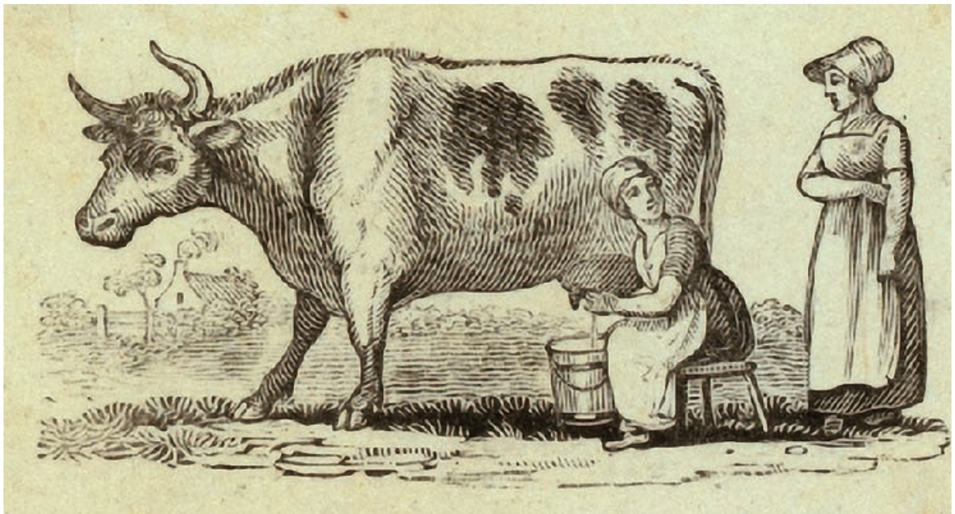


Figure 19. *Women had crucial roles in farm labor, often including dairying. At least a portion of their income was often their own, and typically was paid through barter.* Image courtesy of the New York Public Library.

5%. I suspect there were applicants for ten times the amount issued by the state. There is a great scarcity of circulating medium. The continental money is no better than blank paper. There are no bank bills and specie are very scarce. A few moneyed individuals purchase lands and everything at their own prices.

Coventry was operating during challenging economic times. Later in August 1786, just across the border in Massachusetts, the so-called "Shay's Rebellion" would take place as small farmers protested against State-led efforts to foreclose on tax delinquent properties and enforce the payment of other debts. The Federal government had issued currency to pay soldiers, but a post-revolutionary economic downturn, caused by war-time damage to commerce and subsequent British limitations on international trade, especially with the West Indies, led to inflation and quick devaluation of that currency. While Massachusetts, at the behest of wealthy land owners, tried to raise taxes to pay its arrears (thereby fueling more discontent), New York State took a more populist approach, and loan offices, such as the one whose opening Coventry recounts above, were one of the results. Such offices meant that individuals seeking loans could escape having to deal with the elite classes and their "exorbitant" interest rates.[35]

– Alexander Coventry, 25 November 1789
Cuff took a load of wood to Hudson for which he got 5 shillings in molasses and twist. He also took three skim milk cheeses and two pounds of butter for my wife and got a black silk handkerchief.

– Alexander Coventry, 22 January 1790
Cuff took two loads of wood to Hudson today and got 12/- for them. Took it mostly in trade; me a hat for twelve shillings, a shawl for Betsy, a set of tea cups and the rest for himself.

> – Alexander Coventry, 22 February 1790
> *Took two ox sled loads of wood to Thurston…Paid Foot for my wife's shoes, with 3 lbs. of butter at -1s per lb. and 1 bushel of potatoes at – 3s per bushel.*

These excerpts illustrate aspects of the barter economy. Fuel wood was a main staple of Coventry's commercial production, it was often valued in money but paid for in goods. Like many farm wives, Coventry's wife had her own economic production – cheese and butter were often the woman's domain – apparently she used the resulting gains to buy goods for herself. Cuff was Coventry's slave.

The Hudson was the 18th century interstate highway, with its direct river connection to New York City and thence the World. It was a key component of commercial life, and the market connections it facilitated helped determine which agricultural products were profitable. One wintertime entry, for example, noted that two ice-bound Irish ships in the Hudson port were packed with cargos of wood and flax destined for the Old World. Coventry makes the following and a few other passing mentions of the state of politics in Europe.

> – Alexander Coventry, 9 July 1786
> *Report the appearance of a new war between France and England.*

Whether he realized it or not, this news was of much more than passing importance to Columbia County farmers. Much of the post-revolutionary boom in American agriculture can be attributed to war in Europe – that fighting robbed farmers and farmlands from European production and prompted large-scale imports from America. The agricultural newspapers of the next century spent much ink discussing the North American agro-economic downturn precipitated by peace in Europe, Europe's return to agricultural production, and the consequent reduction in demand for North American farm products.[36]

CONSEQUENCES FOR THE SOIL The above quotes are not about the soil. And yet, economic context certainly affects a farmer's relationship to the land. As farmers more deeply entered markets during the 19th and 20th centuries, they began to specialize their production, focusing on, for example, dairy or fruit. Even during the 18th century, external factors were probably skewing farmers towards certain crops of commercial trade. Wheat in particular was easily sold and widely demanded. Manor lords often specified rental payment in wheat; tenants on the Livingston properties were required to plant a certain acreage of wheat in order to supply lords of the manor with wheat for commerce. Wheat is a demanding crop in terms of soil nutrients, and probably accounted for much of the soil exhaustion reported during the 18th century.[37]

A diversified farm provides more opportunities for rotating crops and circulating nutrients. Few practices drain soil nutrients as consistently as the long-term production of the same crop on the same piece of land. But opportunity does not equal practice, and one can question how much colonial farmers practiced crop rotations and nutrient recycling, even when practicing relatively diverse farming.

4. Agronomic Innovation and Tradition

One can highlight three realms of innovation during this period: the advent of upland 'artificial meadows' (see Chapter 3, p. 109), the search for new crops and breeds, and the increased use of manures. Floodplain meadows played an important role in colonial and early federal agriculture (Fig. 20). They offered some of the best hay and pasture available, but, because they were limited in expanse, they also restricted the extent of animal farming (and hence of manure production). One key innovation was thus the widespread seeding of upland fields with European hay and pasture grasses. These species were able to produce high hay yields on relatively dry land. The upland fields were, however, outside of the revitalizing influence of the floodplain and so open to potential soil exhaustion. In response to the increasing pressure for intensification of farming and perhaps to fight soil exhaustion in upland meadows, there was increasing interest in manures and crop rotation. While these ideas were hardly new, there was renewed attention to their application. Finally, Coventry and Livingston both evidenced a keen interest in new breeds and crops as new plant (and animal) candidates for their upland meadows and as botanical collaborators in soil regeneration.[38]

***Figure 20**. Floodplains, such as this man appears to be sowing, were a key part of the agricultural landscape because of their rich, and often refreshed soils. On the other hand, tilled soils in the floodplain did and do invite erosion during high water.* Image courtesy of the New York Public Library.

MEADOWS: OLD AND ARTIFICIAL Wet meadows were not only lush but regularly fertilized by flood waters. These nutrients could then be transferred to farmland via hay and then dung. Brian Donahue's book on Concord, Massachusetts details the role of such meadows in the 18th century sustainable agriculture of that town. To one degree or another, this practice was probably widespread and local evidence suggests it was a component of at least Shaker and Dutch agriculture in Columbia County. For example, at least during the late 1700s and early 1800s, the Shakers on

Mount Lebanon got 50% or more of their hay from meadows in and around today's Shaker Swamp. In general, such farming meant that the extent of mixed farming was limited by the availability of natural wet meadows; some colonial communities went to great lengths in order to assure that most farmers had access to wet meadows for hay. Escaping this constraint was an important step in colonial farming, and upland "artificial meadows" (as they were termed) were thus an important advance, at least in the short term. Native upland grasses produced poor hay and short-lived pasture, so expansion of hay land and pasture into the uplands was associated with increased planting of better-adapted European species.[39]

> – Alexander Coventry, 11 June 1786 (during a visit to a farmer across the Hudson)
> *He showed me a piece of meadow, which he had drained, where the water stood three feet deep before draining. It resembles very much the moor or peat land in Scotland, consisting of decaying vegetable, trees, etc., and the wash of the neighboring hill. This substance is 6 feet deep on a clay bottom, and would make good fuel. It was planted with maize and potatoes, which, though planted late, look well. He values it very highly, and indeed it is excellent, being from its nature inexhaustible.*

This was the 'old-fashioned' kind of good farmland – a managed, occasionally flooded wetland in which the rich soil was regularly replenished by water-borne sediments and hence was "inexhaustible."

> – Alexander Coventry, 1 July 1786
> *Crossman and Ghose mowing the north hill of the Clayberg where is the nicest and stoutest grass in Claverack. The clover of which it consists, is all laid down and covers the ground six inches thick. The fox-tail is four feet high, and in its prime.*

This was 'new' farming – the creation of what was called 'artificial meadow' by the planting of European forage plants, such as clover and "Fox-tail" (probably what we call Timothy today) on uplands (for more on the botany of fields, see Chapter 3).

> – Alexander Coventry, 4 August 1786
> *Began cutting the hay. Cut it down and turned it once over, which is all sufficient for this kind of grass. It is called "Copper" or blue grass. It is the most substantial, and easily cured, of all the calmiferous grasses. The stalk is flat and solid, and contains the substance, the leave being small. It is short, and does not arrive at maturity until after harvest. It is natural to clay soil, seldom giving above ½ ton to the acre. It is only 6 or 8 inches high, but on rich land, as the Coxackie flats, it is much taller.*

Blue Grass (probably *Poa compressa*) was another introduced grass. Coventry's comments reflect something of an experimental air, together with a roving eye that learned from the experiences of others.

THE INTRODUCTION OF NEW CROPS Finding the right crops and crop varieties is one key step in agricultural development. "Rightness" is determined both by plant (or animal) biology and by economics. Eighteenth-century Columbia County farming mixed the old with the new.

– Alexander Coventry, 18 May 1786

Alexander [his cousin] planting Indian corn. To prepare the land for planting, alight furrows are strod out about three feet apart; these are crossed by furrows at similar distances; where the furrows intersect 3 or 6 grains of corn, with a pumpkin seed, are dropped, and covered 1 ½ or 2 inches deep with the fine mould, with a hoe.

The planting of corn and squash together represents a Native American planting pattern of two native crops; this technique was adopted early and was maintained.

We do not know if Robert Livingston was the primary author of the following document, but the minutes of the Society report that its distribution was accompanied by a letter from Livingston requesting that this notice be posted in ship's cabins. So, even if he did not write it, he was clearly well familiar with it.

– Robert Livingston (?), 1793

INSTRUCTIONS to Captains of Vessels sailing to any part of Asia, Africa, the North of Europe, the Southern or Western parts of North-America,

First. PROCURE a small quantity, not exceeding one quart, of those kinds of grain which make the principal food of the inhabitants, and this even though it should be wheat, barley, rye, oats, or maize; for though those grains are common in this country, yet there are varieties which may be extremely important, as was instanced in the accidental introduction of the white-bearded wheat, which was found to resist the insect: when every other species was destroyed by it.

The document had seven clauses in all, requesting not only the collecting of seeds of grain, but also of legumes and pasture grasses, together with various observations of livestock (but cautions that captains should not take this as an excuse to illegally smuggle out controlled sheep breeds, like the Merinos that Livingston was soon to be raising).

– Alexander Coventry, 18 April 1790 [during a visit to northeast Dutchess County]

Mr. Knickerbocker…seems a wealthy, warm farmer, in a very thriving way, owns a considerable farm….He keeps his cattle almost altogether on straw but allows each head 6 ears of Indian corn a day and this he gives at three different times.

– Robert Livingston, 1794/1795

Turnips cannot be raised in our climate to advantage, as a food for cattle: the season in which they are sown being usually very dry, and the plants liable to be destroyed by the fly….

> *Let us now examine those [advantages] we exclusively possess: The noblest of these is the maize or Indian corn; neither the beans or turnips of Britain can be compared to this plant: First, it need not be planted till the last of May, so that the farmer is never hurried by it with his spring-work: Second, it is cultivated with a plough or horse-hoe; and as the plants are large, and placed at five feet distance, there is ample room for this… it is easier to hoe ten acres of this [corn] than one of the turnips or beans: Third, it defies the drought, and never fails to make ample returns to the husbandman that cultivates it with diligence... The grain furnishes a palatable and nutritious food for man, and is greatly superior to any foreign species for farm stock…as this crop is easily and necessarily kept clean, it is the best of all fallow crops….*

The foddering of cattle with the concomitant increase in the ability to manage their manure and their comings and goings was one component of 'improved farming.' Clearly, it required a form of management other than the grazing commons. English "high farming" was, in part, based on the insertion of a forage root crop, such as turnips or mangels, into the rotation. Forage crops provided farmers with the ability to better manage their manure and to supplement hay with potentially better-yielding fodders (Fig. 21). As Coventry notes and Livingston explains, maize became the fodder of preference here. His allusion to it being a good fallow crop refers to the role of fallows as a weed control measure – plantings of grains could get weedy if they weren't interspersed with a plowed fallow or the equivalent (i.e., a plow-hoed maize field).[40]

***Figure 21**. Corn has been an important crop in the Hudson Valley since Native Americans began cultivating it. It took on new importance once it began to be used as animal fodder, taking the place of root crops in English 'high farming.'* Image courtesy of the New York Public Library.

> – Alexander Coventry, 22 February 1786
> *[The visitor was a] man from whom Mr. Elias gets most of his oxen…He had some clover seed to sell at 2-6 a quart and I bespoke 8 quarts: also a pair of oxen at 8 pounds New York currency.*

> – Alexander Coventry, 20 April 1786 [in and around Pittsfield]
> *I bought 8 quarts of clover-seed for 1 pound.*

– Alexander Coventry, 25 September 1790
John from Lenox here … He told me of a new kind of wheat they have got there, which grows larger, and has whiter flour: they call it "White Wheat." He says a man found a set or bunch of wheat in his field, which was larger than the other wheat, he sowed it by itself, and sowed it by itself, and from it – the rest propagated.

– Alexander Coventry, 2 June 1791 [while on a trip to western New York]
Mr Tunnicliff's…ashworks which are very complete…have a greater variety of fruit trees than any man in the Northern part of the State. Saw here the best stock of cattle and sheep I have seen in the country: saw here a species of grass called orchard grass, which grows very large, and is quite early: they had the seed from Rhode Island. Mr Tunnicliff, Sr. …. has good judgment and large experience: has crossed the Atlantic 9 times, and is, in my opinion, the best farmer I've seen in America.

Coventry's diary makes ample mention of the sharing of seed and cuttings; the September 1790 entry above describes how some local varieties evidently came about: farmers were taking imported seeds, growing them out, and keeping an eye open for useful variability that they could then cultivate. The connection to the Old World was continual and formative; Coventry regularly grilled emigrants about farming in their native lands.

Livingston devoted entire articles in the *Transactions* to his experiments with Lucerne or Alfalfa, and with Vetches; given the widespread cultivation of these plants today, one could credit him with prescience. His subsequent suggestions that Elk and Moose be domesticated have not, however, been realized.

MANURES As we'll explore more in an upcoming section, "manure" was more broadly defined historically than it commonly is today. Rather than referring only to animal dung, it included what are now called "green manures" (i.e., plant material that is left on the field) and almost all soil amendments including lime, gypsum, and ashes (Fig. 22).[41]

***Figure 22**. Dunging the fields. It seems that dunging was not widespread during the late 1700s, however it had long been recognized as important for soil fertility. Livestock dung was not the only manure – a variety of other materials, including gypsum, marl and "human ordure" were considered manure and applied to fields.*
Image courtesy of the New York Public Library.

– Alexander Coventry, 7 May 1789
Finished carting [animal] manure yesterday; have ridden 56 waggon loads from here, and 27 waggon loads from the other house, in all, 83 loads.

Somewhat frustratingly, Coventry does not explain where the manure was being carted to, but he apparently had a supply. Aside from mentioning the construction of a 'dung hole' by the horse stable, he makes no other reference to his own animal manure management.

– Alexander Coventry, 2 June 1786 [in Connecticut]
About three miles from the beginning of the woods, you see a place where a man had cleared several acres, having burned all the brush and timber, so that the ground is covered with ashes.

– Alexander Coventry, 5 July 1786
Hauling logs off the east end of the Clayberg. Set fire to several stumps, in the afternoon, which we could not draw out….[6 July) The fire from the stumps had caught in the fence in two places and several lengths were burned.

– Alexander Coventry, 18 April 1790 [during a visit to northeast Dutchess County]
He raises a great deal of corn, and finds ashes exceeds all other manures for the corn. He has a small stone house to contain his ashes, and declares he would not sell them for 2 shillings a bushel. He puts a single handful around each hill when the corn is about three inches high, he plants in a shallow furrow, harrows the first time.

– Alexander Coventry, 2 June 1790
Finished putting ashes around my corn, put a single handful around each hill. A single bushel serves for 200 hills. Have used about 28 bushels.

– Alexander Coventry, 25 March 1791 [across the river near Coeymans]
The people being to have provision in abundance, and several have grain to sell, also: hay is pretty plenty: the woods get cleared fast, and the wheat looks exceedingly well. The people reap great benefit from saving the ashes off the fallow…the man whose wife I attended, saved one hundred bushels from one acre, which brought him 1s per bushel. They take them up while in coal, pretty much, and carry them in boxes, tubs, or a box fixed on a hand-barrow, to a place built up with logs like a log hut: but small, and convenient to or in the Fallow, and the coals consume entirely into ashes. And here they remain until winter etc: one man may take up 30-40 bushels in a day.

The ash referred to came not only from the burning of newly opened woods (and of fences!), but, as suggested in the last entry, also from burning the brush off of fallows. Evidently, ash management was an integral part of on-farm nutrient management and deserved dedicated care. The frequency of burning in the area is indicated by Coventry's regular mention, in his weather summaries, of smoky air.

Gypsum was another 'manure' that became popular at around this time. Also known in its processed state as Plaster of Paris (or simply, plaster), gypsum is similar to limestone except that the carbonate is replaced by a sulfate. As such, it can help reduce the effects of acidic soils, improve the tilth of clayey soils, and provide sulfur and calcium for growing plants. While sulfur is not normally considered a key limiting nutrient in agriculture, legumes, such as clovers and vetches, are particularly demanding of sulfur and so seem to most benefit from the use of gypsum. Its use was widespread in Columbia County, at least in the early decades of the 19th century. It was frequently applied prior to a sowing of clover, which was then followed by wheat. Its apparently widespread effectiveness suggested that soil acidity was a limiting factor. While some acidification can be natural, it can also be one symptom of soil exhaustion – removal of natural buffers through cropping, increased leaching due to the removal of deep-rooted vegetation, and the production of acids by legumes may have all contributed to widespread acidification of regional farmlands. However, gypsum was not the panacea its early supports touted. Its effectiveness depended upon the degree to which a crop was experiencing limitations that gypsum could ameliorate. Such was not always the case: some crops (such as wheat) and some lands (such as Long Island) benefited little from its application.[42]

> – Robert Livingston, 1792
> *The use of Gypsum as a manure, seems in some measure to have created a new era in agriculture; prior to this it was generally admitted, that tho' farming might rank among the rational amusements, it could not be considered as a profitable employment for those whose avocations or dispositions do not permit them to attend to that infinite catalogue of minutias, that high wages to the labourer, and the low price of produce render essential in our rural economy. The farmer's profit, being the joint result of the fertility of his ground and his labour, the excess of the first can only compensate for a deficiency of the last. Thus the acquisitions of the gentleman farmer, (who may lay his account in being worse served than the common husbandman) must be principally derived from the means which a larger capital affords him, of fertilizing his ground.*

Livingston proposes an interesting balance between dealing with soil issues through management (labor) or amendments (money); in the end however, management could only go so far, and the use of amendments, such as gypsum, became widespread.

The use of gypsum perhaps foreshadows an important future trend: for our County's farms it was an 'off farm input,' meaning that farmers could not produce it themselves. Instead, gypsum was imported from other parts of the Northeast, ground at plaster mills, and then purchased by farmers. This trend towards importing nutrient sources has grown over the intervening centuries.[43]

CONSEQUENCES FOR THE SOIL Eighteenth century agronomic innovations were about releasing farmers from the limitations of their soils. Artificial meadows made animal agriculture practical on a much wider portion of the landscape, while increasing the need for new plants. These meadows, on lands that may not have been inherently suitable for long-term crop production, probably opened new lands to soil exhaustion and so increased the search for effective manures and soil amendments, a push that may have paid off by the mid 19th century (see Table 1). This would eventually lead to the advent and widespread commercialization of synthetic fertilizers. While new breeds and new soil amendments did not necessarily lead to dramatic yield increases during the remainder of the 19th century, the fact that yields did not decrease dramatically in the face of on-going and extensive harvests suggests farmers were, from a production perspective, successfully managing their crops and soils.[44]

Taken together, all of these snippets do not describe the state of 18th century Columbia County agriculture so much as they describe its flow. Farming and the soils that underlay it were evolving as farmers coped with the agronomic and socio-economic consequences of a more developed agricultural state. Higher population densities coupled with increasingly distant open lands were emphasizing the need to produce more per acre of farmland, while the soil fertility consequences of long periods of minimum nutrient inputs were also becoming evident. Changing global and national demands and possibilities were drawing some farmers deeper into markets. Tenants, slaves, lords, and freeholders all interacted in a complex labor and land market with varying implications for attention to the soil. Meanwhile, the on-going search for new crops, animal breeds, and soil amendments was supplying a constant trickle of new agronomic tools.

The four themes highlighted above are not explicitly about soils. However, in some ways, that is a key point of this section: soils are an unseen scapegoat of sorts, a habitat whose condition has been influenced by many factors only tangentially related to the immediate management of the soils themselves. The socio-economics of farming had a large hand in shaping the approach of farmers to their land and their soils; however it was only occasionally, and then often in retrospect, that the health of the soil itself was considered.

	Land Cover	% Organic Matter
1843 (NYS)	Cropland	8.7
	Hay/Pasture	5.1
	Forest	6.8
2000s (Col. Cty)	Cropland	ca. 4.25
	Pasture	3.6
	Hayfield	3.1
	Forest	7.5

Table 1. *Percent organic matter as measured by Ebenezer Emmons in the 1840s and by Cornell in the 21st century. Emmons' work was broader and includes soils from a variety of locations in Eastern NY. Of interest is the relatively low levels of organic matter in grasslands during both periods, suggesting they were and are generally not replenished to the same extent as cropland. The relative abundance of organic matter in 19th century cropland relative to grassland and forest is notable when compared to 21st century conditions. The relative richness of the early croplands may be attributable to the greater importance of solid manures (vs. synthetic fertilizers or liquid manures) during that period. Because methods varied somewhat between eras, direct comparisons may be somewhat risky.*

These changes did not and have not ceased. For example, during the beginning of the 19th century, vastly improved transportation routes (which were to make huge strides with the 1824 opening of the Erie Canal and, soon thereafter, the arrival of the railways) put local farmers into direct competition with others farther west, and heralded major restructuring of regional farming. However, rather than follow each of the above themes further, we will leave them here as a contribution to a description of this early era's agriculture and as 'teasers' that readers can try to trace to the present day. Our consideration of the modern period will change its approach by focusing more explicitly on soils and asking, how have published views of soils and their fertility changed from the 18th century through to the present? Again, in order not to stray too far afield, we will focus on soil perspectives from in and around Columbia County.

Changing Soils: The Evolving Vision of Soils and How to Manage Them in the 18th-21st Centuries

The last era of soil management to consider will encompass most of the 19th, all of the 20th and the start of the 21st centuries, with references back to the 18th century for context. This is a broad sweep of time, and much change in farming and landscape occurred during this stretch. It could reasonably be broken up into smaller periods. However, treating it as a whole lets us consider changes in perception that occurred relatively slowly and are thus most evident when viewed in the long term.

This time span saw a dramatic evolution in how agricultural scientists and then farmers viewed and so treated the soil. The goal in this last section is to illustrate this arc by describing some regional milestones in soil description. The timeline on the next page (Fig. 23) shows the works we will be considering; this is an eclectic blend, and many other publications could logically be included, but it's enough to get our hands dirty.

People are often caught between working with the everyday realities around them and trying to find over-arching explanations of those realities, explanations that may allow them to better predict and manage that reality. These two threads – practical existence and the search for explanations – are woven through the historical farming literature and, presumably, the minds of early farmers and 'agronomists' (although 'agronomist' is a modern term). Treatises on husbandry contain both 'try this, it's worked for me' and 'here's how this works, so do this' sorts of recommendations.

In this quick, parochial survey of soil science, we want to focus on the explanatory aspect. In other words, how did those writing about agriculture and soils envision the interaction between the two? In doing so, it will help us to focus on the question, 'what is soil fertility and why does it occur'? Unlike many other terms in agronomy, it seems likely that a farmer of 300 years ago and one of today, would quickly agree on the importance of fertility and a common working definition of it (something like, 'the ability of a soil to produce crops'). They might find themselves more at odds if they tried to

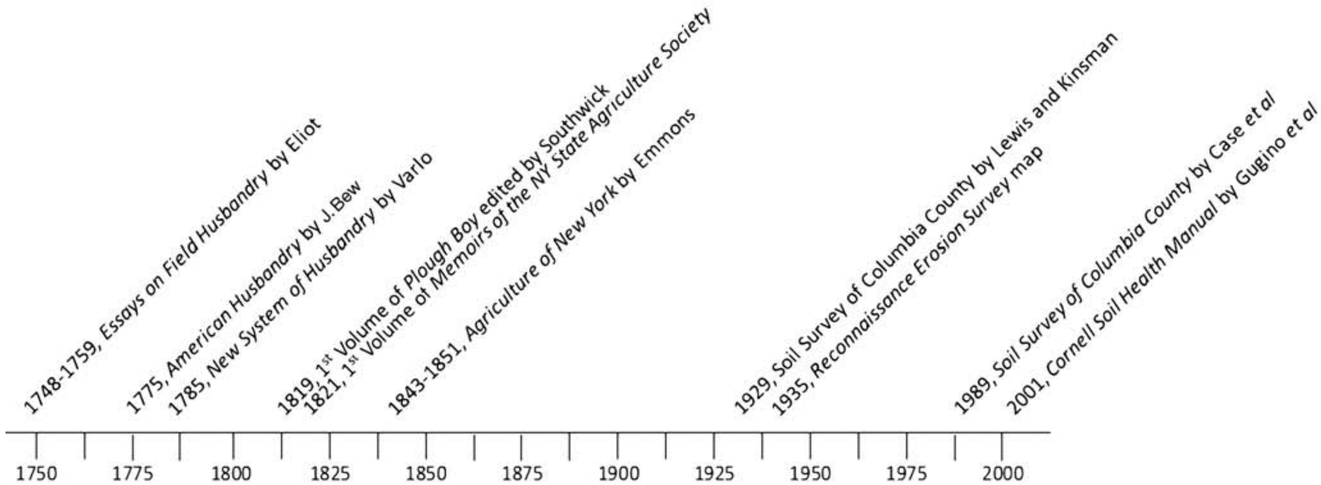


***Figure 23**. A timeline showing the publication dates of the works referred to in this section.*

discuss why a soil was fertile. In the next few paragraphs, we will try to trace implicit and explicit understandings of fertility through the regional literature.

Jethro Tull, Jared Eliot and a Little More. Jared Eliot was well-placed to expound on the practical and the explanatory. He was a physician, cleric, and one of the earliest graduates of what became Yale. One biographer describes him as New England's Benjamin Franklin, and he was certainly not an 'everyday farmer.' And yet, his pastoral and medical duties led him to travel around New England and, observing the various methods tried by farmers in the region and having access to the then-burgeoning production of English farm books, he decided to write and experiment with agricultural methods. Published as a series of essays between 1748 and 1759, his work was collected in the 1760 volume *Essays Upon Field Husbandry in New England*. He communicated with a variety of well-known contemporary scientists including Franklin and John Bartram. Eliot was writing after the publication, in England, of Jethro Tull's seminal *Horse-hoeing Husbandry*, but before the early 19th century raft of soil chemical analyses that included the works of Humphrey Davy and then Justin Liebig. His voice will represent the starting point of our time series.[45]

One concept that seems central to Eliot's view of fertility is what we now call friability, that is the looseness and 'fluffiness' of the soil. In emphasizing friability, Eliot was explicitly echoing the influential words of Jethro Tull (the 17th century agronomist, not the 20th century rock band). Tull's main thesis was that deep and intensive cultivation allowed air to reach soil surfaces, opened the way for plant root development and made more nutrients accessible (Fig. 24).

Eliot quotes the following extract from Tull's book as the definition of its core proposition; we present it in length because Tull's book and concepts were so influential:

The only Way we have to inrich the Earth, is to divide it into many Parts, by Manure or by Tillage, or by both: This is called Pulveration. The Salt of Dung divide or pulverize the Soil by Fermentation, Tillage by the Attrition or Contusion of Instruments, of which the Plough is the Chief. The Superficies or Surfaces of those divided Parts of the Earth, is the Artificial Pasture of Plants, and affords the Vegetable Pabulum to such Roots as come into contact with it. There is not Way to exhaust the Earth of this Pabulum, but by the Roots of the Plants, and Plants are now proved to extend their Roots more than was formerly thought they did. Division is infinite, and the more Parts the Soil is divided into, the more of that Superficies of vegetable Pasture must it have, and more of those Benefits which descend from the Atmosphere will it receive. Therefore if the Earth be divided, if it be by Tillage, it answers the same End as if it had been performed by Dung.

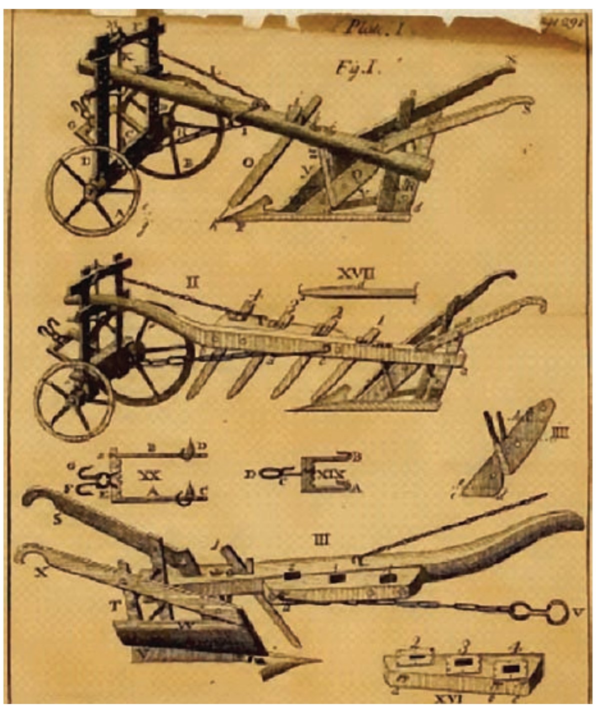


***Figure 24**. An image from Jethro Tull's 1720* Horse-Hoeing Husbandry, *a book that had a large influence on Jared Eliot. For both Tull and Eliot, much of fertility management had to do with, as this image suggests, how one plowed the land.*

After some comments on the inscrutability of such language, especially for "common farmers," Eliot goes on to make a translation, "The only way we have to enrich the land, is by Dung, or by Tillage separately, or by both of them together: It is performed by dividing the Earth into many Parts, or, as the common way of speaking, it is done by making the ground mellow and soft, so that the Roots may pass and find their proper Nourishment…. Dung, or any other Measure, divides the Ground, sets the Parts at a Distance, and so gives a free Passage to the Roots of Plants. In this Action the Salts in Dung hath much the same Operation and Effect as Leaven, or Emptyings hath on Dough; it makes it rise, makes it light, that is sets the Parts at a distance."

What Tull and then Eliot seem to be saying is that tillage improves fertility for several reasons: it is at the surfaces of earth particles that plants find their nourishment (and hence, the more surfaces, the more chance for nutriment; it is this surface area that Tull explicitly calls "the pasture of plants" in analogy to cattle pastures); tillage and dunging not only increase this surface area, but also help plants dig deeper in their search for nutrients; and finally, as Eliot makes more explicit elsewhere, tillage opens the soil to receive the fertilizing benefits of air and water. As he puts it,

> *The method… prepares the land… to receive the floating Particles of Sulphur, and the nitrous Salts of the Air, the Benefit of the Sun's Rays, which, when accompanied with a sufficient Degree of Moisture, enlivens and invigorates all Nature. When winter hath brought a universal Gloom upon the face of the vegitable Creation, Paleness and Death appears on all Sides: The Psalmist saith of it, Thou hidest thy Face they are troubled. Then speaking of the Sun, thou sendest forth the Spirit they are created, and thou renewest the Face of the Earth.*

He goes on to single out the benefits of dew fall, and to cite an experiment that, by evaporating both rainwater and dew water, showed the greater nutrient content of the latter.

Charles Varlo, someone who appears to have been an agricultural knight errant/snake oil salesman of sorts, published a two volume work in 1785 professing to provide a 'new system of husbandry' adapted to North America. Whatever his dubious success in achieving that aim, Varlo does provide a more explicit description of the link between tillage and life, one that complements Eliot's, "The nature of two bodies, mixing together thus, admits or rather opens a passge for the air to penetrate amongst it, so as to cause a fermentation; for nothing will or can ferment without air…..If he [the farmer-reader] does not open a passage into the body of the clay with some instrument, or compound, so as to admit, or make a passage for the air to penetrate therein, to raise it to action by fermentation, it will remain a dead inactive body; and if any seed happen to be bound or inclosed therein, it will never grow…"[46]

The purpose of quoting the original language here is two-fold: it provides a bit of the flavor of the time, but it also reveals, at least in Eliot's case, the mix of the analytical and the spiritual. Eliot has a practical, sometimes even chemical, explanation for what is happening. He cites experiments and specifies nutrients. Yet, he also has recourse to another rationale, a religious rationale. And there is the perhaps implicit belief that this forms the ultimate 'why' behind reality. The hallowed mystery of life, combined with even greater chemical knowledge, will be made explicit in our upcoming consideration of Featherstonhaugh's work.

Before leaving Eliot, it is useful to follow the fate of the 'tillage as manure' theme a bit farther. Eliot was in correspondence with John Bartram of Philadelphia, a noted naturalist of his day, and asked for his comments on the *Essays*. Bartram responded by praising Tull, but then going on to caution, "Notwithstanding, if we continue to plant & till one spot of ground annually for many years…ye fertilizing material will be exhausted, tho we artificially pulverize ye earth as much as we please…" This was an important observation and one that later came to be understood: tilling could loosen soils, aid plant growth and, to some extent, give plants access to previously inaccessible nutrients. However, in and of itself, tillage could not maintain these benefits indefinitely. Furthermore, while Bartram doesn't mention it in this letter (although he does in another letter to Eliot), plowing could also enhance the risk of soil loss through erosion when loosened soils were swept away by rains and floods. The interaction of plowing and of erosion (by both water and wind) was to become a central focus of 20th century soil conservation concerns, prompted in large part by the Dust Bowl.[47]

Eliot provides relatively little description of particular soils; that was not his focus. However, it will be useful, as we follow this history, to ask how our local or at least regional soils were being described. How do contemporary understandings of soil fertility influence what people saw when they looked at the ground?

Writing about a quarter century after Eliot, the anonymous author of *American Husbandry* described New York soils in 1775 and will serve as our example of a soil description from this period. Given the geographic extent of agriculture at that period, he was largely referring to Hudson Valley soils (those of Long Island were noted separately) when he wrote of New York State, over the course of several pages,

> *The soil of the province is in general very good... they have notable tracks of rich black mold [referring to a soil layer high in organic matter], red loam, and friable clays---the country swells into fine hills... the soil on many of these is rich and deep….seduced by the fertility of the soil, on first settling, the farmers only think of exhausting it as soon as possible... [they] depend on new land for everything, and are regardless of such management as would make their old fields equal the value of the new ones.*

We'll come back to consider this description in the light of later works.[48]

Broadsides and Memoirs As was occurring elsewhere, beginning in the late 18th century, New York State saw the rise of what might later be called agronomy, but which contemporaries called the science of "husbandry or rural economy." This was an attempt to derive and popularize a structured approach to the improvement of agricultural knowledge and practices. It followed a fashion established somewhat earlier in England and elsewhere in Europe, and we alluded to it in our introduction of Robert Livingston. With some basis, these efforts were criticized as 'book farming' – in truth, most of those who had the time to read, write and experiment with agriculture were not those in the thick of it. Furthermore, some publications or recommendations sounded naïve and impractical to working farmers. Nonetheless, these efforts did, undeniably, have an influence, which is recognizable today in the work of Cooperative Extensions, state agricultural departments, and formal agronomy-related university faculties.

In 1819, Solomon Southwick, an Albany publisher, began to publish an agricultural weekly called *The Plough Boy* (Fig. 25). In its first volume, he serialized a book that had come out 6 years previous: Sir Humphrey Davy's *Elements of Agricultural Chemistry in a Course of Lectures*. Southwick seems to have been more moralizer, publicist (he signed his name as Henry Homespun, Jr in the first

***Figure 25**. The masthead of The Plough Boy, published in Albany, one of our first agricultural newspapers.*

volume of his paper), and publisher than farmer, and yet he was a 'mover and shaker' in our region, and his inclusion of Davy's work suggests its influence. Today, Davy's lectures seem a bit removed from the immediate needs of agriculture, a fact Southwick seemed to acknowledge in his introduction to them, "Those who have never paid any attention to chemistry, may, in some instances, be at a loss to understand the meaning of some chemical terms with which the work abounds…", but, he went on to add, "being the first work of its kind ever published, its near approach to perfection is not to be expected; – we believe, however, that it may be justly considered as an able and valuable performance – as exhibiting the intimate relations of agriculture with chemistry." This was a nuanced introduction, but over the next year, Southwick published regular installments in his monthly paper. In the concluding installment, published on Saturday, August 15th, 1820, Davy sums up, "I trust that…in proportion as chemical philosophy advances towards perfection, it will afford new aids to agriculture."[49]

By the second volume of *The Plough Boy*, the paper was being described as the official publication of the New York State Society of Agriculture, although it mixed a fair dose of Southwick's moralizing with poetry, news headlines and 'odds & ends' only tangentially related to agriculture. Perhaps to regain focus, in 1821, with Southwick as publisher, the Board put out the first volume of *The Memoirs of the New York State Board of Agriculture*. This volume contained an interesting mix which linked to both local and national trends.

Apparently in the hopes of shedding their image as book farmers, the Board had appealed to farmers throughout the State asking them to report back on local agricultural conditions. However, the introduction to this first volume makes clear that such efforts were not very productive. As a result, instead of excerpting county reports, the publication is made up primarily by a long series of essays on 'Rural Economy' by G.W. Featherstonhaugh. His work will serve as a somewhat theoretical report on the state of soil knowledge in our region at this time. More practically, and closer to home, Amos Eaton co-authored a 'Geological and Agricultural Survey of Albany County' that appeared in the same volume. Eaton's work is one of the first attempts at what will later be recognized as a 'soil survey.' Finally, former president James Madison's 'Address to the Agricultural Society of Albemarle Virginia' is reprinted in the volume. We won't explore this address in detail, but it was widely read at the time and was an eloquent and rather direct description of farming's ills as perceived by this plantation farmer and former president. In it, Madison articulates several issues that sound familiar today including the need to provide space for non-production considerations in the landscape (e.g., native plants and animals) and the fact that we will need to limit our own hunger for resources. [50]

One biographer described Featherstonhaugh as "a strange figure in a strange age." English by birth, Featherstonhaugh was apparently touring the world and, in 1806, happened to be outside of Albany in Duanesburg, when, the biographer notes, he saved the life of Duane's daughter, promptly married her, and undertook the farming of the 1,000 acres she had inherited. Despite what may seem like a rather 'spur of the moment' attitude, Featherstonhaugh settled in, was an early promoter of Albany-area railways and became secretary of the Board of Agriculture when it was established in 1821. Perhaps feeling somewhat responsible for the Board's lack of material for their first volume, he prepared his 'Essay on the Principles and Practice of Rural Economy.' This Essay, coming as it does after the relatively widespread publication of Davy's works, helps us understand how agricultural chemistry was being digested.[51]

Featherstonhaugh begins his essay with something of a justification for book farming, "The deceit with which many men beguile themselves, that they understand a thing perfectly well, and wish to know nothing more about it, has been more injurious to the interests of mankind than any other of the long list of human prejudices; and in no department of knowledge has it been more fatally exercised than in practical agriculture." He goes on to describe how agriculture is at the core of human fulfillment and thus ignorance of its "great principles" is especially troublesome. He continues,

> *Agriculture, or the cultivation of the earth, strictly speaking is but an art, which teaches the best way, under particular circumstances, of tilling the earth, in order to make it productive. But husbandry, or rural economy, is a science which involves the vegetable and animal economy of the whole creation, and their dependence on each other. It exhibits man as rational animal created for the pleasure of his maker, and explains to him the secure and benevolent way in which providence has enabled him to perpetuate the existence of his kind. By science is meant, not the knowledge of technical words, and theoretical systems, but the knowledge of the general relation of things useful to mankind, and which can be immediately comprehended by practical men of clear understandings: and it is hoped in the development of the science of husbandry, after the manner in which it is here planned, that notwithstanding the necessary recourse which must occasionally be had to chemistry, the subject will be treated in a perspicuous [i.e. clear] manner.*

Perhaps a somewhat long-winded extract, but an important one: Featherstonhaugh is bridging a gap between Tull, Eliot and their intellectual kin, and Liebig and the world of agrochemistry. To say he had a foot in both worlds could be misleading because it was perhaps more of a single stream than two con-current ones. It is a man's moral duty, Featherstonbaugh can be read to argue, to pursue agricultural chemistry – in order to understand how to make the best of the providence provided to him. This general philosophy, couched in various terms – sometimes economic, sometimes nationalistic, sometimes religious – is prevalent during this era. Featherstonhaugh is not by any means a lone or leading voice; he is a local exemplar. He is worth quoting as he demonstrates the origins of agrochemistry not primarily in the profit drive sometimes ascribed to it today, but rather in a deep conviction of its importance to agricultural improvement which, in turn, was a moral imperative. He went on,

> *These soils also are various in their appearance and properties, and the forms of vegetables and their properties appear to depend upon the particular nature of the soil they grow in, aided in some degree by climate and situation. We know that in sandy districts, the pine tree universally prevails; we may therefore very fairly conclude that the pine is the natural production of that soil. We know also that…black ash and spruce are the natural production of a rich vegetable mould, continually saturated with water. It being conceded that particular soils under the same circumstances, will always produce the same results [i.e., same vegetation]; the next step to learn is, how many varieties of soil there are, and what the properties of each variety as they are connected with vegetation. This branch of knowledge is certainly important; for as man depends upon the fruits of the earth for his subsistence, he ought to be well acquainted with the properties of the different soils of which its surface is composed in order to combine in the most advantageous manner for his own use… by the aid of chemistry, the elementary parts of which they [the various soils] are composed, can be separated from each other and distinguished. By thus analyzing fertile soils, the constituent parts of which they are formed are discovered, and the knowledge of that which constitutes fertility obtained.*

Here is an explicit logic for soil chemistry: different soils produce different vegetation due to the different characteristics of those soils. Working in reverse, if we wish to encourage particular vegetation (such as our crops), then we need to understand the soil characteristics that will produce them. So, he asks, what are our soils, what can they produce, and how can we manage them in the ways "most advantageous" for our own use? Agricultural chemistry provides one key.

Featherstonhaugh goes on to describe proper soil management more particularly. Some of his ideas are akin to those of Varlo and Eliot and stress the importance of plants receiving nutrients from materials dissolved in water, materials which, in turn, partially come from atmospheric deposition of previously vaporized organic matter. He defined "manure" as, essentially, "mixture," meaning that its main purpose was the mixing, and hence opening, of soil materials. He also provides a perceptive description of nutrient cycling, describing how soils build plants; plants, as food, build 'higher' organisms such as humans; and, finally, those nutrients are returned to the soil when we die and decay. However, the strand of Featherstonhaugh's work which we will pursue here is his call, essentially, for soil surveys – an agricultural resource still familiar to us today.

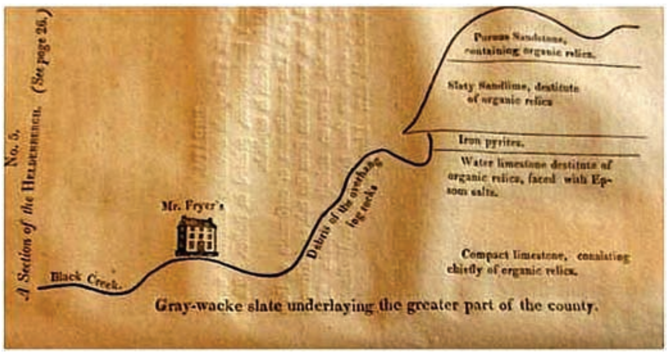


***Figure 26**. An illustration from Eaton and Beck's 1821 "geological survey" of Albany County, one of our region's first soil surveys. The authors sought to apply growing geological understanding to describing a region's agricultural potential.*

Conveniently, one of the first such surveys is in the same volume of the *Memoirs* (Fig. 26). Geology was one of the hot sciences of the early 1800s. People had realized that patterns existed in the composition of rocks; that they told stories; and that they were intimately related to soils and mineral resources, and hence to the human condition. Amos Eaton was both a geologist and a botanist, hence excellently situated to execute a soil survey focused, as Featherstonhaugh suggests, on the interaction of land and production. He was a Columbia County native, born in New Concord in 1776; he withstood various buffets including a life-time prison conviction (he was later pardoned) to become one of North America's leading geologists and botanists and one founder of RPI. He was teacher of many of the region's prominent naturalists. Amos Eaton and an Albany physician, T. Romeyn Beck, were commissioned by the Board of Agriculture to conduct a survey of the geology of Albany County.[52]

There can be no doubt that Eaton and Beck were conducting a soil survey. Their explicit methods detail their communications with various farmers in Albany County together with their collection and subsequent analysis of soil samples from various farms and attempts to correlate those results with agricultural behavior of the soils as reported by the resident farmers. In some ways they do a stunning and ground-breaking (no pun intended) job: together with a detailed description of the geological formations, they provide a classification of soil types and, based upon samples pooled from various farms within each type, a chemical analysis of each soil. They describe the sort of agricultural management that had worked best on each type of soil and try to provide links between the chemical characteristics of the soil types and their underlying geology. These are still essential components of modern soil surveys. What is notably lacking is any explicit connection between soil chemistry and soil management. In other words, the chemistry is tabulated by soil type, and management recommendations, apparently based largely on farmer input, are likewise presented for each type, but almost any attempt to link the two in a cause and effect way is absent. It is a bit as if the general, inherent importance of soil chemistry for agriculture were recognized, but nobody had quite figured out the nitty-gritty details of the connection.

As an example of their soil descriptions, one can quote their description of Albany County riverside soils, in which they remark, "The earthy part of this soil is not alone very favorable to vegetation, being chiefly a loose sand, but it is remarkably fertile, on account of the supply of vegetable matter derived from frequent inundations... when a field is much worn and exhausted, a deep ploughing ... seems to bring forward new stores of nutriment, which had been reserved below the proper action of heat and air."

To add a little more local flavor, we can also cite Horatio Spafford's description of Claverack soils from a bare three years later, "very extensive alluvial flats, frequently inundated and very fertile... The Claverack flats are proverbially rich, and nothing can exceed the abundant luxuriance of their products..." or, from his entry for Canaan, "The use of gypsum is nowhere more beneficial than on those lands [the Canaan hills], warm and sweet, wanting nothing but vegetable matter, duly converted into mold."

We can pause here to consider some common threads through these early soil descriptions. First, they speak of the innate fertility or richness of the soils. The previously-quoted soil description from *American Husbandry* is hardly specific, but, accurately or not, it heralds an inherent quality; likewise Eaton/Beck and Spafford describe nutrients arising from the land itself, albeit aided by certain natural and human additions. Eliot and Featherstonhaugh, while speaking more generally, present the view of soil as a nearly live entity deserving of nurturing. Second, correlated with this perspective, these authors bemoan soil exhaustion almost as a fall from grace – it reflects an anomalous condition connoting poor farming. This exhaustion can, in part, be ameliorated by tapping into natural sources of fertility, that is by fallows, by working floodplains, by plowing deeper so as to access new nutrients; and/or by restoring and preserving organic matter (or "mold"). That said, none of these writers was adverse to using soil amendments to make grounds more productive or restore their fertility.[53]

Applying the Science: Ebenezer Emmons Our next milestone is a much lengthier, if less focused, tome by hard-working Ebenezer Emmons. Born in western Massachusetts and a physician who trained at Williams College, Emmons had an early interest in geology and helped conduct a geological survey of Berkshire County. Pursuing his geological bent, he went to what was to become RPI, where he studied under Amos Eaton. As typifies many realms of ardent scientific pursuit, Emmons got into a bitter public debate with a colleague, in this case over the geological origin of the Taconic Mountains. He and James Hall, his 'opponent,' had both been working on the statewide geological survey, during which Emmons produced an important volume on Adirondack geology. As fallout from the row over the Taconics, Emmons was 'demoted' to head of the agricultural survey while Hall, the political winner (Emmons's scientific view was later found to be more valid), was named state paleontologist.

Emmons responded with a five-volume report on New York agriculture published between 1843 and 1851. Reflective of Emmons's wide-ranging interests, these volumes span the gamut from a survey of state soils (Fig. 27) to volumes on NY apples and insect pests; a long aside on Taconic geology is inserted for good measure. It is Emmons's statewide soil survey which will form the next link in our historical chain.[54]

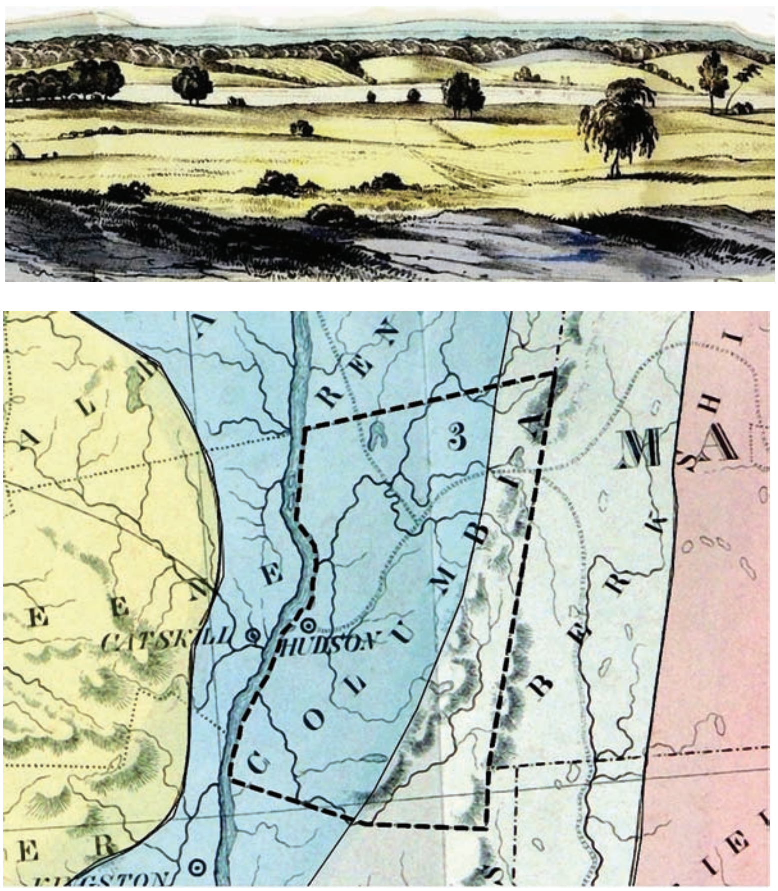


***Figure 27**. Two somewhat enhanced illustrations from Emmons' 1843 work on the agriculture of New York State. In both cases different colors indicate different agricultural regions and are reflective, at least in part, of differences in soil quality. Emmons explicitly applied new approaches to soil chemistry to an understanding of a landscape's agricultural suitability and the management that would enhance that understanding.*

For our purposes (this is our organizational structure, not his), Emmons's work can be said to possess three parts: a rationale, in which he lays out the logic of his approach; a data presentation, in which he provides the information he collected; and an application, in which he brings the first two parts together in order to provide practical recommendations for soil management.

In explaining his approach, Emmons explicitly links agriculture and chemistry. His writings are scattered with reference to Davy, Liebig and other researchers. He first echoes Featherstonhaugh by pointing out that different types of plants differ in their native soil preferences. There are, he says, "potash [i.e., potassium] plants and lime plants; that is some seem to require more potash, or lime, than others. This apparent selection of potash, or lime, is due … to the original constitution of the plant." Building on this, he summarizes his tack, "What agriculturists now aim at, and it is the most they can do, is to put within the reach of each plant all the nutritious elements its nature demands. These elements have been determined by analysis of the different parts of plants…" One volume of his work is nearly filled with the results of such analyses of various plants. He is explicitly making a link that Eaton and Beck only scratched. As a specific example of his application of chemistry to farming, he uses the example of wheat. "Every bushel of wheat contains a large amount of potash, and of the phosphates; and as plaster [i.e., gypsum, an amendment that was commonly applied by wheat growers] does not contain either, it is undeniable that the exhausting process is going on by this mode of cropping." There is a nutrient budget, he is saying: what goes out must come in if the soils are not to degrade over time. Also, as he makes clear a bit later, the nutrient composition of the crop will depend upon the chemical composition of the soil, a realm of management which is "only beginning to receive attention" (and, some might add, still not receiving due attention).[55]

Finally, he applies his approach to a definition of fertilizers, "The farmer is compelled to employ a class of bodies to restore to his land those elements which he has removed in his crops… the great reason why fertilizers are required, is in the consequence of the removal of the mature crops from the fields, and their consumption elsewhere. Anything is a fertilizer which can restore one or more of the removed plant-aliments to the soil." Notice how distinct this is from Eliot's and Featherstonhaugh's definition of manures as mixers of soils, and it lets Emmons evaluate various manures or fertilizers from the perspective of what chemicals they provide to the plants in comparison to what chemicals are in the crops themselves and in the soils. He provides a very specific example,

> *In the vicinity of New York, Albany…and other towns in New York and New England where milk is largely consumed, it is evident that…the lands must deteriorate in richness by the milk alone which is consumed. Every forty gallons of milk contain one pound of phosphate. In the average yield of milk for one cow, per annum, there will be carried off phosphates which are equivalent to thirty pounds of bone dust. There is still to be reckoned the consumption of other matters…about fifty six pounds of bone dust [per cow per year] in all….Pasture lands, therefore, which are fed for many years, will show the losses they have sustained by the appearance of poorer kinds of grasses, moss, loss of vegetation in many places. That bone dust, or the phosphates, applied in some form or other, will restore greenness and fertility, need not be doubted….There will be economy in this procedure…as the feed deteriorates, so will the milk, and hence, milk which is produced by well fed thriving cows yields a greater profit in butter and cheese.*[56]

This excerpt illustrates an essentially modern conceptualization of the role and value of fertilizers, be they organic or synthetic.

The soil survey portion of Emmons's reports, which actually precedes the rationale presented above, does, as one might expect, more explicitly link soil chemistry and agricultural management than Eaton and Beck's survey. Being statewide, it is more general than their work, but our region is encompassed within Emmons' "Taconic District," one that, given his time at Williams and RPI and the previously mentioned scientific debate, probably held special significance for him. He presents soil chemical analyses for a variety of soils within the district (see Table 1, p. 193), including samples from Chatham, State-line, and Schodack. From these analyses, he draws some conclusions on "the means of improving the soils of the Taconic District," specifically noting the dearth of lime, phosphate, and potash. As remediation, he recommends the application of, in addition to animal manure, lime, peat, and ashes; preferably in composted forms. These are not random suggestions: Emmons had information on the chemical constituents of each of the additives he recommended, and he was trying to match soil deficits with the restorative powers of particular amendments.

Emmons, while heralding chemistry as a provider of important insights, does not claim that it alone explains the world. Preceding his section on fertilizers is one on "Force." "Vital force" is, he explains, "something which we are obliged to admit, though we know nothing of it, except from its effects." And yet, unlike Featherstonhaugh or Eliot, he does not resort to metaphysical or religious explanations. The eight pages he devotes to force are largely occupied by reports on the experiments of others who were exploring the organizing principles of life.

Despite or perhaps because of the wide-ranging nature of Emmons's work, it is difficult to find a representative description of our own soils. The following is derived from his summary of the Taconic District soils, "The best materials for increasing the quantity of manures of this district, are lime and peat, of each of which there is an abundance. These materials are both wanted on every farm, without exception: it is proved by the analysis of every variety of soil in the district... Generally, the basis for improvement in the Taconic district is excellent, there being sufficient tenacity in the Soil to hold manure."

Emmons's words may be used to highlight a changing perspective. Perhaps most notable is the analysis-based description of soil qualities. Note too that the talk is more of improvement rather than restoration of natural fertility; one begins to feel that soil scientists are moving towards a vision of soil as a tank to be regularly re-filled, rather than a living substance to be nurtured. Emmons's work in 1843 speaks less of innate richness, preferring to delve into its chemical definition.

Like earlier and later authors, Emmons does recommend soil additives, but he is somewhat old school in his focus on locally-derived fertilizers or manures. In part, this probably reflected the relative lack of alternatives, and yet he mentions guano (bird droppings collected largely from islands off the Chilean and Peruvian coasts; guano was to become hugely popular) and "Liebig's patent manure." However, one focus of the *Natural History of New York* series (of which Emmons's agricultural survey was a part) was the State's resources. There is emphasis throughout on what can be attained locally or at least from the state itself, as opposed to purchased elsewhere like guano.

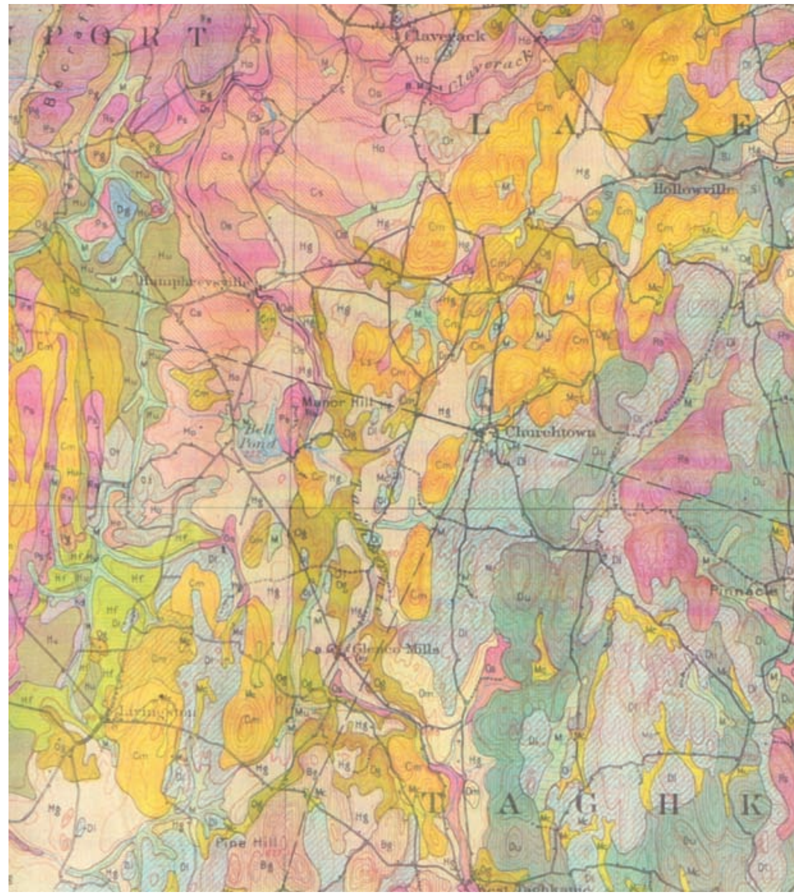


Figure 28. A colorful map of soil types from the 1929 soil survey of Columbia County. The soil mapping was detailed but much of the (naïve?) enthusiasm of soil science's earlier years seemed to be gone.

Charting the Soils About 80 years after Emmons, in 1929, the first official soil survey of Columbia County was published, co-authored by H.G. Lewis of the USDA and D.F. Kinsman of the New York State College of Agriculture (that is, the state portion of Cornell). It is, perhaps, more interesting for what it is not rather than what it is. True, it presents a level of detail unseen in earlier works. The multicolored maps (Fig. 28) with soil types carefully outlined would likely have been the envy of earlier scientists, but, given adequate resources and technology, not necessarily outside of their abilities. Its tables of temperature and agricultural statistics are apparently precise, but, again, not outside of what Emmons, if not Eaton, could have and sometimes did compile. Its soil classification scheme, based on nationally accepted standards, and breaking the County up into 21 soil series, embracing 36 soil types, 7 phases, and 6 sorts of "miscellaneous materials," implied impressive classification skills but not necessarily new understanding.[57]

Most of the specific agricultural remarks are observational and even less detailed than those of Eaton. The summary of the agricultural landscape primarily notes that there are forests on the hills, that "crop rotation is commonly practiced by the better farmers... the use of lime is increasing,… the value of organic matter in the soil is realized,... there is a general recognition of the adaptation of soils to crops… in the hill section some farms have been abandoned because of unfavorable soil and climate and the remoteness from markets." There is little additional discussion of soil chemistry or its relation to production. That the "better farmers" are practicing rotation reads almost like one of Eaton's or even Coventry's hopeful comments, and echoes even earlier recommendations. Read in the 20th century, it echoes with hints of stagnation, further emphasized by the concluding remarks on farmland abandonment.

An example of their description of a local soil is dry and to the point, "The surface of Hudson silty clay loam, to an average depth of 8 inches, is light-brown or yellowish-brown smooth silty clay loam... The upper part of the subsoil, to a depth varying from 12 to 15 inches is typically slightly mottled yellow, gray, and rust-brown silty clay loam... The surface soil is acid or very acid, and lime is not present above a depth varying from 3 to 5 feet....The relief is favorable to intensive cultivation...it is rather hard to be managed under cultivation as it cannot be plowed when too wet or too dry....The surface soil is poor in organic matter and lime."

Talk of innate fertility is largely gone, although physical description of texture and color is much more extensive. Correspondingly, there is consideration of the physical practicality of farming such soils. Chemical results are mentioned, but almost in passing.

This survey might have pleased Emmons and earlier authors to some extent – the authors' affiliations with national and state institutions of agriculture represented realizations of long-standing dreams among agronomists – but they might also have been disappointed. Gone is the fresh fervor that one might alternatively call conceit or enthusiasm and that typifies a vibrant science. These are diligent authors, but not necessarily pioneering ones. Unlike the preceding authors, a quick web search for the authors' names produces no ready scientific biography. There are data in the Survey but there is little cutting of new ground. Surely a farmer looking for land or a government official assessing County resources would have found this survey a useful tool, but one guesses that Emmons and colleagues would have hoped that 75-150 years of study would have produced more insight.

It is unfair to fault Lewis and Kinsman for lack of insight; that wasn't their job. They were following a standardized model that produced an admirable set of surveys during this period. Furthermore, the humbleness of these surveys did perhaps reflect insights, but ones of correction rather than linear progress. Soil scientists had realized, for example, that soil chemistry was not as simple as Emmons and his generation had hoped for. As a nearly contemporary textbook, authored by a Cornell professor, points out in its critique of soil testing, "no phase of soil science has received as much popular recognition as chemical analysis, nor is any other technical soil procedure so little understood in general and at the same time so greatly overrated."[58]

This was an important realization, namely, while chemical analysis might reveal the soil's total content of various nutrients, it could not so easily reveal what was actually available to the plant. In other words, one might count all the money in a bank's vaults without learning anything about how much of it might actually be available to that next customer who walked in the door. For much of the 20th century, soil chemistry, as a way of understanding soil function (as opposed to a way of applying fertilizer), would be stuck in this doldrum. A sense of disappointment during this period is understandable: the enthusiasm of the soil improvers had not borne fruit in at least two ways: their improvements had not saved regional agriculture – farming in the Hudson Valley was now clearly declining in prominence (not that this was due to declining soil fertility), and its scientific method had not provided an all-seeing, practical explanation of soil's hidden world.

Soil as a Nonrenewable Resource The juxtaposition of the Great Depression and the Dust Bowl brought home graphically the connection between the well-being of soil and of society, even if the two events weren't intimately linked. Taken together, they urged a new view of both our social and ecological relationship with the land and resulted in a government-backed movement towards so-called "permanent agriculture," similar to what we today call "sustainable agriculture" and what may have earlier lurked in the term "systematic agriculture." Figures like Hugh Bennett and William Lowdermilk played key roles raising public awareness, and their names, as head administrators of the then-novel USDA Soil Conservation Service, top the banner of the 1935 Reconnaissance Erosion Survey map of New York (Fig. 29). This was complemented, in 1936, by a Cornell Extension Bulletin entitled, *Soil Erosion in New York*, written by the director of the New York erosion survey and a colleague.[59]

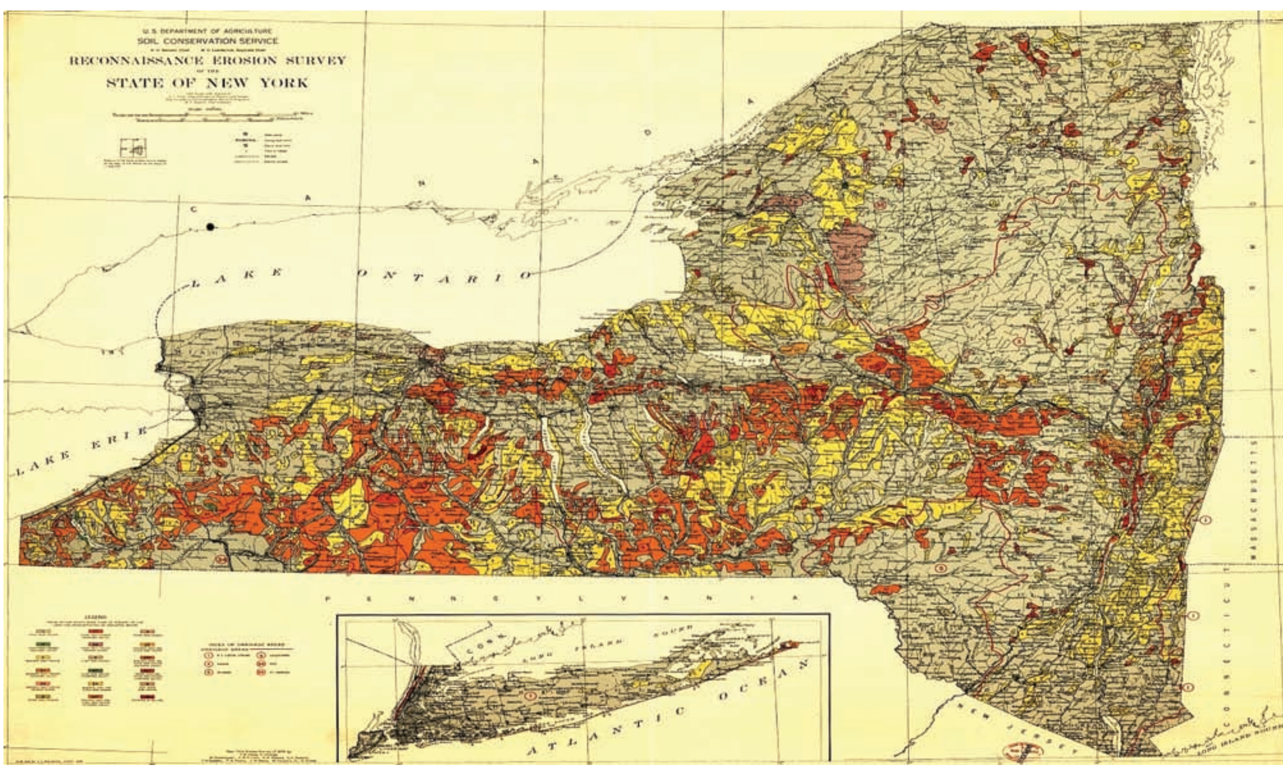


Figure 29. The 1935 Reconnaissance Erosion Survey map of New York State. The Dust Bowl created a new emphasis on soil health, this time in terms of its erodability. For source, see Note 59.

The map, the Columbia County portion of which is portrayed in Fig. 30, classifies soils based upon the kind and degree of erosion that has affected them. It is, essentially, a historical description. Technically, such a map could have been made a century or two before; rather than reflecting a

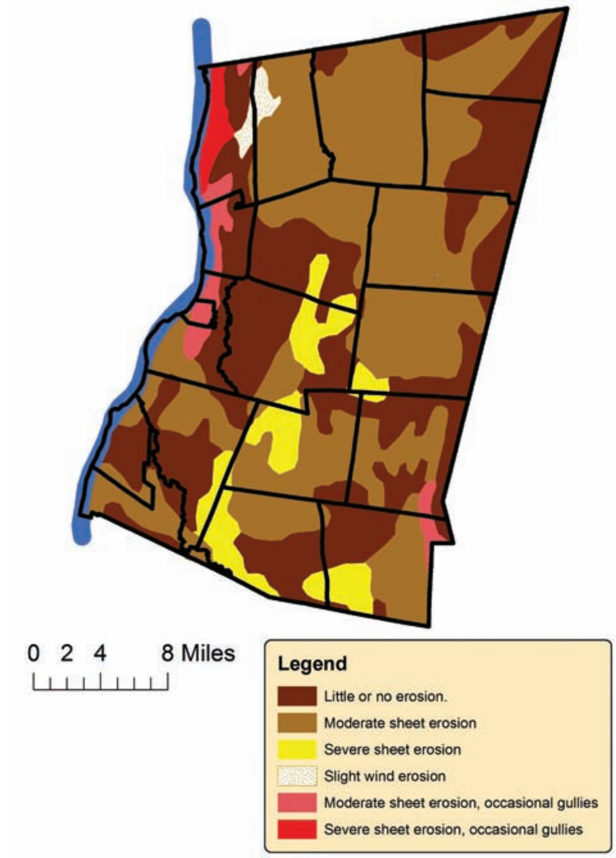


***Figure 30**. A modern representation of the Columbia County data shown in the 1935 Reconnaissance Soil Survey map (i.e., Fig. 29).*

scientific re-envisioning of the soil, it reflected a cultural re-conception of the soil as a resource that was, literally, washing (or blowing) away. Such a view of soils did not disregard soil nutrients, but it altered emphasis, changing the main threat to soils from nutrient drain via harvest without replacement, to physical nutrient drain. As the report put it, "the principal effect of sheet erosion is the removal of topsoil from cultivated fields… topsoil is the most fertile and productive part of the soil." We again find echoes of a 'fall from grace'; as the authors wrote, "Under the natural forest or grassland conditions which the white man found in this country, a very limited amount of erosion occurred, for the process of soil formation had gone on as rapidly as the erosion, so that a good topsoil was maintained. But the white man's method of handling the land has so changed that it now takes but a few years to lose soil which required thousands of years for its formation." One glimpses again some of the earnest conviction of new understanding that one could taste in the work of Emmons, Eaton and their contemporaries.

As a commentary on the natural history of our soils, the county erosion map highlights the northwest part of the County as being the most affected by erosion, with relatively severe erosion occurring on the clayey and sandy soils in that region. The bluffs above the Hudson are both steep and relatively rockless, leaving them particularly prone to erosion once forest cover is removed. The sandy soils north of the Village of Kinderhook are highlighted as the only place in the County even slightly affected by wind erosion. As the report points out for New York State as a whole, while erosion was an important issue, we were, relative to some areas farther west, doing well. In our County, more than a third of the surface had little or no erosion, moderate erosion was experienced by 50% of the County, and only 12% (still more than 40,000 acres) showed signs of more severe loss. In contrast, the report describes Oklahoma where at least three quarters of the land had experienced severe erosion.

The report's view of soil fertility is perhaps opportune: while alluding to the nutrients held by the soil, the focus, as in the 1929 soil survey, is not on the chemical intricacies; instead it's on the physical aspects of the soil: it doesn't matter what's in your lunch box if your lunch box just washed downstream, and so controlling the effects of those wash waters just became the primary focus. For a variety of reasons, including changes in climate, politics, and farm management, the focus on erosion subsequently ebbed. It did, however, remain an ingredient of later soil evaluations. A look at our muddied, post-rain streams emphasizes that the alarming prospect of soil draining away is still with us.

Soils of the Late 20th Century In 1989, the USDA published its second soil survey of Columbia County (the data have since been translated into a web application). With 266 pages and 27 map sheets (Fig. 31), it is a much more detailed document than what had been published 60 years previously. Each of its more than 100 identified soil units is described in terms of depth, color, texture, chemical properties and current use. Soil distribution is detailed by graphic overlays on aerial photographs. The extent of the fieldwork is impressive, and analyses and descriptions reflect new understandings of how soil is formed and behaves. For example, the idea of the soil 'pedon' as a unit of soil composed of various layers or horizons formed by the effects of weathering, biology and parent material results in a more systematic description of soil than in any of the previous works we have mentioned.[60]

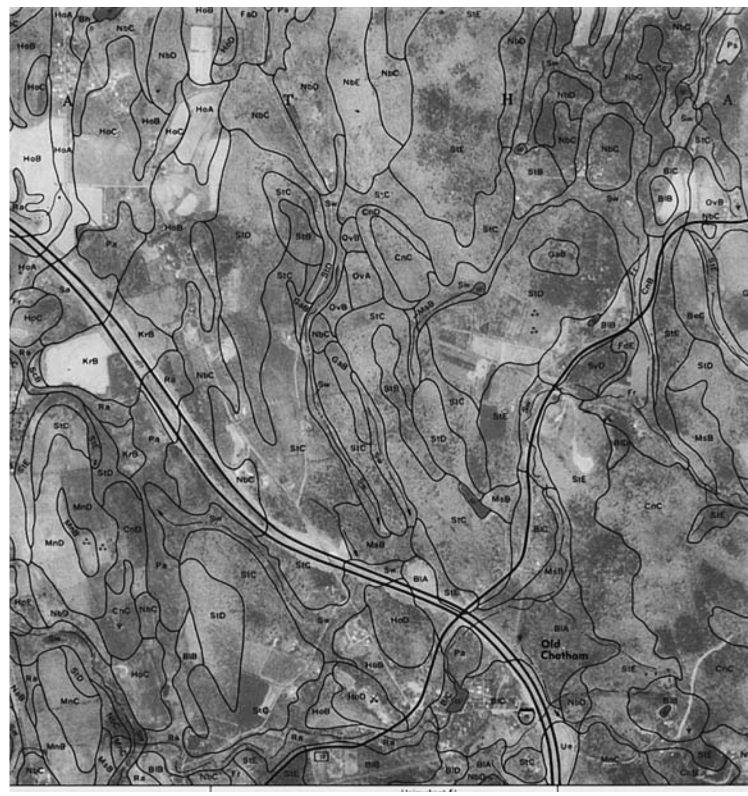


***Figure 31**. An aerial photograph/map from the 1989 USDA soil survey of Columbia County. A new soil classification and very detailed information on soil structure and composition were provided. Numerous uses, aside from agriculture, were also considered.*

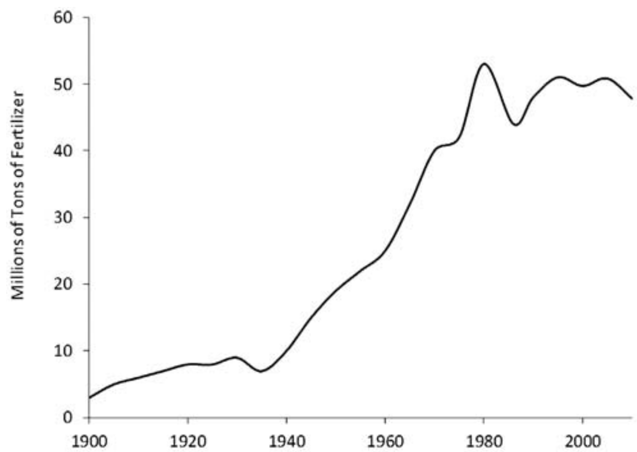
As the previous survey hinted might happen, this is only partially an agricultural document: aside from noting suitability for farming, the survey describes the derivation of building materials such as gravel, and the suitability of the land for house foundations, septic tanks, civil engineering, forestry, and recreation. Some of the document's perspective on agricultural soils might be illustrated by its standardized definition (these same words are found in various USDA soil surveys of the period) of prime farm soils: "Prime farmland produces the highest yields and requires minimal amounts of energy and economic resources, and farming it results in the least damage to the environment….

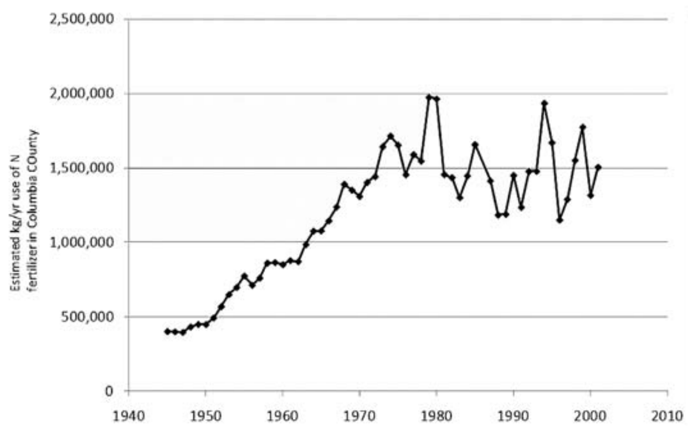
The general criteria for prime farmland are as follows: a generally adequate supply of moisture from precipitation or irrigation, favorable temperature and growing season length, acceptable levels of acidity or alkalinity, few or no rocks, and permeability to air and water." Conspicuously absent is mention of innate fertility.

The survey's section on "Use and Management of Soils" was written with the help of several regional specialists, including Jim Calhoun, the long-time county representative of the USDA. It contains the following sections in the following order: "Erosion"; "Drainage"; "Surface Stones, Boulders and Outcrops of Bedrock"; "Available Water Capacity"; "Soil Tilth"; "Fertility"; and "Special Crops." Erosion, reflecting its aforementioned rise to prominence, gets the pole position; it is interesting to note how far back fertility is positioned. Under "Fertility," the following description is provided:

> *Fertility in the county is enhanced by lime and fertilizer....Nitrogen fertilizer is needed to supplement the nitrogen from organic matter in the soil. Management that builds up the supply of organic matter, such as the use of green-manure crops, sod crops, and crop residue, improves the natural nitrogen content....The soils in Columbia County are generally low in natural phosphorous....The addition of appropriate amounts of phosphate in the form of commercial fertilizer is essential for good plant growth... Most of the soils have a low to medium level of available phosphorus potassium... Even soils that have a fairly high content of potassium, however, require additional potassium for optimum yields of most crops. Lime is needed in most of the soils in the survey area to raise the pH to an acceptable level for optimum yields of most crops. Additions of lime and fertilizer should be based on soil tests.*

Comparison with our earlier milestones suggests that something has happened to fertility – it has become an added ingredient. While earlier works bemoaned loss of innate fertility, by 1989 such loss is almost a given. Drainage, texture, and control of erosion establish your matrix, the nutrition of which can then be managed through inputs to produce the "optimum yields." This is a reasonable perspective for the survey to take. Synthetic fertilizer application had become widespread (Figs. 32, 33 and 34) and had been accompanied by at least short-term leaps in production. As a consequence, the list of which soil characteristics were most important to the farmer changed. Nutrients could be applied, but rocky or sticky soil, standing water, erosion, or similar physical conditions might be more difficult to overcome, and hence became the primary determinants of soil suitability. Soil chemistry has come of age as a source of new ingredients with which to create fertility. In somewhat the same way that cheap land and dear labor had made intensive care of soil fertility economically nonsensical for 17th century farmers, the relative cheapness of synthetic nutrients relative to labor and land in the 20th century was leading most farmers to depend upon such fertilizers rather than upon rotations, cover cropping or other more work- or space-intensive ways of maintaining soil fertility.[61]





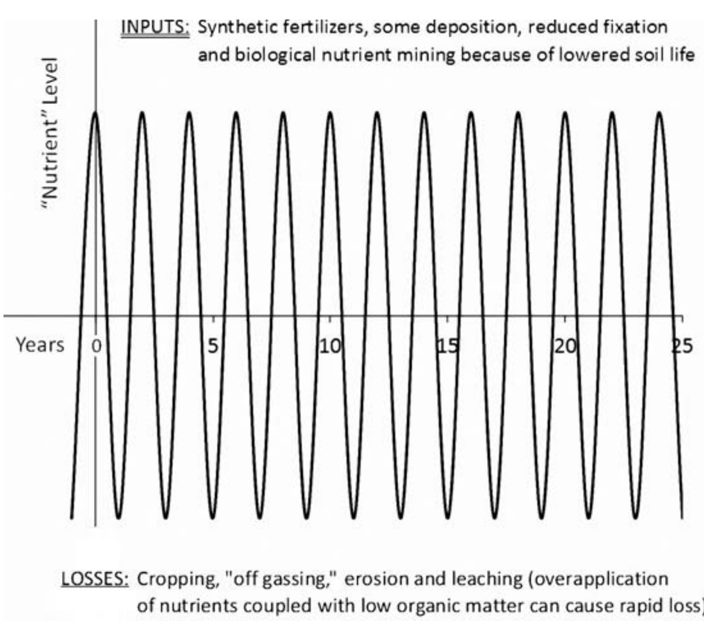


Figure 32 (top). *Total national fertilizer application as tons of fertilizer applied (more recently, these statistics have been presented in terms of tons of nutrients [i.e., active ingredients] supplied). This figure is based upon older data plus a few years of modern data which has been converted back to approximate total tonnage. This is a graph derived from eyeballing graphs for which no numeric data were found and making estimations such as the one just mentioned. It is therefore approximate. One theme of recent evolution in the perception of soils has been its conceptualization as a largely inert matrix whose fertility gets maintained by regular fertilizer applications. This approach has coincided with marked increases in farm output, but also with huge petrochemical use and financial investments. The long-term sustainability of this approach is unclear.* Data are from American Agriculture in the Twentieth Century (2006) by Gardner, and the USDA's Agricultural Resources and Environmental Indicators, 2012 Edition (2012) by Osteen and colleagues, www.ers.usda.gov/media/874175/eib98.pdf.

Figure 33 (middle). *Estimated nitrogen fertilizer use in Columbia County during the past 70 years. From 1945 to 1980 fertilizer use quadrupled.* Data from the USGS 1990 report County-Level Estimates of Nitrogen and Phosphorus Fertilizer Use in the United States, 1945 to 1985 by Alexander and Smith, pubs.usgs.gov/of/1990/ofr90130/report.html.

Figure 34 (bottom). *A hypothetical sketch diagram illustrating the hypothetical course of generalized nutrient dynamics under stereotypical conventional agriculture. High harvests are maintained by annual infusions of fertilizer which are removed by harvest, leaching, and other losses.*

Inputs themselves are not new, as our earlier descriptions illustrate. What is new are the elemental, synthetic fertilizers. Animal and green manures are not irrelevant, but they are secondary. There is no hint that local or on-farm nutrients might be preferable to distant imports – advances in transportation and cheap fossil fuels meant that proximity of source was no longer a consideration.

Finally, in re-reading our historical series of soil descriptions, one might say that soil's conceptualization has lost some of its living quality. To be honest, one can find passing references to microorganisms and other soil life in the 1989 report, but soils are no longer "warm and sweet" or even "rich"; it is almost as if soil has become the "dead inactive body" that Varlo warned against.

The 21st Century: Holistic Soil Health Life is returning to our descriptions of soils. There is growing awareness amongst students of soils that soil life is an important ingredient of a healthy soil. An awareness perhaps spurred on by the realization that an energy-efficient approach to soil fertility maintenance might require a more collaborative relationship with the soil's natural ecology. The Cornell textbook that was quoted earlier was already remarking on soil life's importance in determining which soil nutrients a plant was actually able to obtain. Since the 1989 survey, no new soil surveys of the County have been done, but new analytical tools reflecting a renewed respect for soil life have become available.[62]

For example, the Cornell Soil Health Test profiles soils according to a variety of descriptors in addition to physical and chemical attributes (Fig. 35). It has added biological parameters such as nitrogen mineralization rates, soil respiration, and aggregate stability (a physical condition largely reflecting the relative presence of biological glues), which are meant to indicate the functionality of important biological processes. A description of soil nematode communities was found to be a valuable indicator of overall soil condition, but was left out because of its high cost. Tests available from other laboratories estimate bacterial and fungal densities. As the Cornell working group notes in its manual, "Over the years the concepts and understanding of the importance of the soils' physical and chemical properties have been well accepted. However, it has not been until recently that the importance of understanding soil biology and biological properties has become a focus." In defining their moniker, the manual that accompanies the new Cornell tests describes "Soil Health" by equating it with soil quality and then quoting a definition of the latter as, "the capacity of a soil to function, within ecosystem and land use boundaries, to sustain productivity, maintain environmental quality, and promote plant and animal health."[63]

This is heady stuff. In both its enthusiastic tone and its return to crediting soil with a certain vitality worth nurturing, it reminds one of some of our earlier soil treatises. We are perhaps also where Featherstonhaugh, Eaton and Emmons were in another way too: just as they grasped the importance of soil chemistry but were unsure of exactly how it converted to soil fertility, we now realize soil

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

Name of Farmer: Chazy Plots	Sample ID: E147
Location:	Agent: Bob Schindelbeck, Cornell University
Field/Treatment: CH 14	Agent's Email: 0
Tillage: 7-9 INCHES	Given Soil Texture: SILTY
Crops Grown: COG/COG/COG	Date Sampled: 4/25/2007

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	22	25	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.18	63	
	Surface Hardness (psi)	107	78	
	Subsurface Hardness (psi)	400	13	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	2.1	14	energy storage, C sequestration, water retention
	Active Carbon (ppm) [Permanganate Oxidizable]	462	21	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	2.0	0	N Supply Capacity
	Root Health Rating (1-9)	2.3	88	
CHEMICAL	*pH	8.3	0	Toxicity, Nutrient Availability (for crop specific guide, see CNAL report)
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	9.5	100	
	*Extractable Potassium (ppm)	20	11	Plant K Availability
	*Minor Elements		56	
	OVERALL QUALITY SCORE (OUT OF 100):		39.1	Very Low

Measured Soil Textural Class:==> silt loam
SAND (%): 17.0 *SILT (%): 77.0* *CLAY (%): 6.0*

Location (GPS): Latitude=> 0 Longitude=> 0

Figure 35*. A sample Cornell Soil Health Report. Aside from the relatively standard chemical measures, these soil assessments add biological and physical measures with the hope of providing a more holistic understanding of the soil's status and potential.*

biology's importance, can even describe some of its actors, but we still struggle to make links to soil function. With notable exception (e.g., mycorrhyzal fungi), we cannot yet describe soil microbe, protozoan and fungal communities in ways that provide direct predictions of resultant soil quality, be that for natural or cultivated vegetation. Perhaps, although the memory of Emmons's foiled optimism provides a shade of caution, we will be able to develop a biological understanding that converts our working conception of soils from one of an inert physical matrix through which we pump nutrients on their way to becoming food, into one that sees soil as a living collaborator to be nurtured as we seek to derive from it the nutrients we need for our own life. Can we, in effect, recognize soil as a habitat for both its own pool of organisms and for us?

Conclusions If one were to reach down and collect a handful of soil, it might in some ways bear the physical and biological impressions of the history that we have outlined in this chapter. Perhaps, it might have once experienced the slow, pulsed removal and return of nutrients as indigenous agriculture, with its relatively short croppings interspersed by long fallows, worked the surface. Finding the soil cleared or in young forest, early Dutch colonists may have also worked the land, perhaps surprised by its initial fertility, but perhaps also driving its nutrients downward before moving on to new ground. A New England settler, having already learnt about soil exhaustion the hard way, may, through rotation and careful manuring, have rebuilt the soil's nutrients and life at least enough to make a good subsistence living. Over the next 150 years, the soil may have felt a more intensive use – higher harvests may have been requested of it, and, in keeping with the increasing commercialization and specialization of agriculture, the variety of crops that it grew may have become more limited. And yet it also got new help: leguminous crops, with their ability to restore nitrogen may have been more frequently planted; lime or gypsum may have ameliorated its acidity; novel, more concentrated fertilizers such as bird guano may have been spread atop it. Finally, about 60 years ago, the soil would have begun to be turned by heavier, faster machines, perhaps resulting in more regular and deeper upheavals, and its annual pulse of nutrient content would have become much more dramatic as larger crops removed more nutrients, but synthetic fertilizers meant quicker, more concentrated replenishment of plant-accessible nutrients (although not necessarily in ways that built the soil's own reservoirs of life and nourishment). The soil in your hands, once relatively moist and crumbly like a fresh muffin, may have become more apt to be dry and powdery, absent the biological glue that would provide structure and sponginess.

What will happen next is unclear. We now attribute renewed value to lively soils and are searching for better ways to produce crops without heavy juicing from synthetic fertilizers, but it is not clear how this learning will be applied on the vast majority of our agricultural lands. In the short term, at least, pumping nutrients through a soil matrix might be the cheapest, easiest way to produce the most food, a consideration which in no way should be belittled. Some would argue, however, that such cheapness will not long remain, and that it might behoove us to treat that clump of life in our palm a bit more respectfully as we envision collaborating with it a bit more actively. The next section describes some of the life that such collaboration would consider.

Natural History Profiles: Ground Beetles

What more aptly-named duo than ground beetles and earthworms to provide a natural history link to all the human history discussed above? These two groups of organisms have contrasting levels of interaction with the soil. While earthworms live embedded in the soil and consume it, ground beetles spend more time, at least as adults, scuttering across the top of the ground and are not known to ingest the soil itself. Yet, both groups are closely tied to the soil upon which they live and so are appropriate to discuss here.

Ground beetles (the beetle family Carabidae) are, in some ways, like birds of prey. They don't drop like lightning bolts on rabbits, nest in the tops of gothic trees, or get mobbed by crows, but they are, in their invertebrate world at least, a set of diverse predators. As with birds of prey, some are active, daytime visual predators, others primarily stalk the night; some cue in on the movements of live prey, others seem satisfied to scavenge; some are large-bodied and able to tackle relatively large prey, others rely on small size which lets them seek tiny prey in their homes; some are prepared to battle with their meals, others 'pick the locks' of snails.[64]

In other words, our ground beetles are, for the most part, a set of predators whose differing behaviors and morphologies reflect in large part the adaptations that enable them to capture their prey of choice.

Pursuing the raptor analogy further, one might say that, while hawks circle in the air or perch on lookouts, sometimes picking off other birds on the wing, sometimes diving into forest, field or shrubbery (and often having morphologies adopted to these different covers); ground beetles live at the interface of air and soil, sometimes capturing their prey off the surface, sometimes pursuing it into nooks and crannies among rocks, pebbles and soil particles. Their morphologies and hunting techniques reflect the evolutionary paths they have taken.

Our description of select ground beetles will focus on these predatory adaptations of the adults, but, of course, ground beetles have been shaped by other needs as well such as larval ecologies, temperature, and water tolerances, etc. Finally, evolutionary or adaptive stories are just that – stories. Because an organism's evolution is shaped not only by its habitat but also by its inherent limitations and by the whimsy of historical happenstance, and because we cannot conduct experiments in evolutionary time, sketches of adaptive scenarios are exercises of imagination as much as historical research. That said, if we can engage our imagination in the lives of the creatures around us, we have taken an important step in creating the compassion upon which their long-term survival may depend. The paragraphs below introduce you to the appearances and behaviors of some of our local ground beetles.

In some ways, *Harpalus rufipes*, which we'll call the **Fuzzy Tillage Beetle**, is a prototypical ground beetle (Fig. 36; there are no standardized common names for most ground beetles, so, for our purposes, we've made up some descriptive ones). Blackish and about ½" long, it abounds in the tilled soils of some of our farms. During our study of 19 farms around the County, we found it on at least nine. The vast majority of the time, it was encountered in the ploughed ground of the farm fields themselves. In some cases, they were so abundant that flipping dirt clods regularly revealed them. In a few cases, they were found in adjacent woodlands, and this species was captured once during our study of floodplain forests. However, that capture occurred when we scoured one of our floodplain sites after a major flood – the receding floodwaters seem to have left the floodplain littered with displaced beetles up trees and huddled under debris. It can overwinter in fields as an adult, but repeated ploughing can impact its populations.

The Fuzzy Tillage Beetle has at least two other traits illustrative of certain aspects of ground beetle ecology. As its preference for tillage might suggest, it is not actually a native beetle. It is a Palearctic import who appeared in the Canadian Maritimes during the first half of the 20th century, and has since expanded its distribution. In Columbia County, at least, it seems to have spread far and wide: among other sites, we found it up in the hills of New Lebanon, down in Ancram, and in Kinderhook. Of the roughly 200 ground beetle species we have so far recorded from the County, about 7% are non-native. These are primarily species of open ground, who seem to be favored by ground-clearing human activity. This species also illustrates the 'nuanced' relationship of ground beetles and agriculture: its diet reportedly includes such items as strawberries and caterpillars. A grower might welcome the latter propensity while cursing the former. Several other ground beetles show such a mixed diet, although the majority of ground beetle species are predators and, as a group, they have generally been placed in the 'beneficial' category.

Figure 36. Harpalus rufipes, *or the Fuzzy Tillage Beetle, is a relatively large ground beetle with a yellow-gold fuzz over most of its body. This common beetle of agricultural fields was introduced from Europe.*

Another introduction, the **Big-eyed Beach Beetle** (*Asaphidion curtum*), seems to be a more recent arrival or a slower disperser (Fig. 37). Unlike the Fuzzy Tillage Beetle, we never found this species in farm fields, instead it was limited to floodplain forests where it seemed to favor areas relatively close to the water. Bob Davidson, who helped us with so many of our early beetle identifications, was surprised to find it amongst our samples and hailed those as the species' first records from upriver in the Hudson. We found it at three of our floodplain forest sites, all located within the Kinderhook Creek watershed, suggesting that its colonization in the County may so far be limited to those waters.

The Big-eyed Beach Beetle is about 1/3rd the length of the Fuzzy Tillage Beetle, and, relatively speaking, has a runner's build. While the Fuzzy Tillage Beetle has to haul its hulk close to the ground, this species has long spindly legs that give it high clearance and fast running ability. Coupled with its big eyes, which seem typical of diurnal (day-time active) predatory ground beetles, the long legs suggest that it chases surface active prey in somewhat the same way as the Tiger Beetles. Its diet reportedly includes mites and springtails, capture of the latter at least requiring a quick pounce. Sharing the Big-eyed Beach Beetle's penchant for springtails, although perhaps with a different knack for their capture, is the **Bristly Rover**, *Loricera pilicornis* (Fig. 38). This beetle is a native of Europe and Asia; however, unlike the previous two species, it is also native here – it is one of the relatively few ground beetles with a Holarctic distribution meaning that they managed to spread themselves around the northern hemisphere apparently without human help. Its form is perhaps more similar to

__Figure 37__. Asaphidion curtum*, or the Big-eyed Beach Beetle, is small-bodied but big-eyed. It is an introduced species whose most northerly and westerly locations in the US are Kinderhook Creek floodplain forests.*

*__Figure 38__. The Bristly Rover (*Loricera pilicornis*) is a medium to small ground beetle equipped with a hairy chin and hairy antennae, both of which seem to be tools for catching the springtails it preys upon.*

that of the Tillage Beetle than the Beach Beetle, yet it has a lighter build, relatively longer legs and, correspondingly, is also described as an accomplished runner.

Its face is unique among the ground beetles for its collection of bristles (or, more properly speaking, setae) on the basal sections of the antennae and underneath its chin. Work in Europe has suggested that these operate somewhat analogously to the trigger hairs on Venus Flytrap, when the setae encounter a springtail, they trigger the mandibles to close and antennae to move together, boxing in the potential prey. The eyes of the Bristly Rover are prominent, but, proportionally at least, not as encompassing as those of the Beach Beetle; it is said to hunt both day and night. We found this species at a trio of floodplain sites, including tidal mudflats along the mainstem of the Hudson.

There are several species of **Bombardier Beetles** (genus *Brachinus*), but we'll treat them here as a group because of their superficial similarities and the fact that our knowledge of them is little more than superficial in any case. These are trim black and red beetles (Fig. 39). As their frames and long-legs suggest, they are generally fast runners. They are found mainly along rocky stream shores; we found them at the majority of our floodplain study sites.

Bombardier Beetles have developed the ground beetle's general art of chemical defense to a particularly pungent extreme. If you handle ground beetles regularly, you'll soon smell evidence of their chemical self-defense system – many species exude noxious chemicals that might either repulse potential predators or, at the least, render the beetles themselves a foul mouthful to be quickly spat out. Bombardier Beetles, as their name implies, are able to focus and direct their chemical armaments.

Apparently, they carry two chemicals together in a chamber in their abdomens; when alarmed, these chemicals are squirted into an adjacent chamber that holds an enzyme. When united with the enzyme in this internal 'reaction chamber,' the concoction begins to boil. Using an aimable nozzle, the beetles can squirt the scalding liquid from their rears with quite precise aim. It has been suggested that, in the style of many other distasteful insects, the relatively (for a ground beetle) bright colors of the Bombardier Beetle are a warning to potential predators.[66]

***Figure 39**. Bombardier beetles, such as this* Brachinus janthinipennis*, pack a powerful chemical wallop that may deter predators.*

Some Bombardier Beetle species have poorly developed wings and can't fly, while others have better wings and are flighted. Evidently, the benefits of dispersal or escape via flight don't always outweigh the direct or indirect costs of developing and maintaining wings. In other groups of ground beetles, the variation seen amongst Bombardier Beetle species is sometimes found amongst individuals of a single species. For example, for at least one European ground beetle, it has been found that long-established populations occupying mature, relatively stable forests tend to have few if any flight-capable individuals, while populations in young forests and regularly disturbed areas have many such individuals. The implication is that new populations are founded by winged individuals, but that the prevalence of flight capability is progressively lost as such populations become more established. Presumably, some individuals fly off into the great beyond during each generation, and a few of these become the dominant founding stock in newly-available habitats.[67]

We don't know much about the largely subterranean lives of ground beetle larvae, but what we do know is intriguing. The larvae of Bombardier Beetles, for example, are parasites, feeding off the beach-dwelling larvae of various aquatic beetles and certain other beach-dwelling ground beetles.

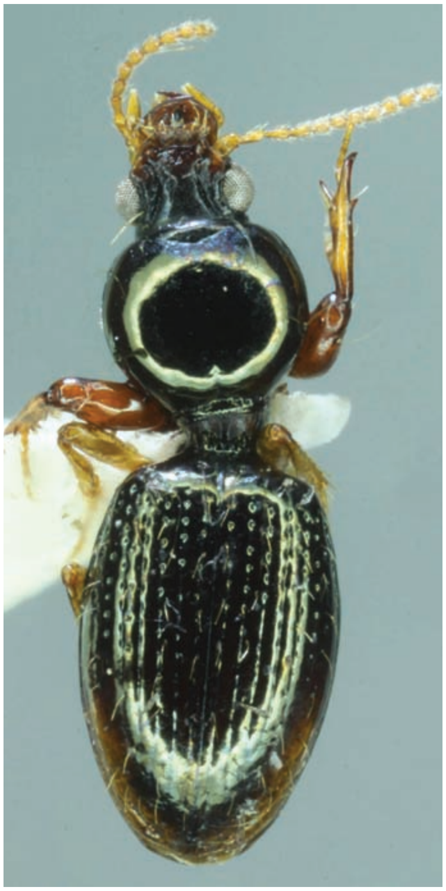
The Long-necked Field Beetle, *Colliurus pensylvanica*, doesn't even look like a ground beetle (Fig. 40). Its red back is more colorful than most other beetles in this family, and it looks as if somebody pinched it behind the head and stretched its neck (actually, not a neck at all, but rather its thorax, to which a pair of legs are attached) nearly to the snapping point. Although small (about ¼" long), it is unmistakable. It is one of the few ground beetles that one regularly finds out and about during the daytime, clambering over grass blades, exploring an ant nest, and the like. It has been suggested that its elongate form also makes it appear antlike; complimentary to that, it apparently also excretes formic acid, a common ant compound – looks like an ant, smells like an ant…. The fact that it will turn up at moth lights suggests it is also afield in the dark. We have found it on several farms, but always in tilled ground or other fields.

Such a unique morphology begs a unique lifestyle, but it is not yet clear what that is. Reportedly, it feeds on moth and butterfly eggs and caterpillars, and upon the young of certain true bugs (several of whom are considered agricultural pests). Is its morphology a ground-beetle equivalent of weasel's elongation – one that allows it to take the maximum predatory brawn down the narrowest prey's hole? Does it have some special relationship with ants for which a slim and nimble physique is more appropriate? Does its shape somehow enable it to clasp less conspicuously to blades of grass?

Figure 40. Colliurus pensylvanica *or the Long-necked Field Beetle has an odd body shape that surely reflects some aspect of its natural history, we're just not sure what.*

The Big-shouldered Digger (*Dyschirius spp*) is built to dig, and it prefers sandy banks or beaches where it can do so. We found these small (ca. 1/10" long) beetles at three of our 15 floodplain forest study sites, although we don't know whether its distribution is actually so patchy or if its small size and underground ways just made it inconspicuous. The Big-shouldered Digger shares a body shape with several other digging ground beetles – all have broad front legs, apparently useful as shovels; narrow 'waists' between shoulders and wings, a feature that may aid the contortions needed to find a path through the soil; and somewhat rounded edges, a shape that may also facilitate slipping through the soil (Fig. 41). Not surprisingly perhaps, this morphology does not seem to have created a fast runner, and these beetles might prefer digging (or flying) to running, when escape is necessary.

It reportedly feeds upon some of the other beetles with which it shares its ground-dwelling ways, particularly the earwig-looking rove beetles. Indeed, the literature suggests that this species almost always co-occurs with a particular genus of rove beetle (*Bledius*). What are the intricate and hidden interactions that shape this relationship? These ground beetles are eaten by some of the insectivores it is likely to encounter such as toads and ground-foraging thrushes. Toads in general seem to be frequently reported as ground beetle predators, although that might, in part, reflect the fact that toads,



unlike small mammals, do not grind up their prey during the digestive process, leaving easily identified pieces of chitin in their stomachs and feces.

However, just to demonstrate that the football-player body form is not the only one suitable to digging, there's the **Speckled Beach Pill**, *Omophron americanum*. We found this beetle at many of our stream-side beaches. Its occurrence in pit traps and its camouflaging, speckled coloration implies that it spends some of its time prowling above ground, but we also found it by dumping water onto the beaches. These mini floods prompted the Speckled Beach Pills to pop out of the sand and clamber for higher ground. As our common name is meant to suggest, these are circular beetles with little differentiation among head, shoulders and the wing-bearing portion of their bodies (Fig. 42). They appear to be able to burrow into loose earth in much the same way as a flat, water-worn pebble might easily be inserted into such ground.

How it spends its life above and below ground is, as is becoming a refrain in these accounts, little known. The adult's sturdy mandibles and diet in captivity suggest it is predatory. Its larvae feed on the likes of mealworms in captivity; however, surprisingly, the larvae of a similar-appearing, closely related species are said to feed on the seed kernel and young shoots of corn to the degree that they sometimes become an agricultural pest. Might the larvae of the Speckled Beach Pill sometimes feed on the tender young shoots and seed flotsam which one often finds on beach-like streambanks? Might those strong adult mandibles also serve as pruning shears in a more vegetarian diet?

The **Long-jawed Snail Eater**, *Sphaeroderus stenostomus*, occupies a different landscape. We have found it most commonly

***Figure 41 (top)**. Big-shouldered Diggers, like this* Dyschirius pilosus*, burrow into the ground using their thick forearms.*

***Figure 42 (bottom)**.* Omophron americanum*, or the Speckled Beach Pill, is an oval ground beetle of sandy beaches.*

by turning stones in upland forest. It is a lumbering beetle, nearly ¾" long, with a head that looks oddly thin compared to its body (Fig. 43). Its palps (the jointed miniature legs that surround most insects' mouths and facilitate feeding) are tipped by large triangular structures rather like spoons or shovels densely furnished with sense organs. It has been suggested that these help the beetle follow snail slime trails. One can imagine that its long, slim head may help it fish snails from their shells. However, I could discover no actual account of their feeding behavior; and some have even questioned whether beetles such as these actually feed regularly upon snails in the wild.[68]

Despite the large wing covers on its back, the Long-jawed Snail Eater does not fly when threatened, but rather runs, burrows or shoots off its rearward cannon in the style of a Bombardier Beetle. Nonetheless, perhaps because of its large size, which makes it both a rewarding mouthful for larger animals and eases the identification of its remains, it has been reported from the menus of various amphibians and birds.

Finally, the **Fur-backed Wanderers** (*Chleanius spp*) are a moderately common suite of species, almost 6% of the nearly 1,500 ground beetles we have so far identified belong to this group. Rather than end our accounts with some exotic but, by definition, atypical sort of ground beetle, the Fur-backed Wanderers was chosen because it perhaps typifies a generalized ground beetle lifestyle. They are generally nocturnal, are of appreciable size (some reaching nearly 1"), and have a long-legged body structure that serves to speed them on their generally nocturnal hunting/scavenging runs (Fig. 44). During these forays, they are reported to eat a variety of prey, including caterpillars, worms, and other beetles, be they dead or alive.

***Figure 43 (top)**. The Long-jawed Snail Eater, or* Sphaeroderus stenostomus*, is a fairly large ground beetle which apparently eats snails and slugs, amongst other things.*

***Figure 44 (bottom)**. Fur-backed Wanderers, like this* Chlaenius tricolor *are medium-sized, fuzzy-backed, often metallic ground beetles found in a variety of habitats.*

They tend to prefer, but not be confined to, wet areas. While we have found them mostly in forests, we did occasionally capture certain species midst the vegetables during our farm studies. What if any role the unusually fuzzy back (not unlike that of the Fuzzy Tillage Beetle) plays in their life history is uncertain. However, during my efforts to photograph these beetles in their typical waterside habitat, they have shown a frustrating (for the photographer) readiness to take to the water and even to submerge themselves, equipped for the dive with an airbubble entrapped in their body hairs. They also exude a rancid butter smell that I've come to associate with our beetle outings.

Natural History Profiles: Earthworms

We have not yet done a detailed study of Columbia County's earthworm fauna, and so this chapter will end with a general aside on these creatures rather than a true series of profiles.

Earthworms are familiar to almost all of us, from fisher to farmer to gardener. Robins trip across lawns in search of them, the pavement after rain is scattered with them. However, all or almost all of the 15-20 earthworm species we probably have in the County are not native to North America, having being intentionally or unintentionally imported by humans during the past 400 years or so. That our region lacked earthworms is understandable when one appreciates the soil-sterilizing effects of millenia of mile-deep glaciers and appreciates that, without wings or fins, worms are slow dispersers. One researcher estimated that the natural rate of earthworm expansion is roughly .5 mi / century. Psychologically, it is perhaps more difficult to accept that creatures which we have come to equate with good, natural soils are, in fact, very recent arrivals. In fact, less than two centuries ago, an article in a western NY farm newspaper described local farmers' prescient unease as they observed the local spread of earthworms. "Prescient" not because modern farmers have come to echo those concerns, but rather because forest ecologists have come to doubt the ecological benefits of worms.[69]

As with all other species, there is nothing inherently bad about imported earthworms. Instead, whether we deem earthworms to be good or bad depends upon what we want from them or, more generally, from our soils. If we want soils which will rapidly incorporate coarse organic matter (such as cut grass or cover crop or compost) and make them available to our crops, then earthworms are largely beneficial. If, on the other hand, we are forest conservationists who recognize that our post-glacial forests grew accustomed to a release of leaf-fall nutrients that was unrushed by earthworm 'eco-engineering,' then we might bemoan earthworms as yet one more example of humanity's profound alteration of our ecological heritage.

Appreciating (and judging for yourself) the role of earthworms in our soil requires understanding a bit more about their ecologies. Earthworm observers have grouped our species into three ecological categories based upon where they spend most of their time and do most of their feeding: 1) deep-burrowing, fresh-leaf feeders; 2) litter dwelling, litter-feeders and, 3), soil-dwelling, soil-feeders.

Figure 45. Lombricus *species of earthworm, such as this one, include those most commonly sold as bait. As a result, these earthworm species have been widely introduced.*

Our night-crawlers – the drinking-straw-thick, pencil-long worms which all those looking for bait hope to find – are an example of a deep-burrowing, surface-feeding sort (Fig. 45). While their burrows may reach a depth of 6 feet or more, these worms regularly come to the surface, grab living or recently fallen leaves, and drag these back below ground for safer consumption. In agricultural situations, they can help integrate green and animal manures into the soil. Under forest conditions, they can directly consume the seedlings of some plants and bury the leaves that used to form the duff (or O layer) – that thick, soft mat of twigs and dry leaves in various stages of decay. The duff is a habitat of its own, harboring various invertebrates and microorganisms. Aside from being rich in organic matter, the overlaying leaves tend to form a seal of sorts, keeping the underlying material relatively damp. One need only take a shovel to a forest duff-covered forest floor to appreciate the habitats extending into the earth: the dark, moist layer of leaves, sometimes 4" or more thick, is woven with fine plant roots and likely full of microorganisms and invertebrates (and even the occasional salamander). Depending on how long the soil has gone undisturbed, the ground immediately below the organic layer may exhibit a darkening caused by the downward leaching of organic matter, which grades into the color of the underlying mineral material. The downward leaching at differing rates of various materials can, in an undisturbed soil, produce a series of color layers somewhat resembling a 'chromatograph.'

Earthworms disturb that 'icing on the cake.' Initially, it seems the litter dwellers arrive and speed up leaf litter decomposition. Subsequently, other species, such as night crawlers move in. Even visually, the impact can be dramatic, as the leaf litter and even much of the live herbaceous layer disappears. This combination of structural breakdown and soil incorporation changes conditions in the surface layer dramatically, and nutrient flow into the soil changes from a slow, drip-drip-drip to a much quicker incorporation.[70]

Given the slow rates of natural dispersal mentioned, it is clear that earthworms have found their way into our landscape not only through an initial introduction, but through substantial subsequent assistance in moving about. One obvious route of earthworm introduction into the landscape is through the spreading of bait worms. By transporting worms to remote fishing holes as bait, and then dumping the leftover, fishers have spread worms into previously unexposed forest. Earthworms can survive after being dumped into the water, so it is recommended that one either bag and discard left-over bait worms or, at the least, return them to where they were dug up from, rather than releasing them at the lake's edge.

Although, as mentioned, farmers may have initially worried as earthworms appeared on their farms, modern farmers generally view earthworms as allies who help mix plant-accessible organic matter and other nutrients into their soil. What role does farming play in spreading unwanted earthworms into our forests? Certainly, earthworms like loose, well-manured soils and the sharing of compost and topsoil amongst farms can help spread earthworms across the land. Vermiculture is another source of earthworm immigrants. However, that said, there may now be few farmed soils in our County which have not been well-inoculated with worms. Caution is probably most warranted in the case where farmers or gardeners are opening up garden plots on forested lands. Rather than the farmer, it may be the home gardener/landscaper working around a house built 'off in the woods' who should be most careful to resist importing worms to new locations.

The Nature of the Place ~ Five

OUR SURFACE WATERS: THE CANARY ON THE ICEBERG

Our County is a wet land, crisscrossed by streams and dotted with ponds and lakes (Fig. 1). We irrigate and water cattle from these waters, boat, swim and fish in them, and, in some cases, use them in our industry. The mixed metaphor in the title of this chapter is meant to convey two points. First, our surface waters are but 'the tip of the iceberg,' with much more extensive pools of water below ground that are still connected to the surface through explicit channels and diffuse seeps. Unseen aquifers large and small supply many residents with drinking water. Second, the canary in the metaphor alludes to the fact that, like the proverbial 'canary in the coal mine,' our surface waters can make clear the risks we run in treating, or mistreating, our land: are we coating it with poisons, are we steeping it in excess nutrients, are we stripping it of soil and water-holding vegetation?

Figure 1. *Drowned Land Swamp in Ancram during a particularly wet year.*

Our Watersheds

When talking about geographical regions from a waters perspective, people often speak of 'watersheds.' A watershed (sometimes also called a 'drainage basin') is the area of land which drains into a particular body of water. For example, to talk about the Hudson River watershed is to talk about all the parts of the Northeast upon which a falling raindrop may land and then, eventually, drain into the ocean through the mouth of the Hudson River. In the case of the Hudson River, such an area encompasses a patch of land bordered by the Taconic ridgelines to the east, by the Catskill peaks to the southwest, by the Adirondack Shield to the North and, to be complete, a string of borders stretching west that delineate the Mohawk River watershed, a tributary of the Hudson.[1]

Almost all of Columbia County falls within the Hudson River Watershed (Fig. 2), except for small eastcentral and southeast portions of the County which drain, via the Green and Tenmile Rivers, into the Housatonic and thence to the sea. Most of our remaining waters, all part of the Hudson River watershed, can be divided into several smaller watersheds, the main ones of which are the Roeliff Jansen Kill in the south, Claverack Creek in the center of the County, and Kinderhook Creek to the north. The last two unite as Stockport Creek just before entering the Hudson and thus can properly be described as two components of the greater Stockport Creek watershed. Several smaller streams drain directly into the Hudson without entering any of the afore-mentioned waters.[2]

Running Water, Standing Water

The terms “running water” and “standing water” refer to whether or not the water is flowing. However, in our description of the types of water bodies in the County, we’ll also use “standing water” in another way by asking, what would it feel like if you were to stand in a particular body of water? How would it be, for example, if you tried to stand in (or walk through) a swamp versus a marsh? Let’s begin, however, with the conventional categorization of our waters into flowing and still (running and standing, or what scientists call lotic and lentic). Please realize that, while we present a classification of water bodies, the classes are only in the human mind and, in most cases, there are intermediate situations that blur simple generalizations.

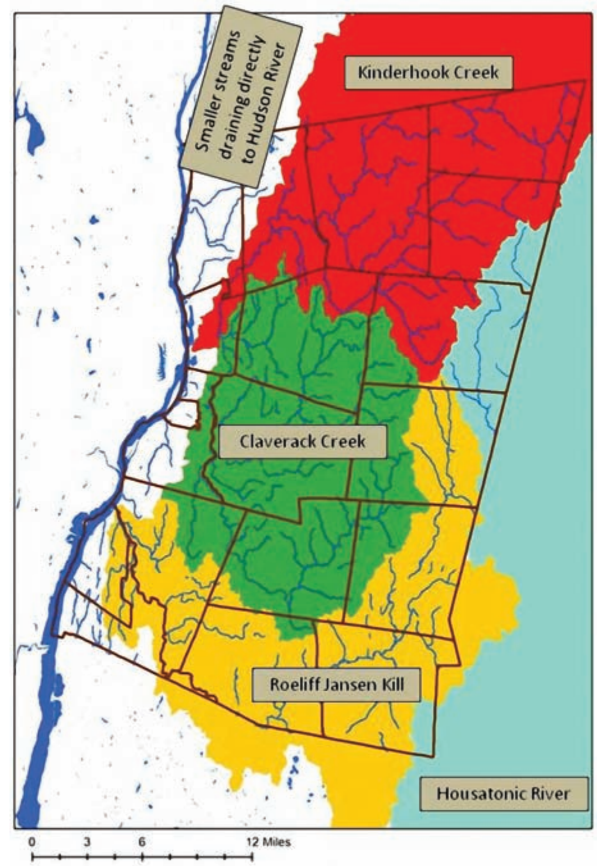


Figure 2*. The major watersheds draining Columbia County. The Kinderhook Creek, Claverack Creek and Roeliff Jansen Kill watersheds drain into the Hudson River.*

Flowing Waters: Rivers, Streams & Seeps A useful way of conceiving of this gradient of flowing waters is the ‘river continuum idea,’ first synthesized in 1980 by a river scientist named Robin Vannote. The basic idea is that, in parallel to the gradient of size as one descends from seep to stream to river (Figs. 3a-c and 4a-e), there are also complex physical gradients that combine to alter the ecology and hydrology of seeps, streams and rivers in predictable but more profound ways than simply how wet you get by standing in them.[3]

For example, suppose you are poised in a seep. In our area, it is likely that you will be shaded by a forest canopy and perhaps standing on the side of a hill in the Taconics. The water at your feet will likely feel cool (unless it is winter, in which case, you may be surprised to find the water still open and warm relative to the snow around you). The current at your feet will probably be perceptible but hardly torrential. Your toes are probably working their way into a bed of water-covered leaves that have dropped from the trees overhead, and are resting at the bottom of the gentle waters. Your fishing pole is probably useless here, although flipping rocks might reveal a nestled salamander or two, and, if you’re really lucky, a large grey dragonfly, a Grey Petaltail, may circle your head. The miniature and intricate houses of caddisflies may dot the leaves and rocks in the deeper pools where your ankles might get wet.

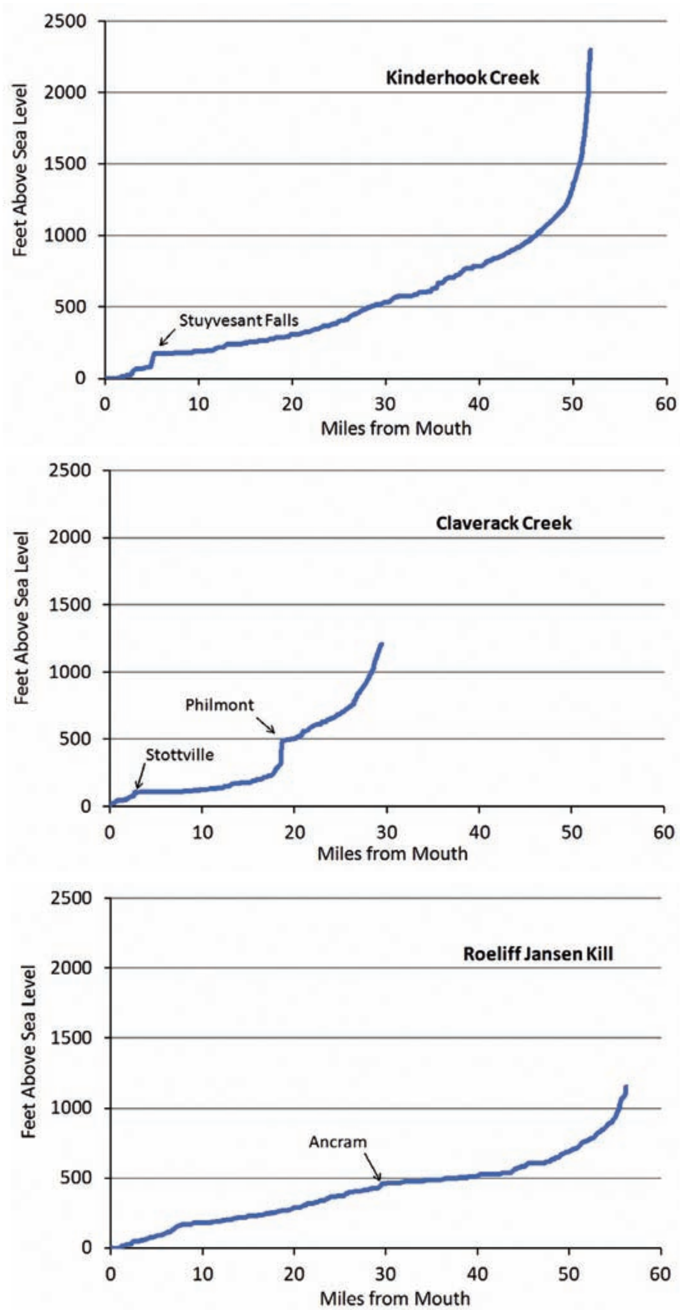


***Figure 3a-c**. Elevation profiles of our three major creeks starting from their hillside sources and ending at the Hudson. All three creeks show steep upper reaches followed by shallower slopes. "Steps" usually mark drops over geological slices; these were often the location of water-powered industries.* Derived from USGS Stream Stats (http://streamstatsags.cr.usgs.gov/ny_ss).

Move a bit farther downhill, and mountain streams have formed from the confluence of seep rills. At least during the right season, the water here may tumble and bubble; before you see the stream, you may hear it. While there may be times of the year when taking a stand on the water-covered rocks is a bit risky, for much of the year the cold water might climb little farther than your knees. Look up, and the forest still blocks your view of the sky with leaves that will tumble come autumn and will help feed the leaf-shredding insects that are near the bottom of this stream's food pyramid. The stones beneath your feet may be somewhat slippery, but the fast water, lack of sun, and generally low-nutrient waters mean that they are unlikely to have a thick coat of algae. Perhaps a Slimy Sculpin seeks refuge beneath your toes, as it searches out some of those caddisfly and stonefly larvae.

Continuing your downstream walk, you may find that the topography begins to level out a little; calmer, deeper, less frenetic pools begin to appear. Here and there, a gap in the forest overstory allows the sunlight to regularly fall upon some patch of rock, which rewards the sun with a splash of green algae. The water is chilly but not as chilly as it was during your first steps. Brook Trout hide in deeper recesses, and small schools of Blacknose Dace flutter in the current. Ebony Jewelwings flit lightly amongst the Jewelweed. Continuing, your stream widens, and the greater distance between the banks allows the infiltration of more light. The land has flattened even more, and the trees on the banks have begun to take on new identities – along some stretches you might see Silver Maples and Green Ashes, or other trees indicating a forest that is regularly flooded during spring freshets. You notice more dragonflies and damselflies: various snaketails dart up and down the sun-speckled stretches. Beneath the water, your feet more commonly encounter the sand or mud of quiet pools. The water occasionally reaches your waist or higher; it's time to get into your kayak.

Floating downstream, the stepped nature of the creek becomes more evident – quiet pools punctuated by faster runs. It might be safest to portage around some of those steeper runs. As you try to haul your kayak out, you may notice that the rocks in the water are slipperier – they're getting more sunlight, and the waters have had more chance to pick up nutrients from forest, field and septic tank; as a result, the algae are more prolific. That thick *aufwuchs* (a term coined by German stream ecologists and meaning, essentially, surface growth) on the rocks is home to both new insects and new fish. The aufwuchs is grazed by insect larvae such as flathead mayflies and water pennies. Fish such as suckers feed on those insects and may also eat some of the algae. If, intentionally or not, you decide to take a dip, you'll find the water is noticeably warmer – a product of the broader stream bed whose gap in the canopy admits more sunlight, the longer time the water has now been above ground, and the greater likelihood that the warmed waters of ponds or lakes have now made some contributions.

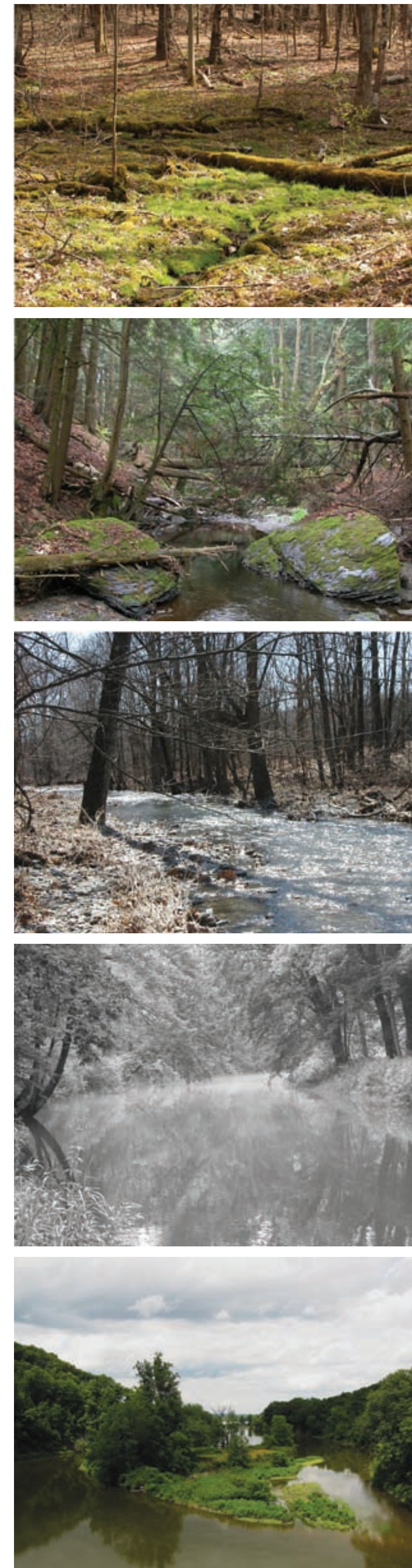
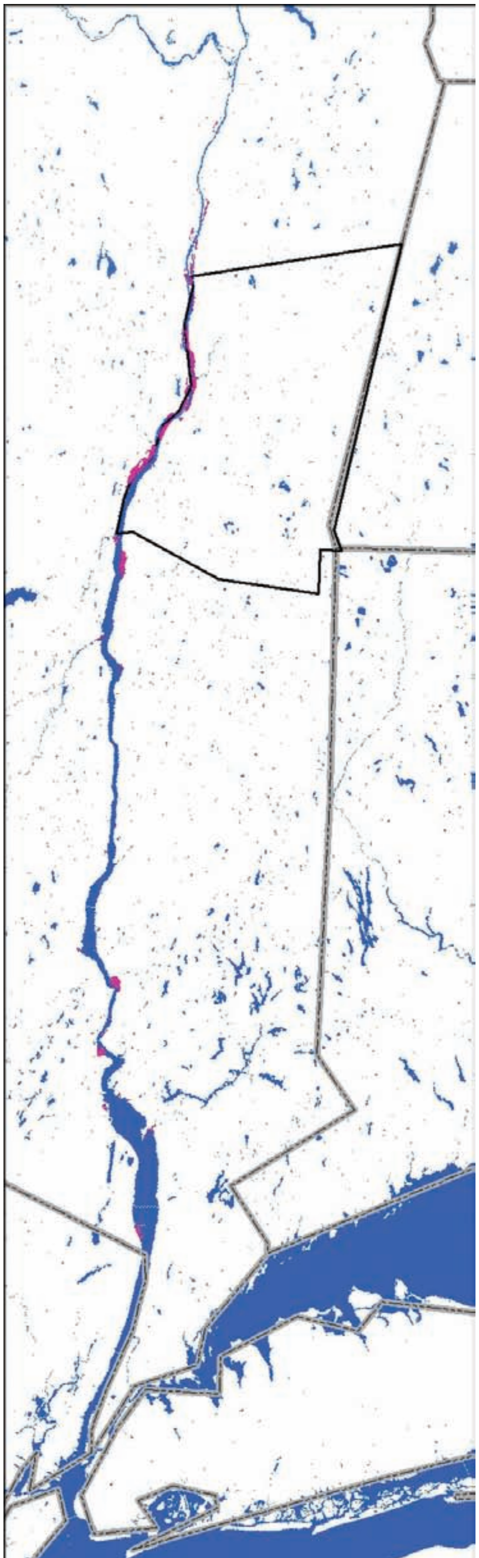


Figure 4a-e. *Scenes from waterways in the County (top to bottom):* ***4a.*** *Water that will eventually flow into the Stony Kill and then Kinderhook Creek begins its life above ground as a woodland seep in New Lebanon, forming a small rill escaping from a diffuse wet spot in the forest.* ***4b.*** *Near the wetland source of the Roeliff Jansen Kill, the Kill begins its tumble to the sea as a rocky, steep, tree-enclosed stream.* ***4c.*** *This foothill stream in the Claverack Creek watershed remains largely rocky and rapid, although its course has leveled out somewhat.* ***4d.*** *The Roeliff Jansen Kill in Ancram is a slower, broader creek, but much of its course still remains tree-covered.* ***4e.*** *The mouth of the Roeliff Jansen Kill with the Hudson River visible in the background; the stretch is open and slow. Striped Bass and other migratory fish make it into such reaches.*



As you reach the creek's mouth into the Hudson, the waters may have widened and slowed even more, although the course has perhaps been punctuated by a roaring waterfall or two. You're now within the realm of the sea's direct influence: tides and ocean-going fish might be found here (you may have already found the ocean-visiting American Eel a bit earlier in your trip if your course had no insurmountable cataracts). If you've arrived at low tide, the banks of your stream will show a muddy full-water line, rather like the residues seen in the bathtub; arrive at full tide, and muddy waters will clog stream mouths and may flood low forest. If you had entered the Hudson further south, say in southern Dutchess or northern Putnam Counties, you might even have started to taste some salt in your water. In any case, the spreading and slowing of the waters means that sediments previously borne in the water may settle out and, as you finally drag your kayak ashore, the ground beneath your feet is apt to be deep mud. These mud banks are, in fact, so dependable, that they are coated with a growth of plants such as Heart-leafed Plantain and Golden Club, which are found only on such freshwater tidal lands (Figs. 5 and 6).[4]

***Figures 5 & 6**. The Hudson's freshwater tidal wetlands are pictured above and shown in pink on the map to the left. The majority of such wetlands are along the stretch of the Hudson bordered by Columbia and Greene Counties.* Data NYS DEC.

Standing Waters: Swamps, Marshes, Bogs, Fens, Ponds and Lakes Standing in our standing waters may help you understand some of the ways scientists have tried to classify our wetlands. Leaving pond and lake aside for now, we'll focus on swamps, marshes, bogs and fens.

Wander first into a swamp (Fig. 7), such as one might find along Route 22 near Art Omi or at New Forge State Park in Taghkanic, and you will be entering a forest, albeit one with its roots in water. "Swamp" is the name given to wooded wetlands. Red Maples, the same tree you might find on a hillside far from standing water, or scraggly, unbranching Swamp White Oaks might close the canopy over your head. Where the canopy is thick, shrubbery might be sparse and the wading easy. Along the swamp's edge with open water or around other clearings, a thick tangle of brush might bar your way: Smooth or Speckled Alder with their dangling catkins, Buttonbush with their flourish of white pom-pom flowers, or Poison Sumac with its pretty but not-to-be-touched leaves. It is all this woodiness that defines a swamp.[5]

Deciding whether you are standing in marsh, fen or bog might require more detective work. Indeed, standing itself might be trickier. All three of these would feel primarily open, although all may contain some shrubs or trees. Herbaceous plants such as grass-like sedges or reeds may rasp or cut at your legs. Underfoot, a marsh may feel solid or mucky, but probably not spongy because, by definition, a marsh lacks a layer of peat formed from accumulated plant debris. The dead sedges and reeds which a marsh produces each year have not been trapped in a soggy state of partial decomposition; instead, they have largely broken down to their water-soluble constituents. This full decomposition occurs because oxygen has been able to reach the debris and help with their digestive slow-burn.

__Figure 7__. Swamps are characterized by trees standing year-round in water. Red Maple and Swamp White Oak are a pair of our common swamp trees. The picture above is from New Forge State Forest in Taghkanic.

__Figure 8__. Shaker Swamp in New Lebanon, most of which, including the portion pictured here, is currently better classed as a marsh because the vegetation is primarily herbaceous. There are, however, a few true swamp patches within the Swamp.

Visit a marsh during the dog-days of summer, and you may be surprised by a dry snap and crackle underfoot. Marshes, such as those at Drowned Land and Shaker “Swamps” (Fig. 8), are often created by the spread of flowing water. During low water, much of the area outside of the stream’s main channel may dry, and oxygen can infiltrate and speed up decomposition. Attempt a walk through such areas during high water however, and you had best swim. Overflow, often with current, might sweep the marsh. This too can bring decomposition-speeding oxygen because cool, flowing waters are apt to contain much more dissolved oxygen than stagnant, warm ones, and floods have the power to plough and thereby aerate the sediments.

Fens and bogs are, in some ways, extreme marshes. These are marsh-like areas where hydrological and geological conditions produce a particularly difficult habitat for plant life. As a result, only certain plant species are able to survive in fens and bogs, and those plants themselves become the defining indicators. One of the primary distinguishing characteristics of fens and bogs is their pH. Its ecological relevance probably comes less from any immediate physiological consequences of fen alkalinity or bog acidity, but rather from the effects of pH on nutrient availability. Both high (alkaline) and low (acid) pHs seem to make soil nutrients inaccessible for many plants. Thus the plants of fen and bog are struggling to supply themselves with nutrients; regularly having roots in suffocating water doesn’t help that. In general, therefore, bogs and fens tend to be less luxuriant than marshes or swamps with more moderate pHs, and novel nutrient acquisition strategies (e.g., insectivorous plants) tend to occur in both bog and fen; there is even some overlap in plant species because of these similar nutritional demands. However, fen and bog differ in their context and in much of their flora.

Figures 9. *Exploring an Ancram fen; the low vegetation is formed by a combination of hydrology and biogeochemistry.*

In some ways, fens (Fig. 9) suffer from too much of a good thing. In the previous chapter on soils, we mentioned that soils on limestone tend to produce more diverse and luxuriant vegetation, presumably because the increased pH helps make soil nutrients soluble and accessible to plants; indeed, farmers will often spread limestone or a similar mineral on their fields in order to boost crop growth. However, when pH gets too high, especially, it seems, in

***Figure 10a-c**. A trio of fen plants: Grass of Parnassus (top), Fringed Gentian (center), and Nodding Lady's Tresses (bottom). The first two flowers are found almost exclusively in fens; the last, while enjoying fens, ranges more widely.*

semiaquatic situations, soil nutrients again become less accessible. The chemistry and biology is not completely clear, but a classical local fen is formed when ground water wells up through limestone or dolostone. This calcium-carbonate-rich water surrounds the plant roots and, aided by algae in the surface waters, some of the calcium carbonate may even precipitate out in the form of so-called marl (ironically, a historically sought-after fertilizer) producing high pH soils. The ground-water-fed hydrology also means that water levels are relatively stable compared to a wetland fed by surface water alone. As a result of these and probably other factors we don't understand, fens in our neck of the woods are a land of gentians and lobelias, of Shrubby Cinquefoil (a Rose-family shrub with delicate leaves and prominent yellow flowers) and of Grass of Parnassus (Fig. 10a-c).

Bogs occupy the other end of the pH spectrum. Organic and rain-borne acids, unneutralized by alkaline bedrock, have accumulated and driven pH downward. Bogs are not common in Columbia County and, as with fens, many of those which do exist have been affected by draining and clearing. A typical bog, aside from having a low pH, often has a marshy or even open-water moat surrounding a more swampy, woody core island formed largely of dead sphagnum (i.e., peat). The moat apparently forms where oxygen-rich waters, first flowing in from the surroundings, hasten sphagnum decomposition and hence limit peat formation. Typical of the central island are the dark spires of Black Spruce (Fig. 11a) and Tamarack (also called Larch); these are surrounded by a rough and bristly lawn of Cranberry and High-bush Blueberries, perched atop a sometimes floating mat of live sphagnum and peat. Orchids and sundews (Fig. 11b) may dot the higher hummocks.

As one might suspect, bedrock composition plays a large role in creating the potential for a fen and a bog. Our bedrock map of the County (see Chapter 1, Fig. 4) thus goes a long way towards outlining where bog and fen might occur, although more than bedrock alone determines fen location, and even within large and apparently uniform geological settings, local idiosyncrasies can create the unexpected.

Figure 11a-b*. Black Spruce sapling (left) begins to grow on a sphagnum mound in the northwest part of the County. Sundew's sticky hairs (right) wait expectantly for insect prey. Sundew occurs in both bogs and fens, where a shortage of accessible nutrients favors plants with novel adaptations for acquiring foods.*

The Culture of Geographical Names These wet-footed strolls may have helped explain some of the differences among the scientific names applied to our waters, but, outside of the science world, human history and cultural geography have probably been the prime determinants of how we name our waters.

The distinction between pond and lake is a prime example. Although our four largest water bodies, Kinderhook, Copake, Taghkanic, and Queechy are lakes (ranging from 240 down to about 130 acres), Robinson Pond exceeds 100 acres; Knickerbocker Lake and three other named lakes are smaller than 50 acres. In practice, the division between a lake and a pond is largely arbitrary. Lakes are bigger than ponds, but exactly when a pond is big enough to qualify as a lake is blurry, at least colloquially. Witness, for example, Queechy Lake: before being renamed in the late 19th century, it was known as Whiting's Pond. From another perspective, to suppose that waterbodies the sizes of Queechy, Copake or Kinderhook Lakes have more in common with the immense Great Lakes than with the fishing hole down the road is to demonstrate the confusion.

Although there is no universally accepted distinction between pond and lake, various individuals and organizations have attempted to distinguish ponds from lakes based on size, and official, size-based categorizations often use something between 5 and 25 acres as the minimum size for a "lake." Despite this nomenclatural confusion, there are real ecological differences that occur because of size differences. For example, an open waterbody so shallow that winds stir up bottom waters and plant-stimulating sunlight reaches the floor has quite a different ecology from a waterbody so deep that distinct temperature layers are maintained for much of the year (termed 'stratification') and most of the bottom is too dark for plant growth. Likewise, water dynamics and shoreline conditions differ markedly between the Great Lakes – where winds can whip up ocean-sized breakers – and small, forest-surrounded ponds where a strong ripple is about as much as arises.

Culture, perhaps more than ecology or hydrology, has been a prime determinant of what gets called a pond or a lake. This is illustrated by the work of cultural geographers, such as Wilbur Zelinksky, who have mapped the geography of word use: New England and select parts of New York have "ponds," while "lakes" tend to dominate in most of the rest of the Country. Geology may provide partial explanations, but, for the most part, the difference seems to be largely cultural. Interestingly, the word "pond" as used in our area is apparently an 'Americanism.' "Pond" derives from the word pound (as in impound) and in most parts of England a "pond" is an artificial waterbody, a distinction that does not hold here. Why this Americanism took particular hold in New England is not clear. Perhaps some of the earliest settlers in New England came from parts of the Old Country where "pond" was used in that broader context (e.g. Surrey).[6]

Creek, brook, kill, stream and river, as monikers for our flowing waters, are another set of words with colloquial meanings but not necessarily direct ecological or hydrological definitions (Fig. 12). While

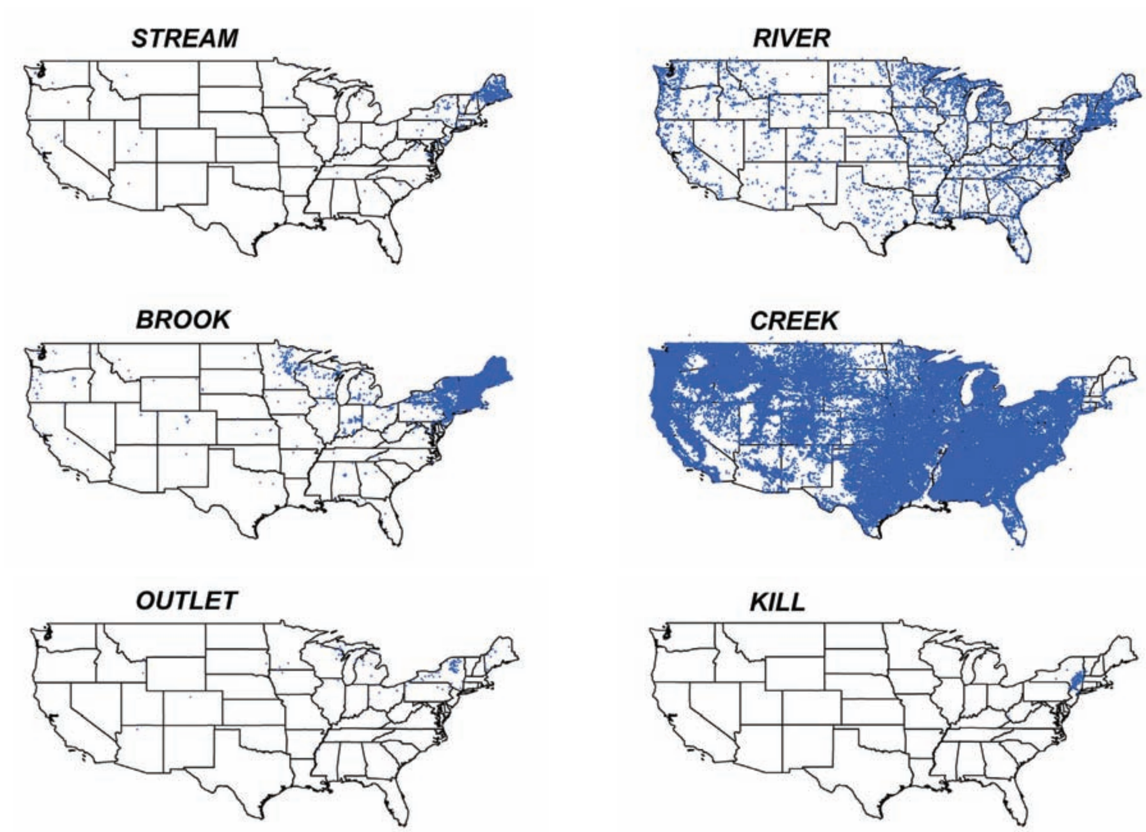


***Figure 12**. The geography of place names for running water. While some of these distinctions may reflect geographic differences (for example, northern Minnesota probably just has more running water than western Texas), much of this reflects cultural differences. New England, for example, seems to favor the use of "brook" in a place name, but not "creek." "Kill," a Dutch derivative often applied to Hudson Valley streams, has a more limited distribution than either brook or creek. "Outlet" seems particularly popular in the Adirondacks. Elsewhere in the country, words such as "lick," "run," "branch" and "fork" have been widely used (not shown here).*
Data are from the USGS's place name data base, http://geonames.usgs.gov.

there is an implied size gradient (one that we applied in our earlier downstream tour), there are, again, broad grey zones: the mean annual discharge (i.e., the amount of water that usually passes through) of the Green "River" is about 1/4th to 1/5th that of Kinderhook "Creek." Culture again plays a prominent role. Geographers have found, for example, that "creeks," as part of a place name, are far more common in the Mid-Atlantic States than in New England, where "brooks" become dramatically more abundant. Use of "kill" is confined largely to the Hudson and Susquehanna Valleys, while "stream" finds greatest favor in Maine. Some of these geographies are quickly explainable – "kill," for example, is Dutch for stream and its use follows Dutch settlement geographies. In our area, Roeliff Jansen Kill, Stein (=Stony) Kill or, my gothic favorite, Moordeners (or Murderers') Kill, all can be credited to Dutch settlers.

Geological Foundation

As with so much of our landscape, geology played a leading role in hydrological design. Speaking in very general terms, one might divide this influence into the contributions of the ancient structural geology, which shaped patterns in the topography of the bedrock and determined mineral compositions, and the influence of more recent glacial events, which scoured valleys and spread rocky till. The "ancient" processes continue today, but at a rate that has relatively little relevance for the past 10's of millennia of human history except when earthquakes or volcanoes spark in what is otherwise a slow grind. As a result, for our purposes, we can take the lay of the bedrock as a static given, albeit one whose relevance has changed as human technology and culture evolved and so altered how humans wanted to and could use the land.

We can highlight two aspects of that hydrological bedrock here: the topography – which largely determines the physical path of water flow – and the composition of the rock itself, which, as we have alluded to with fens, tends to share its chemistry with the water that flows over or through it.

Topography Picture an earthworm placed at the top of a flight of stairs. Eventually, its blind squirming will get it to the bottom. If one traced its path, you'd probably find that, on each step, it wandered for a while, perhaps bumping into the riser of the previous step, before tumbling over the edge to the step below. If any step happened to be tilted, the slope would probably bias the course of the worm's progress.

While our own landscape is hardly such a regular staircase, the analogy is perhaps useful for envisioning the flow of our waters from their Taconic highlands to the Hudson. The Taconic 'staircase' was thrown down as the tectonic bulldozer pushed layers of rock westward out of what is now Massachusetts (Figs. 13 and 14). The different layers (or what geologists call 'slices,' divided by 'faults') provide one of the main determinants of our topography, and our creeks wriggle their way to the Hudson in somewhat the same way as our imagined worm, falling from level to level, sometimes after

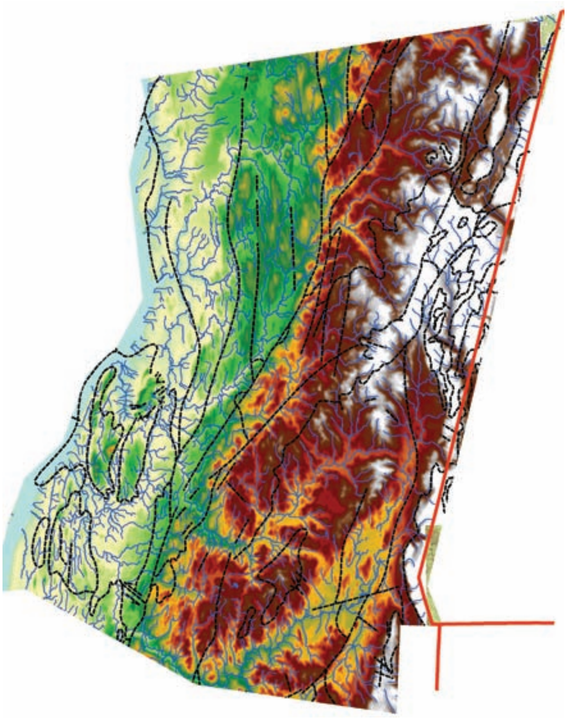


Figure 13. *The topography of Columbia County. Elevations vary from less than 10m above sea level in the southwest to almost 700m in the east-central peaks. The dotted lines indicate USGS-mapped fault lines; most separate different Taconic slices that were pushed into the County from the east during tectonic reshuffling.*

wandering around a given step and even bumping up against the fault that separated them from the previous slice. Add to our imaginary worm-on-the-stairs the fact that the steepness of the steps abates as one nears the bottom and that our worm grows from a hairlike nematode to a snake-thick gargantuan as it descends, and you might get a feel for some of the physical determinants of a stream's path. In our later section on the interaction of ecological and human time, we'll return to stream dynamics and ask why the stream even wriggles as opposed to cutting a straight line between highest and lowest points.[7]

Bedrock Chemistry Geology also influences water chemistry, because rocks are somewhat soluble in water. Water is a great erosive force. It is estimated, for example, that Niagara Falls has eroded its way more than seven miles upstream since the end of the last glaciations some 12,000 years ago. Aside from the landform change such erosion entails, that eroded material also becomes at least temporarily suspended and/or dissolved in the water itself, thereby influencing the chemistry of the water. In addition, chemical forces are at work – even relatively still water that is soaking limestone will, for example, pick up dissolved calcium carbonate. The so-called karst geology around No Bottom Pond, for example, is typified by the Swiss-cheese geological patterns created as water has dissolved away the limestony bedrock, leaving caverns and caves. There are various, natural 'added

Figure 14. *View from the edge of one Taconic slice – the vista from Dorson's Rock at the Alan Devoe's Wilson Powell Bird Sanctuary in Old Chatham. The photograph was taken looking to the northwest. These dramatic elevational drops often mark the borders of geological formations and, when punctuating a stream course, were often the sites of water mills.*

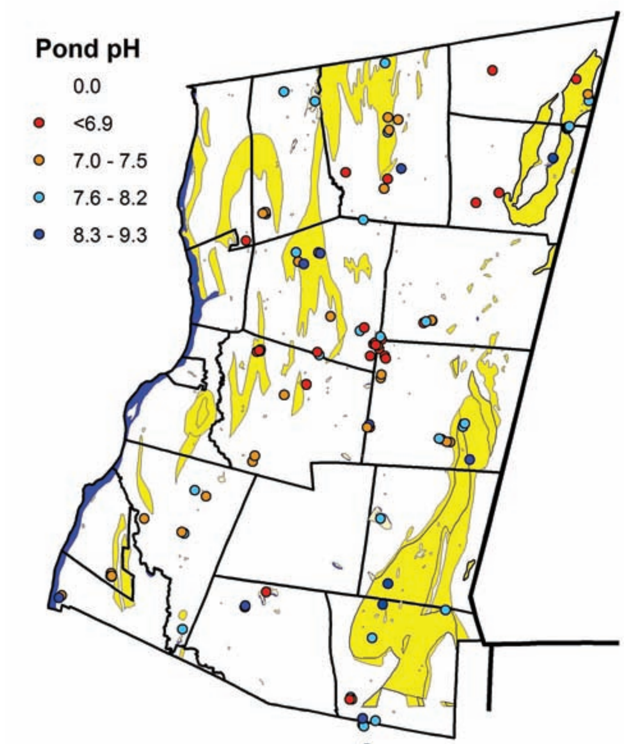


Figure 15. The location of USGS-mapped limestone bedrock (yellow) and the pH of 90 ponds we studied in and around the County. Most of the more alkaline ponds (indicated in blue) were found on or near limestone. However, minor, unmapped limestone patches are found throughout the County and may help explain the apparent existence of alkaline ponds away from limestone bedrock. Alkalinity affects aquatic ecology and can reflect the pond's ability to resist the effects of acid rain.

ingredients' in our waters, but one of the easiest and most relevant chemical properties to measure and map is pH (Fig. 15). "pH" is a measure of the concentration of free hydrogen ions in the water, perhaps not a terribly interesting measure in and of itself, but those ions influence a variety of chemical processes that are important for life. Our geology doesn't contain acid-releasing rocks. Most of the acids in our soils come from atmospheric and biological sources. However, some of our rocks are good acid neutralizers. Rocks containing limestone or dolostone, often called 'carbonate' rocks, can release chemicals which bind with those hungry hydrogen ions and so neutralize their acidic intent.[8]

The Human History of Our Waters

Humanity has been the primary force of change working upon our waters during the past few centuries. This is due to a pair of inter-related reasons: first, we have physically and chemically changed the waters, but, secondly, we have also redefined the waters, changing their identities by changing what they mean to us. Ponds have, for example, changed their public personae from a source of beaver pelts, to a reservoir of potential mill energy, to a cattle pond, to a landscaping component. As with soils, those redefinitions have meant changes in what the human eye looked for and, consequently, what human hands did. Given our immense power to shape our landscape, the milestones of landscape change often occur within our own heads.

In the section that follows, I'll try to sketch a history of how we perceived of our waters and, hence, how those imposed identities directly or indirectly shaped the physical reality of our ponds, streams, and rivers. One way to follow the history of our conceptions of water is to think in terms of "sources" and "sinks." In other words, water was sometimes seen as a font – it could provide food, drinking water, industrial power, and other benefits; alternatively, it was sometimes, literally, perceived as a sink – waters which washed away sewage of ours or our animals; carried off dirt, dissipated unwanted heat; etc.

Native American Use One of the few statements about local Native American landscape use that we can make with any certainty is that waterways and wetlands were important to them. They likely utilized water bodies in several ways. Like all humans, and, in fact, all organisms, water was for them an important physiological requirement. Before the days of deep wells and public water supplies, locating settlements near a reliable source of drinking water or knowing the location of the next spring was important. In addition, waterways no doubt provided important transportation networks. People can walk great distances, but, for moving cargo, boats were and are one of the most efficient modes of transport. A canoe displaces relatively little water, meaning that not only the Hudson but many of our creeks provided early highways. Travel to and from some regions may have been linked to the seasonal water levels which determined the feasibility of navigation.[9]

Water bodies were also a source of food: fish, mussels and crustaceans provided seasonal sources of substantial nutrition. Mahican and pre-Mahican sites along the Hudson (such as at Tivoli Bay, Claverack Rock Shelter, Nutten Hook, and Goldkrest) commonly contain fish bones and shellfish middens. The Hudson with its migratory fish populations may have formed an integral part of the indigenous food system in our county, complementing hunting and agriculture. The remains of sturgeons, which, at least historically, could reach up to 14’ and 800 pounds, are relatively common at archeological sites, perhaps because their large, sturdy scutes preserve easily. At an indigenous site in Ulster County near the mouth of the Esopus Creek, the remains of Striped Bass, American Shad and several other smaller freshwater fish have been found. No doubt hunters found that watering holes were one place to encounter game. Finally, as we have already mentioned in our sections on soils, floodplains were the site of much of Mahican agriculture.[10]

It is sad that we don’t have a more extensive knowledge of the Mahicans’ view of this land. Their perspectives could shape our own. It would be interesting, for example, to know how many different kinds of fresh and still waters they recognized; which fish they knew; and what terms they had for hydrographic features. We do have sparse, context-less crumbs of that knowledge in the indigenous names that have persisted for some of our streams and lakes. European names seem to have claimed many of our larger waters, such as the Hudson River, Roeliff Jansen Kill, Kinderhook Creek and Claverack Creek. Indigenous names have persisted for other water features, although, in a multigenerational and multiethnic game of telephone, they have sometimes been corrupted beyond recognition and strongly colored by how later residents wanted their waters or lands to be described. Nonetheless, they may still give us some faint indication of how local Native Americans viewed their waters.

Mahican names can be found which purportedly mark lakes or streams in our region as a ‘good-fishing place’ (Lake Waramaug in Connecticut), ‘of many fish’ (possible translation for Agawamuck Creek in Hillsdale and Claverack), ‘beautiful’ (Winnepauk, also in Connecticut, meaning beautiful pond), ‘blue’(as in Onota Lake in Massachusetts), ‘in a valley of Butternuts’ (possible translation for Wyomonack, a creek in New Lebanon), ‘place of snakes’ (Copake Lake), ‘place of eels’ (Shekomeko, a place in Dutchess County), 'flintstone creek' (Sanhenak, indigenous name for the Roeliff Jansen Kill), 'wild and dashing stream' (Cochik'nack, early name for Chittenden Falls in Stockport), 'place of beginning' (Kenaghtiquak, former name of a small stream in Claverack) or 'at the falls' (Pontoosuc Lake in Massachusetts). Likewise, places on high ground seem to have often been identified by their relation to adjacent waters; for example, 'at the ford' (Tuscumcatick, an early name for Greenbush), 'at the bend in the river' (Wnogquetookoke, Stockbridge), or 'at the confluence of two rivers' (Schaghticoke in Rensselaer County). The little that we can draw from these names is that waterways were clearly important to the Mahicans – they qualified waters with a wide range of descriptors and commonly used them as points of reference. This perhaps is not surprising; after all, 'Mahican' itself reportedly means something like "river people."[11]

Mahicans used rivers and large streams as transportation routes, drank their waters, sought their fish, and farmed their floodplains. The nature of Mahican technologies and their relatively low population densities probably meant that their impacts on aquatic habitats, while not imperceptible, were likely modest by modern standards. They probably did little to alter waterways in order to improve their navigability. Rocky or tree-trunk strewn courses were probably either avoided or used only when high water smoothed the way. They may have dug out some seeps or smaller water sources in order to make their waters more easily accessible during dry periods, but such 'wells' were likely not particularly deep. Their floodplain agriculture probably did increase soil erosion to some degree – anytime you remove the surface vegetation and thereby expose bare soil to the rain, you risk losing soil to runoff – however, their tillage was usually not deep and so may not have broken up the surface network of roots that often hold soils in place.[12]

The impact of Mahican fishing is more difficult to judge (Fig. 16). According to van der Donck, the colonial Dutch observer we have met earlier in the book, "They fish with seines, pound nets, small

***Figure 16**. Native American fishing techniques. While this image provides an eye-witness view of early indigenous fishing, this oft-used picture does not show Mahicans or even Northeastern American Indians. It was created by John White, an artist and explorer, in the late 1500s, and shows American Indians fishing off the coast of North Carolina. Despite these shortcomings, it does give an idea of the use of weirs to corral or trap fish for harvesting. Northeastern inland weirs, placed along creeks, were often made from brush supported with stone foundations. In a few places, traces of those foundations remain.* Courtesy Library of Congress.

fykes, gill nets and gaffs." It seems that Mahicans probably fished using some combination of nets, wooden or stone weirs, and spears (or gaffs); fishing with hooks seems to have been a rare event (Fig. 16). Nets were either pulled, like a seine, or set as part of a standing trap of sorts. Corrals, made of wood and/or rock (weirs), guided fish into a fyke or catch net, or into a holding area from which they were speared. The pound nets or weir fishing may have been one of the Mahican's favored tools conceivably applied near the mouths of Roeliff Jansen Kill and Stockport Creeks during the springtime runs of anadromous fish (fish such as Shad or Striped Bass who migrate between salt water and fresh during their life cycle) runs. The potential efficacy of these traps may have been high, and fishing the 'run' may have been a social, group event during which people gathered to harvest and process the fatty, anadromous fish caught on their way to higher spawning waters. Even non-anadromous fish may show seasonal movements due to changing water levels and changing habitat needs (e.g., certain sites may be best for spawning, others for feeding). Weirs may have intercepted some of those movements as well. It is not inconceivable that such fishing locally reduced fish populations, but it probably did not have long-term demographic effects – the network of waters was too great and the intensity of fishing may have been too small; although indigenous population density is the key to such an assessment, and, as we have noted earlier, we have few reliable population figures.[13]

Historians of indigenous fishing bemoan the lack of an archeological record: nets rot, fishing hooks – if made – were often small and delicate, and water does a good job of rotting or washing away weir structures. Even less evidence accrues to the use of fish poisons. Certain plants, when pounded in water, have sap which stuns or kills fish. The toxins are usually specific to fish (often affecting respiration through the gills) and have little effect on humans who swim in the waters or consume the fish. These plants, collectively termed 'barbasco' in much of Latin America, remain important to Amazonian Indians and peoples elsewhere. Rotenone was originally derived from one such plant. When applied to small streams, they can nearly destroy the resident fish populations. Not surprisingly, none of the neotropical barbasco plants are found in our flora; however, there are reports that certain native plants, such as Black Walnut, American Chestnut, Jack-in-the-Pulpit, and Pokeweed, have been used as fish poisons, although we have found no documentation of their use by the Mahicans. Indeed, few historical accounts of their actual use by any group remain, and we are left to wonder about the extent of their application and their ecological impact.[14]

In terms of aquatic ecology, we have no idea if Hudson Valley Indians played any role in moving fish species across the landscape. While we worked in Venezuela, indigenous people recounted their simple stocking efforts intended to bring favored fish to new sites. There is no reason Native Americans in the Hudson Valley could not have done the same, at least in so far as introducing fish to remote ponds or lakes or to stream sites isolated by waterfalls.

Early European Use The arrival of the Europeans heralded not only the eventual arrival of more people, but also new technologies and new conceptions of water's use.

Beaver The impact of Europeans on the waters of Columbia County may have, at least initially, been out of proportion with their physical presence for at least two reasons. First, as we have mentioned, in the 1630s, when Europeans were probably the minority in the Hudson Valley, European diseases decimated Native American populations; such losses probably ravaged all aspects of Native American life including the intensity of floodplain agriculture and patterns of fishing. Second, the Dutch West Indies Company, which initially settled the Hudson Valley, was not looking to establish a new society or escape religious or political persecution. Instead, theirs was a commercial venture, and one of the primary resources they were after were beaver (Fig. 17). Henry Hudson met Native Americans eager to trade beaver and otter skins for goods, perhaps primed by indirect contact with French fur traders: the River's fur trade had begun. The beaver trade was largely centered around nearby modern-day Albany, where, in about 1615, the Dutch built a trading house. Most of the trapping was done by indigenous people, and so its ecological impact spread beyond the very limited sites of European settlement at that time.[15]

***Figure 17**. The Seal of New Netherlands. The beaver was front and center in Dutch colonial plans for the Hudson Valley. The beaver is surrounded by a symbolic representation of a wampum belt. Abraham Staats, one of the first Dutch settlers in what is now Columbia County, is recorded as having sent 4,200 beaver pelts down river in 1657.*

We can only speculate what impact these changes had on our waters. Conceivably, if native agriculture waned prior to the rise of European farming, there may have been a slight lull in erosion from streamside fields; any effect was probably fleeting. More pervasive, ecologically, was the effective local extinction of beaver by around 1700. Estimates of pre-European settlement beaver densities would suggest 700-1,000 active beaver colonies in the County, housing a total of nearly 5,000 beaver and more than 3,500 acres of beaver pond or meadow. Beaver trapping was intense during the late mid 1600s (in some years, ca. 45,000 beaver and otter pelts were being sent downriver from Beaverwyck, aka Albany). During the course of a single century, this driver behind wetland creation vanished.[16]

The direct effect of European settlement soon superceded the indirect effects. While the settlers shared some aspects of water use with the Mahicans – drinking water, fishing, and transport, for example – they also brought new uses for water, most notably, the exploitation of water power for early industry such as saw and grist mills.

Mills As European settlers well knew, flowing waters mean energy, although, given floods and droughts, that energy can be temperamental. Colonists quickly created mill ponds as a way of being able to regulate water flow to some degree by absorbing and storing waters during floods and by rationing out waters during dry periods. Columbia County hydrology was relatively favorable to industry. In somewhat the same way that modern boosters might advertise the widespread availability of 3-phase electricity or high speed internet, early reports emphasized the ample waterways and abundance of actual or potential mill sites. Mill wrights and mill hands are scattered throughout the rosters of early settlers in New Netherlands. The first map of Rensselaerwyck, executed around 1632, (excerpted in Chap 1) bears the tiny image of what appears to be a mill on today's Mill Creek, opposite Albany; and a 1643 description of Rensselaerwyck notes its saw mills. In Columbia County, one of the first mills may have been a saw mill slightly north of today's Stuyvesant Landing; it was apparently in existence by 1665. The modern towns of Kinderhook and Livingston apparently had their first mills by 1700. Aside from Stockport in 1721, and Ancram in 1741, mill construction in the rest of the towns waited for the period between 1750 and 1790, during the boom era of Columbia County settlement. Saw mills may have been the most common mills initially, with wheat-grinding mills (grist mills, Fig. 18) becoming more common a bit later as wheat production intensified. Mills were located where a reliable stream of water flowed down a steep drop. As such, some mills marked the stairs alluded to in our earlier earthworm analogy; i.e., the places where one geological slice gave way to a lower one (Fig. 19). In Columbia County, some settlements, like Valatie, Stuyvesant Falls, Ancram and Philmont grew up around attractive mill sites (Fig. 20a, b).[17]

__Figure 18__. The grist mill at Old Sturbridge Village. Mills such as this were probably common throughout the County in the late 17th through mid 19th centuries. In 1821, for example, there were 62 grist mills in Columbia County.

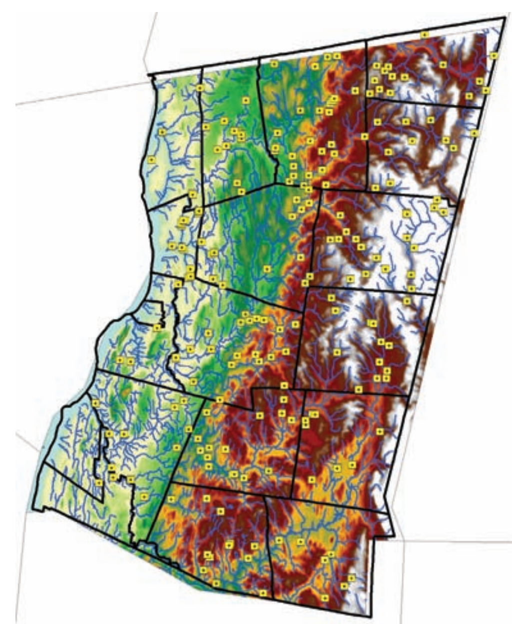


__Figure 19__. The location of 19th and 20th century dams in Columbia County. Most dams powered mills and occurred along steeper reaches or at falls along more gradual stretches. Based upon historical maps and the NYS DEC dams inventory (available on-line at NYS GIS clearinghouse).

Mills created new aquatic habitats in the form of mill ponds, restricted fish movements, regulated stream flow fluctuation, and collected sediments. Some of these are subtle effects that are only apparent in hindsight; but others are,


***Figure 20**. High Falls (left), now part of a CLC Public Conservation Area, marks the steep fall in the Agawamuck which helped power the industry at Philmont; mills were located both above and below such falls, like the mill at Stuyvesant Falls (right). The viability of 20th-century businesses in this mill was helped by a contract promising 'perpetual' free electrical power from the power plant at the Falls. The legality of this was challenged earlier this century.*

and were, more apparent. Fishing people had long been taking advantage of seasonal fish runs, and the ability of a dam to block those movements must have been even more obvious to them than to us. Indeed, as dams proliferated, laws began to appear which were intended to insure fish safe passage. In Massachusetts, where the conflict between anadromous fish and dams perhaps became apparent earlier, acts during the first half of the 18th century required that mill dam owners allow for fish passage. Such laws appear to have arrived somewhat later in New York; in 1800, for example, a New York statute was passed requiring that mill dam owners allow passage to salmon travelling out of lakes Ontario, Erie and Champlain. Illustrative of the times, such laws and statutes often asserted that streams were "public highways" and that the passage of people and fish was thus to be preserved by law. Although coming from a relatively late New York State Supreme Court decision (1813), the following commentary eloquently explains the legal logic of such laws:

> *The free use of waters which can be made subservient to commerce, has, by the general sense of mankind, been considered a thing of common right. Individuals who occupy the adjoining banks may use the waters for their own emolument, so far only as it can be done without any material interruption of the public use. Every owner of a mill-dam on a stream which fish from the ocean annually visit, is bound to provide a convenient passage way for the fish to ascend…. Every impediment to the natural course and the natural use of rivers and streams, which essentially contribute to the public benefit, becomes a public nuisance.*[18]

Numerous scientific articles have documented the effect of dams on anadromous and catadromous fish populations. In the Hudson, the anadromous fish include Striped Bass, American Shad, Atlantic

Sturgeon and Alewives. Some of these not only enter the Hudson during the breeding season but also move up tributaries. Catadromous fish follow a somewhat reverse pattern in which substantial portions of their life are spent in freshwater but breeding occurs at sea; American Eels are our only catadromous fish, and they frequently reside in tributaries. In addition, some entirely freshwater fish may move between the Hudson River main stem and smaller tributaries during the year (a type of so-called "potamodromous" fish); these include at least some populations of White Sucker and Smallmouth Bass. Fish moving up the Roeliff Jansen Kill have free passage at least until the falls at Bingham Mills, more than six miles upstream from the mouth. Fish entering Claverack and Kinderhook Creeks run into barriers more quickly: the first dam on the Claverack is less than ¼ mile from where it joins the Kinderhook, thereby forming the two mile-long Stockport Creek. The passage of fish up the Kinderhook is barred a bit more than a mile from its mouth by the falls and dam at Rossman. A dam-removal feasibility study suggested that the Claverack would be an appropriate site for such work because the removal or breaching of small dams could extend fish migrations some 4.5 miles up the Claverack until the natural barrier and dam at Stottville.[19]

Alexander Coventry, who lived near the mouth of Stockport Creek in the late 1700s, reports numerous fishing trips, including early spring fishing for Suckers and Shad (over one two-day period, he reports the catch of 7,000 Shad at Primar Hook or Priming Hook, an east-bank site just south of the mouth of Stockport Creek); he also reports one outing to catch bass (Stripers? Smallmouth?), and comments that Spring and Fall were the best times to catch them (Fig. 21).

Clearly, the multitude of dams along tributaries hindered more localized movements as well. On the order of 150-200 dams of various sizes and ages are recorded as existing or having existed in

Figure 21. *Pavel Svinin's* Shad Fishermen on the Shore of the Hudson River*, ca. 1813. Shad enter freshwater to breed; in part, their success depends upon the cleanliness of such rivers and the absence of obstructing dams.* Courtesy of The Metropolitan Museum of Art, Rogers Fund, 1942 (42.95.9), Image © The Metropolitan Museum of Art.

the County. Most of these are on small tributaries. Taken together, however, they have resulted in multiple barriers to fish movement. Lakes such as Queechy and Kinderhook Lakes, while natural in origin, have their levels regulated by dams at their drainage points; potentially, these dams interfered with fish species attempting to move in and out of these lakes seasonally. Dams have surely affected fish movements in the County, but we have little direct evidence with which to evaluate the magnitude of the impact.

The effects of dams on stream transport of sediments have been relatively well studied. In the previous chapter, we discussed how floodplains, while at risk from flooding, were also sought out for agriculture because the regular floods brought new nutrients. So long as flooding continued, these fields were thought of as almost inexhaustible. The basic cause for this regular revitalization is that floodwaters almost always carry sediments and debris; when those waters are slowed as they enter wooded floodplains, they drop the sediments they have been carrying. Essentially, they are fertilizing those floodplains with soils and organic matter collected upriver. As Warden eloquently described for the Kinderhook in 1803, "the soil is more fruitful, and the situation more inviting than that of any place yet cultivated. In many places, in spring, the water overflows the banks, and leaves behind it a prolific slime, which increases the fertility."[20]

Dams strip floodwaters of much of the nutrients by slowing down the waters and thereby inviting sedimentation, which is both a headache for the miller and a disappointment for the downstream farmer. Furthermore, by regulating water levels, dams will tend to smooth out flows, thereby reducing flooding and the floodplain's access to floodwaters overall. Actual agricultural magnitude of the impact is unclear for at least two reasons: first, just as mill ponds were flowering, so too was upland clearing for agriculture. Cleared lands erode much more quickly than vegetated lands, so, although mill ponds were surely trapping a greater percent of the total sediments, the amount of total sediments was also much higher. Furthermore, dams may be more apt to trap inorganic vs. organic debris. Inorganic sediments still contain useful mineral nutrients, but at least the organic portion may have floated over the top of most dams.

We don't know the net result. My historical snooping revealed no local accounts of early farmers berating mill owners for stealing their soils (accusations of stealing wheat during the grinding are another matter), although in Concord, Massachusetts, farmers were sued by a local miller (and floodplain meadow owner) for diverting stream flow, which they did not just for irrigation but also to bring in nutrients. Further, sediment studies near the mouth of Stockport Creek suggest that sedimentation rates increased substantially at the time of colonization (10 or more times precolonization rates); the authors attribute this 'boom,' at least in part, to the cultivation of fields higher in the watershed. Sediment deposition appeared to peak more or less in the middle of the 19th century at about the time of maximum extent land clearing in the County (see Chapter 1, Fig. 12). Similar patterns have been noted at Tivoli and Piermont Marshes. Sediments affect a variety of stream characteristics: for example, they reduce transparency (and hence potential photosynthesis), they bury rocks and pebbles in mud (eliminating habitat for some organisms), and they can make a stream more 'hungry' (sediment-bearing streams carry more erosive power). In contrast to the cited Hudson River results, coring done in Jamaica Bay on the South Shore of Long Island, revealed that sedimentation rates decreased around the time of colonization. Those authors suggested that this was due to the accumulation of sediments in the flourishing mill ponds.[21]

Just as we earlier calculated the area covered by beaver ponds, so too can we guesstimate mill pond area. The result of such modeling might be inaccurate, but the process itself helps us appreciate the changes influencing our landscape. Based on our guesses at mill pond number and size (perhaps about .7 acres, based on English work), we can estimate a maximum mill pond surface area of nearly 175 acres around 1825, substantially below the nearly 2,000 acres of open beaver pond that we calculate existed in the County prior to colonization. By 1825, beaver had probably been effectively extinct in our area for at least 100 years.[22]

Mill ponds and their dams also created aquatic habitat. Like the beaver ponds before them, they created open areas of stillwater where waters were warmed by sunlight, plants and algae could photosynthesize more enthusiastically, and take advantage of the nutritious sediments that were accumulating. Such conditions favored some plants and animals over others. Greater photosynthetic potential and muddy (as opposed to rocky) bottoms probably invited in aquatic plants. Year-around still water provided homes for those amphibians such as Bullfrogs, Green Frogs and Red-spotted Newts who hibernate beneath the ice. At the same time, fish and invertebrates seeking cold water and high oxygen levels would have been discouraged. "White water," the froth formed whenever rapids break the water surface, indicates aeration, and colder waters are best able to hold dissolved oxygen; if rapids were stifled and waters warmed by mill dams, then less dissolved oxygen would be available. Finally, decomposition of leaves, branches and other debris that accumulates on a pond floor uses oxygen. As a result, the dissolved oxygen levels of a pond might fall below 3 milligrams per liter, while a cool mountain stream might top 14 mg/l.

Another potential consequence of mill-associated water regulation was described in 1803 by the Rev. David Warden. Talking about Kinderhook Lake, he stated,

> *In 1786, an iron forge was erected on the stream which runs from these lakes. A mound of earth was raised, and a sluice to confine the water, or suffer it to flow at pleasure. It was allowed occasionally to rise six feet above its natural level, overflowing the meadows, swamps, and borders of the lakes, which were covered with wood.*

> *The banks being overrun with noxious weeds and corrupted vegetables, and laid under water, by the influence of the intense heat of the sun, emitted pestiferous vapours, and impregnated that air with unwholesome exhalations, which, as far as they spread, created an obstinate malignant fever, that proved fatal to many. The people imprudently remained on the spot and sought no medical aid. The baneful effects of it extended two miles in circumference, and swept about 40 or 50 persons from the stage of life.*

It may not have been the rotting plants themselves that caused the fevers. The stalled waters may have promoted mosquitoes and mosquito-borne diseases such as malaria or dengue, which, during colonial time, occurred in the region. Alternatively, sewage might have accumulated and encouraged the spread of typhus or cholera. While wetlands offered bounteous fish and game, and, in some cases, valuable meadow grass, they also had their darker side.[23]

Water Pollution It is difficult to trace the history of a condition before it is recognized to exist. Water pollution prior to the late 1800s seems to be an illustrative example. No doubt people in big cities had long realized the human potential to foul the nest with their own waste, but when did pollution as a general concept, applicable to industrial waste and other human effluent, become widely understood?

The word "pollute" or "pollution" in the sense of environmental contamination only seems to come into widespread use during the second half of the 19th century. One of the first to use the word in that way was Florence Nightingale, who applied it to the unhealthy water and air of London. This conceptualization of pollution apparently came slowly and was as much the result of understanding the limits of the natural world as it was the consequence of realizing what a pollutant was. Few would have thought it wise to drink the liquids beneath the privy house seat or the waste from a tannery. Less clear was how far a well should be from the privy or how far below the tannery the stream water was safe to drink. Less clear too was what such waste did to what we now call the "ecology" of our waters – the ways of non-human life.

In some ways, "pollution" is not an item or material but rather a ratio. So long as the undesirable qualities of the introduced material can be nullified by the environment, pollution effectively does not exist. Throw an apple core into a field or dig a hole in the forest to use as an a informal camper's privy, and, chances are, aside from making a localized group of decomposers very happy, you will have done little to threaten human health or ecological balance; mound that field up with cider pressings or expect New York City to take care of its sanitary needs in Central Park, and you have an "issue" – you have pollution.

The degree and duration of the "issue" further depends upon the nature of the pollutant. Take a load of raw human sewage and drop it in a pond and you may have a stinky, green, unhealthy hole for several years but, in most cases, some sort of an ecological balance may eventually return, albeit not necessarily a duplicate of pre-dumping conditions. This is because life has the biochemical tools to eventually 'burn' that sewage and return it to the flow of life, even if its systems get temporarily overwhelmed and the oxygen available for 'burning' is temporarily in short supply. However, lace that sewage with novel synthetic drugs or add to it industrial waste filled with heavy metals or synthetic compounds no micro-organism ever learnt to eat, and you have a different and potentially much more enduring pollution problem. The EPA and the DEC are not dredging the Hudson for human sewage despite the fact that 100,000s of people, scattered throughout the watershed, have tainted its waters for centuries; they are dredging for PCBs which were released into the water for just 30 years and from only a couple of sites.

The water quality impacts of early industry in Columbia County were probably limited in both time and space. The sweepings (sawdust, flour dust, etc.) from mill floors may well have wafted into creeks, but amounts may have been small and, while accumulations around a mill may have been "unnatural," they were not qualitatively different from the leaves, twigs, logs and other plant debris that the waters were accustomed to receiving. The same could largely be said for most of the later wastes from paper mills and dairy plants. This is not to say that, during their operation, such facilities did not create pollution issues; but they may have been localized and temporary. Tanneries, whose contribution to regional deforestation we have mentioned, were relatively common in the County during the 18th and early 19th century. Their caustic brew could have fouled local streams and certainly did so in the Catskills and Adirondacks.[24]

Beginning in the late 1920s, the state of New York Conservation Department (the predecessor of today's DEC) conducted a series of watershed biological surveys assessing our waterways, largely with the goal of facilitating successful fish stocking. As part of this work, they systematically described water conditions and mapped sources of pollution. While their water measurements are somewhat

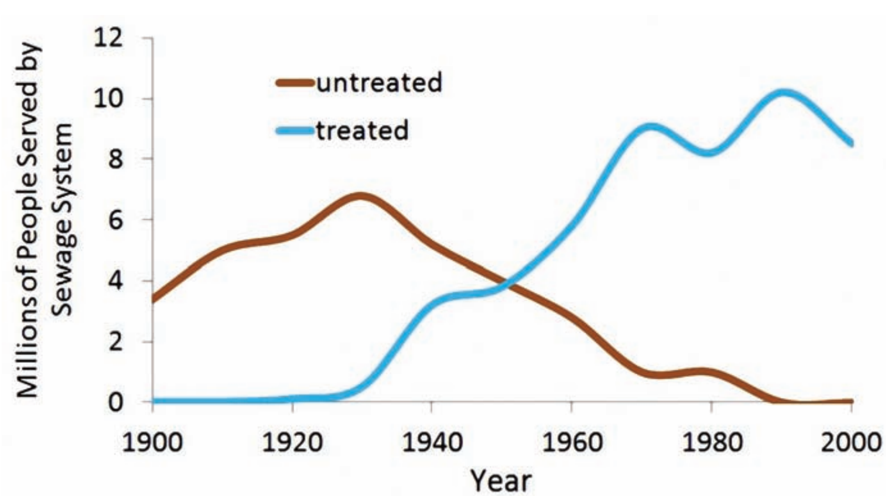


***Figure 22**. Twentieth-century Hudson River sewage flows by degree of treatment. Until the middle of the Century, most sewage entered the River untreated.* Modified from Brosnan and colleagues, Fig. 23.2 of "Hudson River sewage inputs and impacts: Past and present," pp 335-348 in *The Hudson River Estuary* (2006) Levinton and Waldman, eds.

rudimentary by today's standards (pH, O_2, CO_2, alkalinity and sometimes H_2S), these reports are the first detailed descriptions of regional water pollution that I have been able to find. At that time, sewage treatment seemed largely non-existent in the region. The city of Hudson and all smaller settlements discharged raw sewage either through centralized sewage systems or diffuse privies and cesspools.

Ironically, in many cities the issue of water pollution and health consequences became acute when indoor plumbing became available. The relatively sudden availability of water resulted in a rapid increase in water use including increased water use to flush out sewage. In most cases, no organized sewage system was available, and contamination and disease quickly resulted. Indoor plumbing apparently arrived in Columbia County, and points upriver, somewhere around the middle of the 19th century. As was apparently typical, Hudson invested first in providing clean drinking water for their citizens rather than cleaning up their own sewage. In 1874, extensive water filtration was installed to filter river water provided to the City of Hudson, perhaps in response to contamination emanating from Albany and Troy. However, in 1904, more than 150 people died of typhus in the City. The next year, upland reservoirs became the source of drinking water, and typhus declined dramatically. However, the City of Hudson was dumping raw sewage into the Hudson until 1966; apparently, it was not the earliest nor the latest Hudson River community to do so (Fig. 22).[25]

Perhaps because populations were relatively low, aside from listing Hudson (with a then-population of slightly more than 14,000), the biological survey reports highlight no other sewage 'hot spots' in the County. Three inland sites are specifically mentioned as sources of industrial waste; all related to paper making: Rossman, Stockport Bridge and Ancram. The type of pollutant is generally described as "pulp, pigment colors, de-inking, coating and bleaching wastes incidental to the manufacture of paper, fibre and paper products" (Figs. 23, 24). As the report succinctly stated, "From the cardboard paper mill north of Stockport so much waste enters the stream that life is almost entirely eradicated from the Kinderhook Creek in this area." [26]

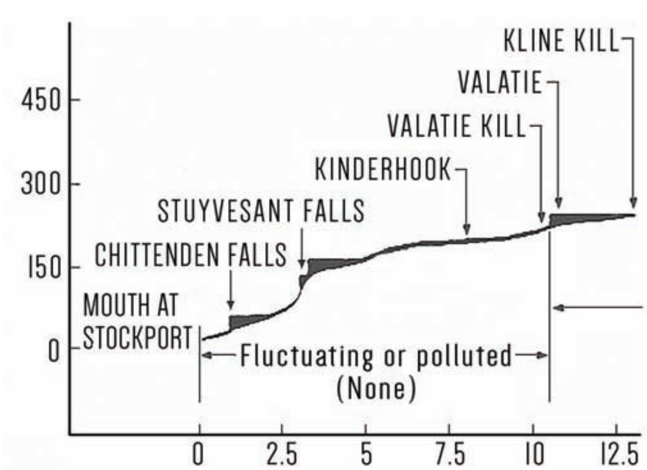


***Figure 23**. Extract from a longitudinal diagram of trout habitat on Kinderhook Creek which appears in the 1934* Biological Survey of the Mohawk Hudson Watershed. *Portions near the Creek mouth, where large mills were especially dense, had fluctuating water levels and high amounts of pollution. The vertical axis is elevation in feet, while the horizontal axis represents upstream mileage from the Hudson. "(None)" refers to the amount of existing Brook Trout habitat.*

While no other Columbia County sites are pinpointed in these reports, the biological surveys do describe several other types of pollution from elsewhere in the mid and lower Hudson Valley, and, given known activities in the County, these likely occurred locally to some degree. Perhaps most relevant are "textile wastes," that is "the wastes incidental to the fabricators, washing, bleaching, finishing and dyeing of cotton, wool, silk and rayon." Textile mills dotted our stream courses during the 19th century, although many had closed by the time of these surveys. The report also mentions "milk wastes" from dairy plants; again, there have been several dairy plants in the County during the past 150 years. Finally, the reports mention "waste from railroad yards and laundries." The Chatham and Hudson rail yards were busy and, in some ways, probably dirty places, and, while laundry establishments may have been scarce, their mention serves to remind us of the other household wastes, besides sewage, that entered the water stream.

Industrial Evolution Even after waterwheels gave way to steam and electricity, water remained important. Relatively pure water was needed to fill the boilers, and localized 20th century power companies often used water-powered generators. These included the efforts of the Red Hook Power & Light along the Roeliff Jansen Kill at Bingham Mills starting in 1908, Fred Munch's 1913 installations along the Stony Kill in Canaan, the 1900 venture to harness Stuyvesant Falls for electricity for the electric rail lines in the County, and the 1895 generation of the Valatie Electric Company along the Valatie Kill.[27]

Philmont, located where the Agawamuck Creek spills over High Falls, is an archetypal 19th century mill town (Fig. 25). Not only did mills border the Creek's course, dams regulate its outflows, and electricity generators eventually tap the water's energy, but a channel was dug through the town so that the inexorable attraction of water to the sea could be used to power a wider array of industry. Today, the channel has been abandoned and largely filled in. Landlocked mill remains stand incongruously far from water, and only scattered, dry trenches and sections of rusting iron aqueducts remain like

Figure 24.
A lithograph from Ellis' 1878 History of Columbia County, New York, *showing a water-powered paper factory. The grass being collected in the foreground may be rye, the straw of which was a key ingredient of early paper production. No doubt the prominently-marked "Bleach House" leaked some of its effluent into the Stockport Creek. Water highlighting added.*

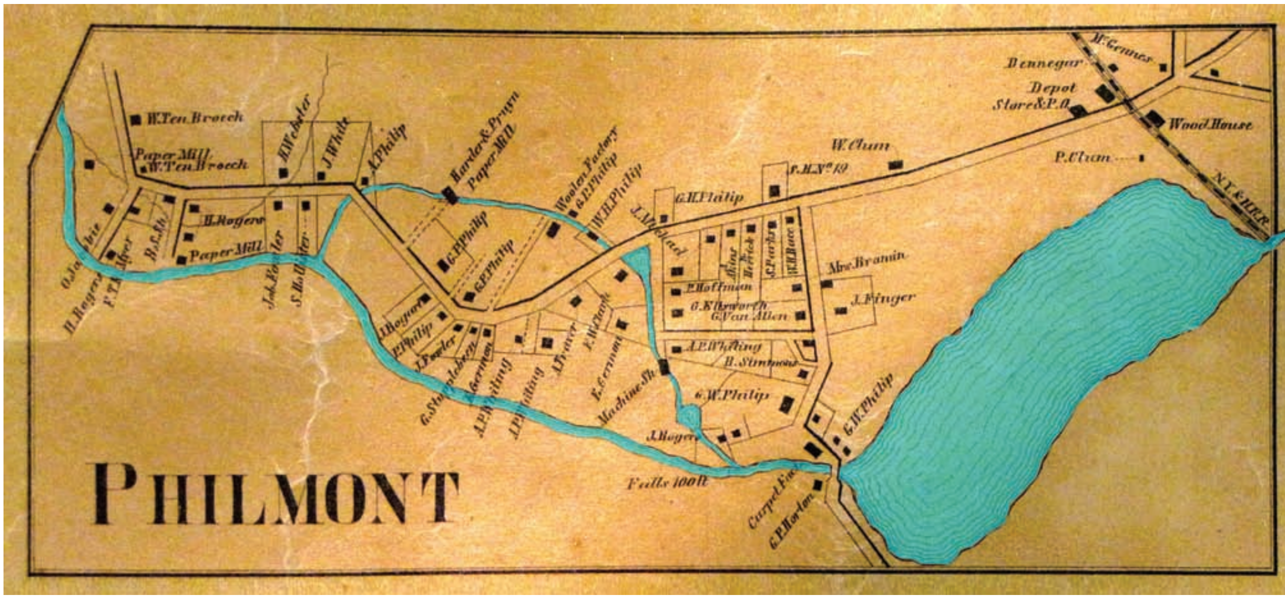


Figure 25. Philmont's aqueduct in the middle of the 19th century. The Philmont Reservoir, to the right, drains into the Agawamuck Creek, the larger and lower of the waters in the left hand portion of the map. The narrower loop of water was an aqueduct that powered several mills farther away from the Creek's natural banks. This map is from an 1858 Beers wall map; water highlighting added.

the fossilized remains of the blood vessels of some long-dead behemoth. They typify the fact that the County's waters are now largely irrelevant to industry. In part, this is because our sources of power have evolved beyond harnessing the pull of gravity on local water, but also because industry (and the jobs it provided) is now a very minor part of the County's economy. Hydropower still contributes some 20% of the State's electricity (third in importance after nuclear and natural gas), but, for us at least, those are distant waters, although recent efforts at Stuyvesant Falls are now supplying some hydropower again.

The Shaker community on Mount Lebanon could also be considered a 'mill town,' although one created despite lacking the conducive hydrological features that marked most of the County's mill towns. Ingenious water storage (Fig. 26) and diversion techniques drove this 19th century industrial village despite the fact that

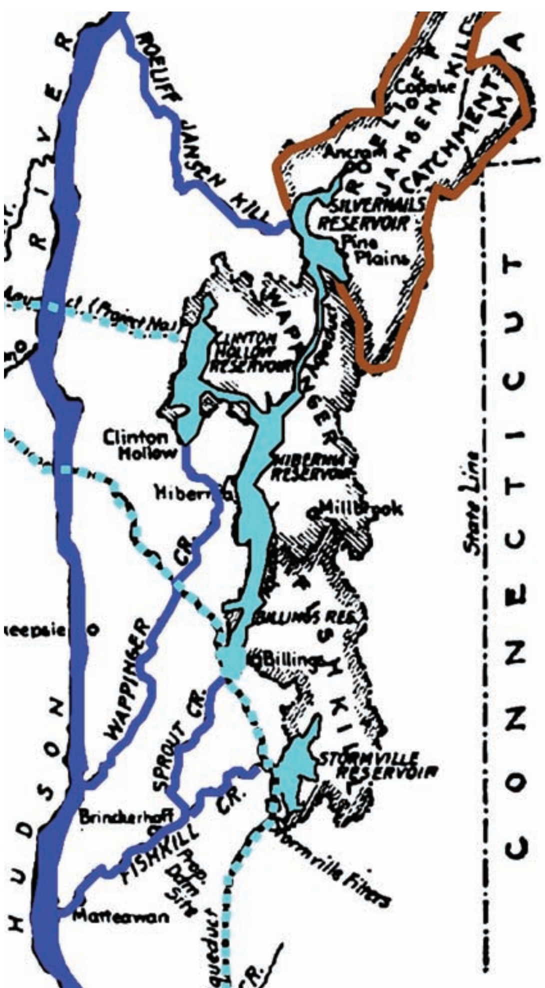
Figure 26. One of the Mount Lebanon Shaker Community's holding ponds. By gathering and holding their precious water supply, the Shakers of Mount Lebanon were able to power much of their industry.

they had little natural access to reliable water flows. By creating a series of holding ponds or reservoirs and linking those to their industries via aqueducts and piping, the Shakers were able to power a variety of devices from mills to power tools. Maintenance and management were, however, apparently a constant struggle.[28]

Ice production was another early use for our waters. The most extensive development of this industry occurred along the Hudson River, but lakes and ponds throughout the County were certainly also used for this purpose – during the winter, local newspapers abounded with accounts of ice-houses filled (e.g., George Tilden's from Queechy Lake), ice cutters receiving icy 'baths,' and run away ice wagons. Rural ice cutting and delivery in the County apparently lasted at least until the early 1960s, when George Staats retired from his ice cutting business at Sutherland Pond. Such activity reportedly provided not only local ice but off-season employment for hundreds in the County. The Hudson River ice industry cooled New York City. Insulated by hay, wood shavings or sawdust, huge ice warehouses dotted the river bank north of Catskill and, once the ice was out, barges transported ice to the City. The Hudson River ice industry was a massive commercial operation in the late 19th century: an 1888 report tallied a riverside ice holding capacity of over 2 million tons and stated that at least 20,000 men were employed during good years. The ice industry began to decline in the early 20th century as uncertain weather, the advent of mechanized refrigeration, and, harkening back to our earlier account of river pollution, public concern over ice purity destroyed the markets. Fire and time have erased most of the ice houses, although the remains of several still remain, including one on public land at Nutten Hook (Fig. 27).[29]

__Figure 27__. Remains of the powerhouse of the R. & W. Scott Ice House built around 1885. A huge ice storage warehouse once sat between the ruins and the camera. It held many tons of ice destined for downriver transport to New York City.

One water use that didn't come to pass, but would have had a large impact if it had, was supplying drinking water to New York City. During the first few years of the 20th century, the New York City Board of Water Supply proposed damming and diverting streams in Dutchess, Columbia and Rensselaer Counties to feed New York City reservoirs (Fig. 28). Having ruled out a reservoir in the Kinderhook watershed as requiring the payment of too much damages, proposed reservoirs did include one of more than 2,000 acres on the Roeliff Jansen Kill above Silvernails. It would have required the "taking" of more than 5,000 acres. Apparently water from the Roelif Jansen Kill would have been routed via an aqueduct to an even larger reservoir in central Dutchess County. This plan faltered when Dutchess County legislators succeeded in getting a 1904 state law passed that ruled out New York City's 'taking' of land and waters in Dutchess County (thereby making then-current plans for accessing Columbia County waters impractical). As one author put it, "Had the Dutchess County people not arisen in protest and won the support of the Legislature, the Croton system would in all probability now extend the length of Dutchess County and north beyond Hillsdale into Columbia County."[30]



More than 20 years later, after the repeal of the 1904 law, the New York City Board of Water Supply was again considering proposals for extensive east-of-the-Hudson hydro engineering (Fig. 29). A plan outlined in 1926 proposed to garner 433 million gallons of water daily from a massive system tapping not only the Roeliff Jansen Kill, but also Kinderhook Creek, the Kline Kill, the Stony Kill, Claverack Creek and Taghkanic Creek, together with Dutchess County waterways. The Board's Chief Engineer advocated this development as the most feasible, but the Commissioners of the Board supported development in the Delaware River watershed instead, perhaps in part because of the higher costs of coping with Columbia and Dutchess Counties' harder waters (i.e., laced with calcium carbonate from

***Figure 28**. Map from a 1904 New York City Board of Water Supply report. It shows the northernmost 'Silvernails Reservoir' located at about the midpoint of the Roeliff Jansen Kill. Water was to be piped south from here to Dutchess County reservoirs and, eventually, New York City. Highlighting added with the Roeliff Jansen Kill watershed to be tapped indicated in brown, reservoirs in light blue, natural waters in dark blue, and aqueducts as dotted, light blue lines.*

limestone and similar rocks) and the potential for rehashing old political fights. Distracting legal challenges to their Delaware River intentions together with the deepening Depression caused the east-of-Hudson plans to founder, and the waters of Columbia County had been spared one more time.[31]

Water and Farming Water and agriculture have had a long love/hate relationship. Our relatively ample rainfall is usually more or less evenly distributed across the year. The growing of crops has frequently been limited more by the quality of the soil or the lay of the land than by any shortage of water. As one local, field-crop grower noted, we may not have the Midwest's extensive flatlands or super-rich soils that permit occasional record yields, but nor do we so often have the droughts that can hammer production. Farmers looking for moderate but steady yields, especially grass-based producers, could do worse than the Hudson Valley.

While a regular rainfall and fair networks of surface and ground waters (sources of potential irrigation) are a boon, the water-logged soils that sometimes result are less welcome. We have already (in the previous chapter) mentioned the replenishing quality of floodwaters and the relatively inexhaustible supply of hay that could be cut from floodplain meadows. Higher floodplains remain a favored site for corn growing (Fig. 30). Wetlands can form rich soils as organic material (the residue of past plant growth)

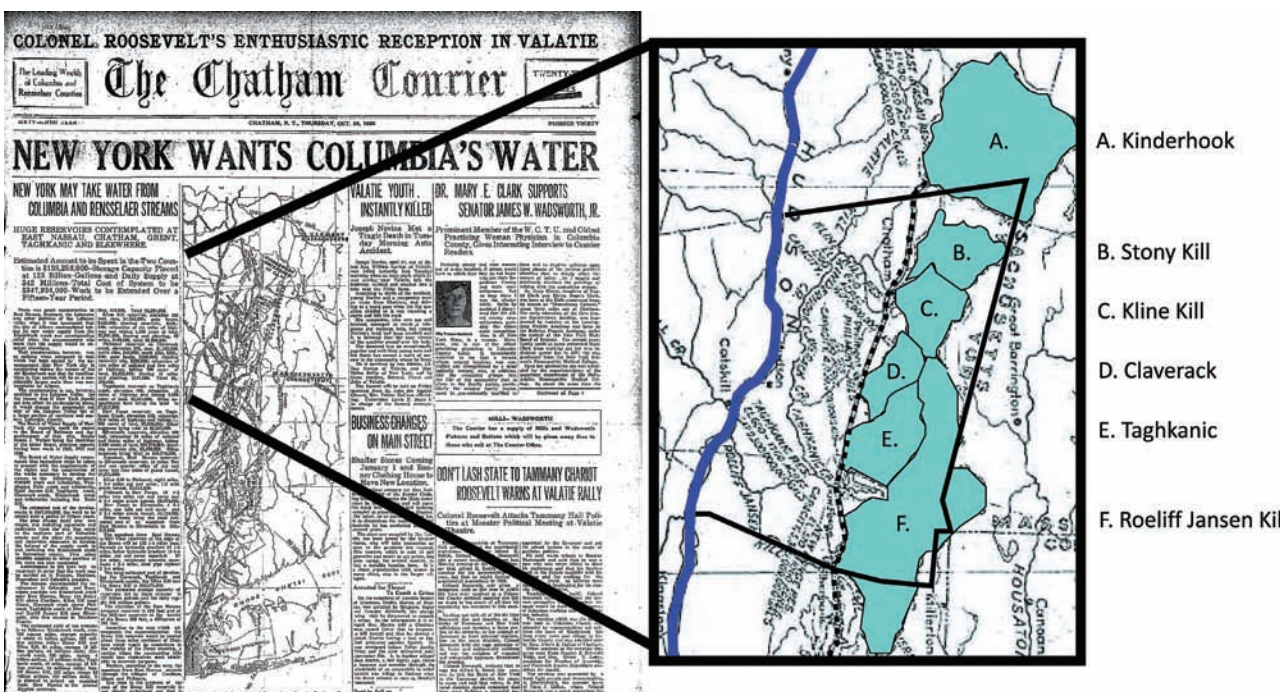


***Figure 29**. The front page of the* Chatham Courier *on 28 October 1926. The map, apparently taken from yet another Board of Water Supply report, showed various reservoirs planned for Columbia County. However, the lettered areas, highlighted in the map enlargement to the right, are of the portions of the watersheds planned for damming, NOT of the intended extent of the reservoirs. The hatched line was a planned aqueduct.*

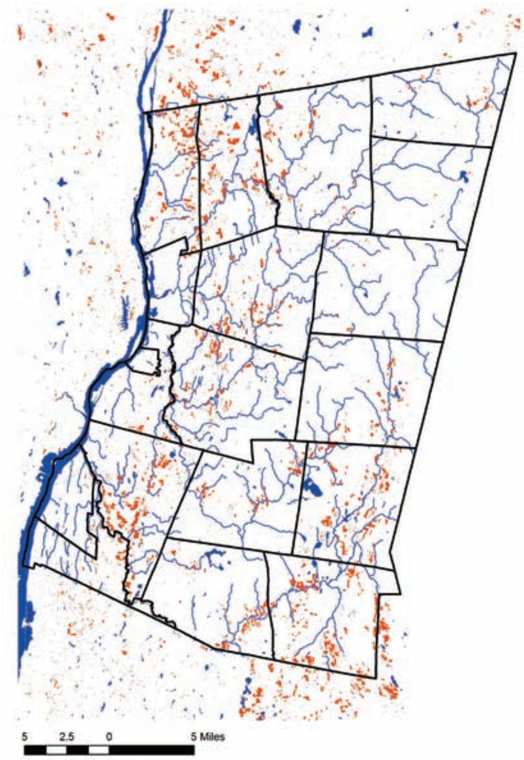


***Figure 30**. The location of corn fields according to the USDA 2010 crops layer. Notice how many of the cornfields are located along creeks. Higher floodplains are often considered ideal corn-growing soils.*

accumulates. But too much water can damage crops and/or inconvenience harvest. The latter limitation has become especially true as heavy machines have become an important part of field preparation and crop handling. Conveniently, such machines also are better diggers of drains. As the technology of farming itself advanced, so too did the technology of soil excavation and engineering.

The 1858 edition of *The Transactions of the New York State Agricultural Society* presents a map of that year's 'trophy farm' (Fig. 31). That farmer (admittedly located on the banks of Seneca Lake rather than here in Columbia County) managed to fit 61 miles of drains into his 344-acre farm. While local drainage campaigns may have never reached such densities, the length of drainage ditches hidden in County fields is probably much greater than one would think, especially in areas of clayey soils where water might otherwise pool near the surface. During recent years, the drainage of some fields has not been maintained, and wetlands have been reborn (Fig. 32).[32]

Aside from altering flows and, as alluded to earlier, silting waterways, the Rev. Warden, in describing Kinderhook Creek, noted another effect of farming on hydrology: old-timers described decreased flows which they attributed to extensive agricultural clearing along the Creek, "Some of the oldest people of the place say that the creek has suffered a considerable diminution. The cause of this appears very obvious. From the place where the creek takes its rise to the North river, of late years, the woods have been destroyed and the

***Figure 31**. Robert J. Swan's Farm, selected as the 'Best Grain Farm' in the State by the New York State Agricultural Society and mapped in their 1858* Transactions. *More than sixty miles of drainage had been laid on this farm; while not located in Columbia County, it exemplifies the draining occurring on farms around the State during this era.*

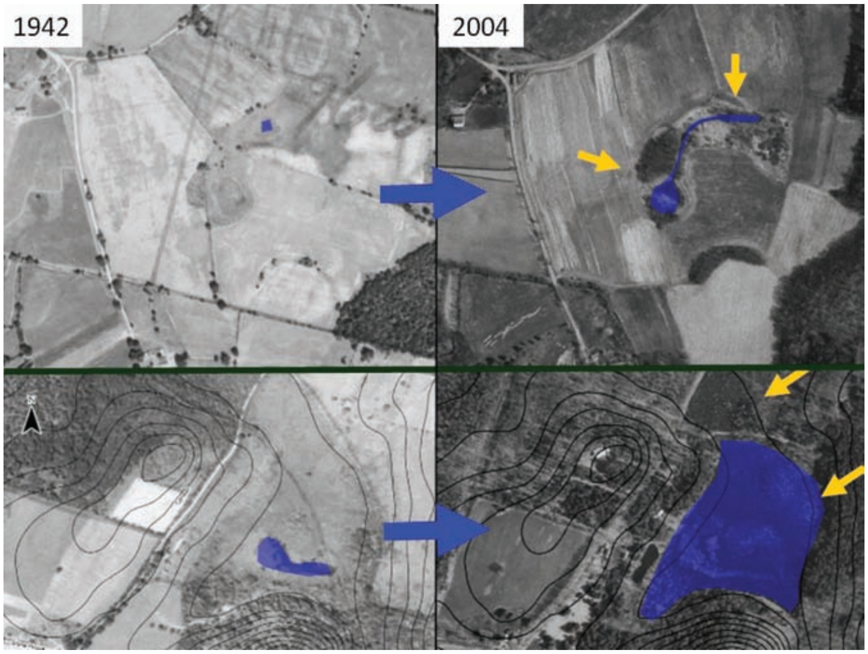


***Figure 32**. Aerial photographs from 1942 and 2004 of wetland sites in the Towns of Ancram (top two photos) and New Lebanon (bottom two photos). Yellow arrows on the more recent photos indicate the location of modern wetlands that are much more reduced in the older images; topo lines have been included on the New Lebanon photograph to help with orientation and understanding of land use. This rebirth of wetlands probably reflects the degradation of drainage systems installed in the 19th century.*

lands cultivated." Modern research suggests that forest removal decreases landscape 'absorbancy,' meaning that heavy rains quickly flow through the system, rather than seeping out more slowly and evenly. However, forests not only hold water, they promote the on-site loss of water through evaporation from leaves. A recent summary of deforestation effects suggests that not only are floods more extreme but total outflow of water is also higher. Nonetheless, for much of the year creeks may indeed have been drier, and 'run of the mill' water levels indeed lower. These effects were widely noted during the colonial period.[33]

Although livestock use of waterways and the manuring or guanoing of fields no doubt enriched some aquatic habitats historically, as it continues to do today (Fig. 33), water contamination may have only become a regular bed-fellow of farming as new fertilizers, pesticides and herbicides were introduced. This trend accelerated markedly after the end of WWII.

As noted in our chapter on fields, various pesticides and herbicides are today applied to the County's surface, and a good portion of these are associated not with agriculture

***Figure 33**. These pigs enjoyed muddy grounds near a small farm stream. Such use adds nutrients and sediments to the waterway.*

per se, but with our attempt to keep lawn, garden and golf course green and weed and pest-free. Depending on what, when, where and how much, many of these chemicals end up in our surface waters. The results of these and other trends for our current waters are described in the next section.

The State of the Waters

Water in nature is rarely pure. Geology and life usually add ingredients. In some parts of the world, such as the Amazon basin, where surface rocks have been washed by multiple millennia of rains, stream and river waters can run startlingly clean (one hydrologist described them as slightly tainted distilled water), but life is still usually adding its weak tea and, during the flood season, waters can be muddy indeed. In our landscape, thanks to recent glacial tickling, the surface geology is generally fresher and erosion is more active, so that surface waters rarely reach such purity. It would be wrong however to equate purity with the good, and 'dirtiness' with contamination. Rain falling on sterile, highly-weathered rock might achieve near purity, but that would not be a landscape we would like to live in. On the other hand, not all dirt is 'good dirt.' Evaluating the current state of our waters thus becomes a matter of trying to tease apart sources of muddying, and of making decisions about what "impurities" at what levels are acceptable.

Water Testing Aquatic scientists have responded to this situation with two general approaches to water testing that could be stereotyped as the participatory, broad-brush assessment and the clinical, highly specific measurement. The former is exemplified by the use of aquatic macroinvertebrates in streamwater bioassessment. "Macroinvertebrate" refers to bigger-than-microscopic, spineless creatures; the word "invertebrate" rather than "insect" is used because not all of the tiny aquatic creatures are, taxonomically, truly insects but all do lack backbones. The idea behind this approach is that the various insects and insect-like creatures found in our waters differ in their susceptibility to pollution. Researchers have estimated these susceptibilities by studying the macroinvertebrates of both pristine and polluted creeks. Compared to clean streams, populations of sensitive organisms, such as mayflies, stoneflies and caddisflies, tend to be measurably lower in polluted creeks (Figs. 34, 35). Other organisms, such as leeches, blackfly larvae, and aquatic worms are heartier and may expand into or at least maintain themselves in some polluted waters.[34]

Figure 34*. The housings of a multitude of caddisflies dot this stream rock. The aquatic young of caddisflies build carry-along houses in somewhat the manner of snails, but they are constructed from plant debris or sand grains collected from their surroundings. Caddisflies tend to be sensitive to water pollution and their presence is generally considered to indicate relatively clean waters.*

If one wades into a stream, grabs a random sample of 100 organisms, identifies them, and then calculates what percentage of the total population is composed of creatures of the various sensitivities, one can get a good general idea of a waterway's health. (A related, if somewhat less practical, index has been derived based upon the composition of fish communities.) While a refined application of this approach does require a microscope and sound taxonomic knowledge of aquatic invertebrates, a basic and not irrelevant assessment can be applied by school children with magnifying glasses. No toxic chemicals are needed and, at that most basic level, this testing can even be done by counting live creatures which are then returned to the water. Not surprisingly, this approach has found popularity among citizen scientists.

The second approach to water testing is that of the direct, specific assessment of particular compounds or water characters. A small subset of these chemicals can be tested *in situ*. There are, for examples, methods for measuring oxygen, pH, nitrates, phosphates and a few other characters in the field, although in most cases such field tests are substantially less accurate than laboratory measurements. Usually some sort of meter and often additional (occasionally toxic) reagents are needed. While some simple measurements are possible with minimal training and equipment, for the most part such testing is the realm of the professional water scientist in the laboratory, where a much wider range of chemicals can be tested for with much more precision.

Both of these approaches have their strengths and weaknesses. Bioassessment lets one escape, to a certain degree at least, the prerequisite of picking one's poison. That is, one asks the basic question: is the invertebrate community in these waters healthy? One receives a 'yes/no' answer. A positive answer is generally re-assuring because the aquatic communities respond to a wide array of toxins and physical perturbations (albeit not all), and so a clean bill of health suggests freedom from a variety of potential contaminants. A negative answer likewise is a valuable red flag suggesting that some, perhaps previously undetected, issue is at hand. Bioassessment also integrates across time. The community of aquatic organisms that one finds in a stream today reflects water conditions over a matter of days, if not weeks. Past toxins, even if now undetectable in the water, leave their biological legacy. This approach's weaknesses mirror its strengths. Its generality means that, in the case of a red flag result, one might still be left asking: what is our water quality issue? When did it happen? Certain refinements are

Figure 35*. A mayfly adult, recently emerged from a nearby water body, perches on a sedge spike. Mayflies often emerge in synchronized groups, and seem to enjoy perching on the screen doors of nearby houses.*

possible – for example, ‘simple’ sewage-caused nutrient enrichment will tend to produce ecological alterations that differ from what a poisonous spill might create. Nonetheless, bioassessment is generally perceived as a biological community ‘first cut.’

The clinical approach to water testing trades generality (and approachability) for specificity. To apply these tests, one needs to decide, *a priori*, what one is testing for. Are you looking for nitrates, bioaccumulated mercury, hormone mimics, PCBs, motor oil? In other words, you need to know what your problem is likely to be before you test for it. While applying a suite of tests to a water sample can broaden the array of chemicals you might detect, you are still left with the basic issue that, if you aren’t already testing for the potential pollutant, then you won’t detect it. In addition, these tests measure conditions at one point in time. If the factory upriver released toxins into the water flow at 2am, and you test the waters at 4pm the following day, then you might find little indication of an issue. These tests are often relatively expensive, and so the urge to ‘test for everything’ is quickly dampened by the bill for such an approach.

A similar conundrum, pitting ease of generality vs. cost of specificity, occurs when testing for microbiological contamination (e.g., disease-causing micro-organisms that might enter water via sewage). For example, there are relatively easy tests for coliforms, a group of bacteria often found in the mammalian gut and hence in sewage. These simple tests can indicate whether or not sewage contamination is occurring. However, most coliforms are innocuous, and so total coliforms tells you relatively little about that water’s potential to cause disease. Detecting the presence of known pathogens or even discriminating between contamination from humans vs. livestock involves detailed analysis beyond the reach of many water assessment projects.

Water testing is diverse, and techniques are evolving. However, as you read water test results, it is important that you understand, in a general way, what such tests can and cannot tell you. Depending on the test, “clean” water may not really be clean, and “dirty” water may not really be dirty.

One final set of terms should be defined: water scientists speak of “point source” and “non point source” contamination. These terms refer to how easily the geographic origin of a particular pollutant can be identified. In some cases, specific facilities or operations can be pin-pointed as the source of nutrients, microbes or chemicals. Wastewater treatment plants that are either misfunctioning or were never designed to fully clean the waste are one example of such sources; a livestock loafing area with direct run-off into a creek might be another; a factory discharging waste products could be a third. These are examples of “point source” contamination. However, in many cases, the waters are being sullied by ‘non-point sources.’ In other words, nutrients might be seeping in from a whole suite of leaking septic systems strung out along a creek, none of which has a discrete ‘outfall’ pipe, but all of which make ’donations’ that progressively contaminate surface waters. No single septic system may be THE problem, but, together, all of them are problems. Likewise, while large animal feedlots

(CAFO's in regulatory lingo) are governed by certain water quality regulations, smaller operations are not and, while fewer animals dispersed over a wider landscape are, again, less apt to be the problem, their contributions can add up. Given the diffuse nature of responsibility, such non-point source pollution is difficult to improve.

Water testing is always playing a game of catch up for at least two reasons. First, unlike our acts of water pollution, water testing has to be done consciously and explicitly. That is, it takes only ignorance to sully our waters, but it takes an intentional investment of time and often money to assess our water's health. Needless to say, the former is easier than the latter. Second, even if one decides to assess a water's quality, what do you measure? We are leaking new chemicals into our waters daily; which of these should get measured and how does one measure them? The example of hormone mimics (see p. 273) illustrates that the subtle effects of prevalent contaminants can long go unnoticed.

Current Status Researchers often predict water quality based upon land use. This approach makes sense both because it is efficient (inspecting aerial photographs takes less resources than collecting and analyzing water samples) and because, after climatic and geological conditions have been taken into account, land use is probably the major determinant of water quality (although aerial deposition is also important). Hydrologists have, for example, created models predicting herbicide and pesticide contamination levels based on the extent of developed or agricultural land in a given watershed. For the most part, Columbia County's modern water quality is what one would predict given its relatively sparsely settled landscape with comparatively little agriculture or industry: most of our waters, exclusive of the Hudson River itself, are fairly clean. Bioassessments done around the County during the first decade of the 21st century indicated primarily non-impacted or slightly impacted conditions (Fig. 36). Nonetheless, our land use is reflected in our water, and "fairly clean" is relative more to other, worse-case regions, than to truly pristine conditions. In fact, only about half of the tested sites were deemed to be non-impacted.

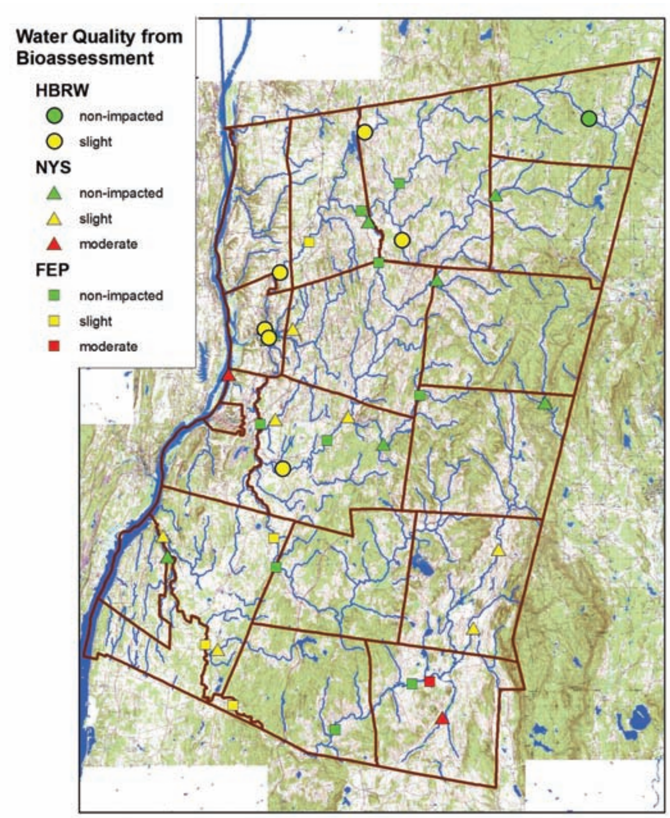


***Figure 36**. Water quality as derived from bioassessments done by the Hudson Basin River Watch (HBRW), New York State Stream Bioassessment Program (NYS), and the Hawthorne Valley Farmscape Ecology Program (FEP). Only 25 out of 48 sites were judged to be non-impacted.*

Six modern water quality and aquatic habitat issues, potentially accounting for some of the observed impacts, are the following: 1) nutrient enrichment, due to human sewage, animal manure and synthetic fertilizers; 2) microbial contamination, primarily from human sewage, possibly also from animal manure; 3) pesticides and herbicides applied to crop fields and home gardens; 4) sedimentation and other physical alterations due to land use modification; 5) PCB, heavy metals and fossil fuel residues or byproducts (hydrocarbons) from industries and engines; and 6) drugs and 'life-style byproducts.' Because of the uncertainties associated with water testing and with determining impacts on health and ecology, one cannot say for certain that these are the most important issues; only that they are ones which, given the tools at hand, have been evident.

Nutrients It would seem that, almost by definition, "nutrients" are a good thing, but too much nutrients can skew a waterbody's ecology. Just as we have seen that nutrient-poor fields tend to have more native plant species than nutrient-rich fields, so too have aquatic communities evolved to coexist with certain, often relatively scarce, nutrient concentrations. When unusual loads of nutrients enter the water, new ecological communities, often marked by algal blooms, result and other ones disappear. "Eutrophication" refers to this process of ecological change occasioned by excessive nutrients (Fig. 37).

When looked at from the perspective of the nutrients that the Hudson River contributes to the Atlantic, the primary pollution source is probably human sewage (and, ultimately, human food imported into the watershed from elsewhere), one study concluded that 58% of the nitrogen and 81% of the phosphorus found at the mouth of the Hudson came from New York City's sewage itself. For nutrients entering the Hudson River from Columbia County, it is likely that agriculture makes, relatively speaking, a larger contribution although, given our relatively low livestock and human densities, the total nutrient load is small.[35]

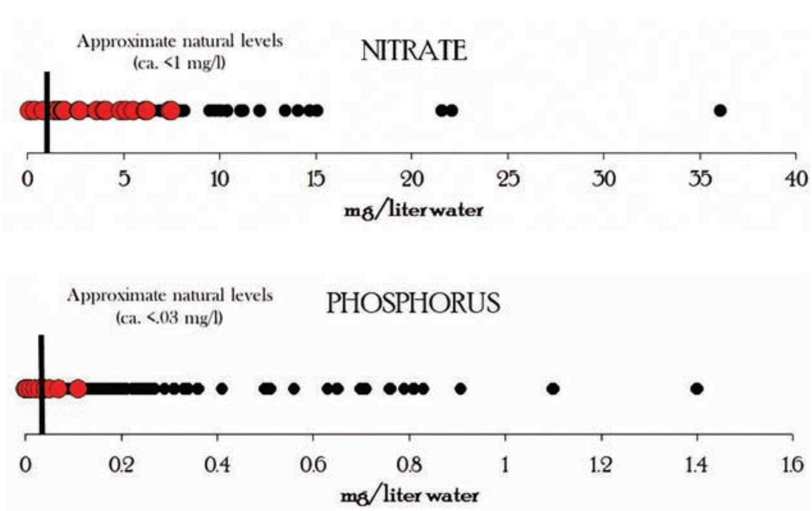
Nitrate data from Columbia County (Fig. 38a) indicate medium levels of enrichment, not as high as some sites elsewhere in the Hudson River basin but up to 5-8 times background levels. Phosphorus levels (Fig. 38b) from the County again showed modest signs of elevation, exceeding presumed background levels by perhaps 3-4 times in

***Figure 37**. Algae and other blooms of aquatic greenery are taken as a sign of eutrophication – the skewing of aquatic communities brought on by too many nutrients in the water.*

certain cases. These levels are high enough to cause visible stream or pond eutrophication as indicated by the green or brown slime that develops on the rocks of many of our streams during summer, and as reflected in bioassessment results indicating "slight impairment" of aquatic ecologies.

Microbial Contamination Nutrient enrichment and microbial contamination often go hand in hand. Animals, including humans, excrete not only a portion of the nutrients that they consume, but also some of the microbes living in their guts. Thus, sewage contamination and livestock run-off tends to result in both nutrient and microbial 'enrichment.' Some such microbes can cause sickness, such as typhus and cholera. Distinguishing between the two sources (that is, human vs. livestock) is difficult without additional costly testing for other compounds such as caffeine. Based upon microbial assessments done in the County by the Greater Stockport Watershed Alliance and DEC, there is strong evidence that sewage treatment plant 'leakage' is one source of contamination in the County; the sites with the highest microbial counts were located downstream from municipal or institutional water treatment plants. However, during two rounds of testing by The Greater Stockport Creek Watershed Alliance during the summer of 2011, only one third to one half of the 16 sites tested had satisfactorily low microbial levels. This implies broader, non-point source contamination as well, probably deriving from leaking septic systems and/or agriculture.[36]

In general, sewage contamination is a persistent issue, despite technology to avoid it. In rural areas, adequate control requires that each of the many private septic systems is functioning properly. Because this requires individual land-owner investment and because the testing of established septic systems is virtually non-existent, septic system malfunction is a chronic problem. Modern regulations concerning the construction of new septic systems may help reduce future problems. Another issue, evident around towns and cities, is that many municipal sewage systems, installed with the help of federal funding decades ago, are now requiring upkeep, which financially-strapped communities are



***Figures 38a, b**. USGS data on nitrate and phosphorus concentrations in Hudson Valley waterways (combined data from the 1960s - 1990s). Nitrogen and phosphorus are applied as plant fertilizers and also enter the waterways at cattle farms and from leaking sewage systems. The red dots indicate Columbia County sites. While Columbia County does not have the most polluted waters, for both nitrate and phosphorus, multiple sites exceed natural levels and probably experience eutrophication.*

Data are from USGS on-line water quality data, http://waterdata.usgs.gov/ny/nwis/qw not able to provide. A 2008 DEC report stated that Federal funds for waste water management during that year were one third 1991 amounts. After a period of dramatic improvements, the quality of Hudson River waters continues to be challenged by this issue; more than one third of the readings taken by River Keeper at the City of Hudson waterfront since 2006 had unacceptable bacterial levels.[37]

__Figure 39.__ Synthetic pesticides, while helping to control damaging pests, have seeped into waterways where they can impact aquatic communities and enter into drinking water supplies.

Herbicides and Pesticides (Fig. 39) Herbicide and pesticide pollution reflects our landscape's agricultural and non-agricultural development. A review of such contamination in the Northeast, based on sampling done in the 1990s, suggested that agriculture could be linked to the majority of herbicide pollution, but that lawn/garden/home care was the primary source of insecticide contamination. Overall, total pesticide (herbicide + insecticide) sales are markedly higher in urban and suburban counties than in more rural areas.

Columbia County stream water testing conducted during that decade found appreciable contamination of the then-common herbicides atrazine, metachlor and simazine in the Roeliff Jansen Kill. In fact, the Roeliff Jansen Kill had some of the highest concentrations recorded from the Hudson Valley for all three chemicals. Atrazine (Fig. 40) is the most widely used and most controversial of the three. Atrazine is an herbicide commonly used for weed control in corn fields and, sometimes in orchards. The results of research into the effects of atrazine have been mixed, but various studies, including one by USGS, have indicated possible effects on amphibians and fish. There have also been suggestions that atrazine

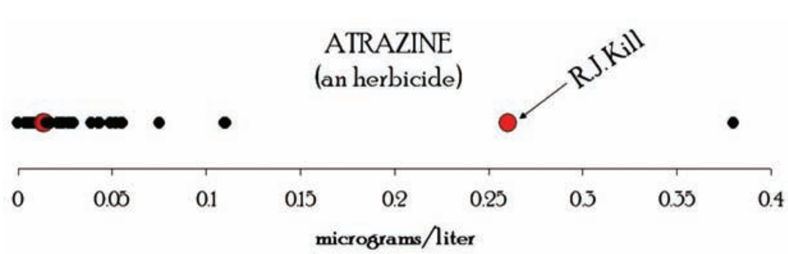


__Figure 40.__ USGS data on atrazine concentrations in Hudson Valley waterways; the red dots indicate Columbia County sites. All these data come from the 1990s. Atrazine is a widely-used herbicide, which has been tied to aquatic ecology impacts such as reduced fish reproduction. The Roeliff Jansen Kill, one our most agricultural watersheds, had a markedly high atrazine concentration.

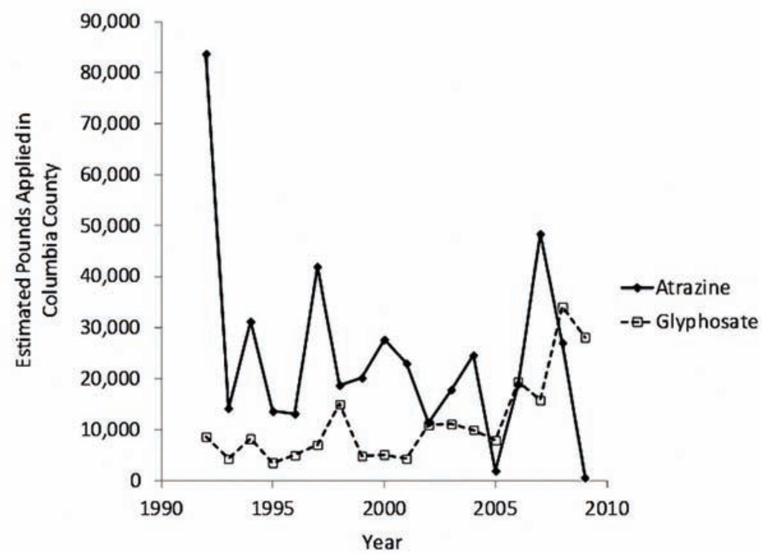


Figure 41. *USGS's estimated use of the herbicides atrazine and glyphosate (the active ingredient in Roundup) for Columbia County from 1992 to 2009. Atrazine use may have dropped after the adoption of glyphosate, but recent indications, at least at the national level, are that concern for glyphosate-resistant weeds is leading to renewed interest in atrazine.* Data from http://water.usgs.gov/nawqa/pnsp/usage/maps/

might be a carcinogen and may affect reproductive health, although the findings have been mixed, and both EPA and the National Cancer Institute have stated that there is little indication that it is unsafe. Since the 1990s, glyphosates, better known under the trademark Roundup, have become the herbicide of choice for both home and farm. Unfortunately, we have no recent regional data on glyphosate contamination. Local (Fig. 41) and national data suggest that, while atrazine application initially dropped off with the introduction of glyphosates, the spread of glyphosate-resistant weeds is resulting in continued, if not increasing, atrazine use.[38]

One of the major reasons that atrazine safety has been so hotly debated is that, nationally, it has been commonly found not only in surface waters but also in well water. Work in the Midwest documented atrazine in more than one third of stream samples collected during the 2000s, and glyphosates or their degradation products in about two thirds. A slightly later study of vernal pools and adjacent streams in protected areas in four different states found atrazine in over half of all samples and glyphosates in about a third. Unlike glyphosates, which apparently bind tightly to the soil, Atrazine readily enters the ground water and hence numerous drinking water supplies. Atrazine apparently occurs in the majority of Midwestern public water supplies, and a recent DEC report summarized the relatively frequent occurrence of generally low levels of atrazine in public water supplies and private wells on Long Island. In 2012, Syngenta settled a $105 million class-action lawsuit from towns claiming damages due to the presence of atrazine in their water supplies. The use of atrazine is highly restricted in the EU.[39]

Amongst insecticides, DDT was used extensively in the Hudson Valley, and testing during the 1990s indicated that it was most common in urbanized watersheds. DEC testing in the 1990s found high levels of DDE (a breakdown product) in the Kinderhook, our most suburbanized major watershed (Fig. 42). A second pesticide, dieldrin, used on both crops and lawns, was higher in the Claverack

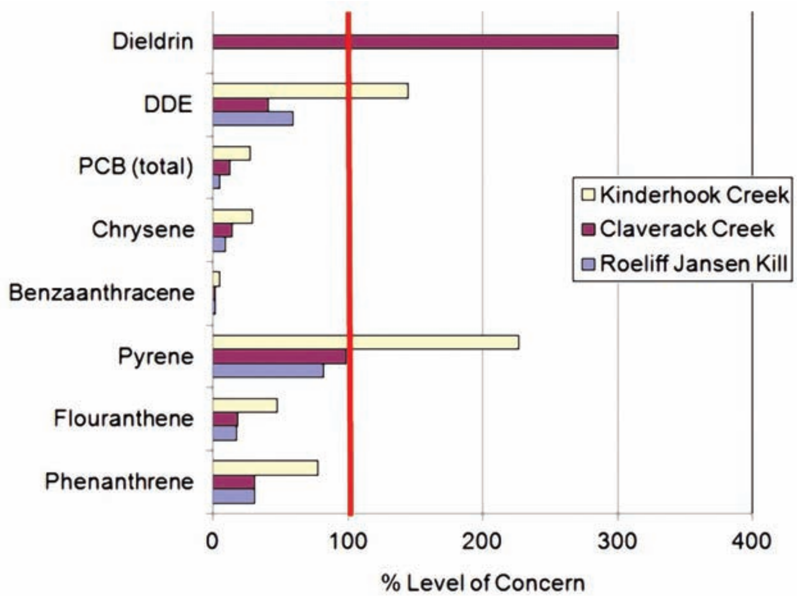


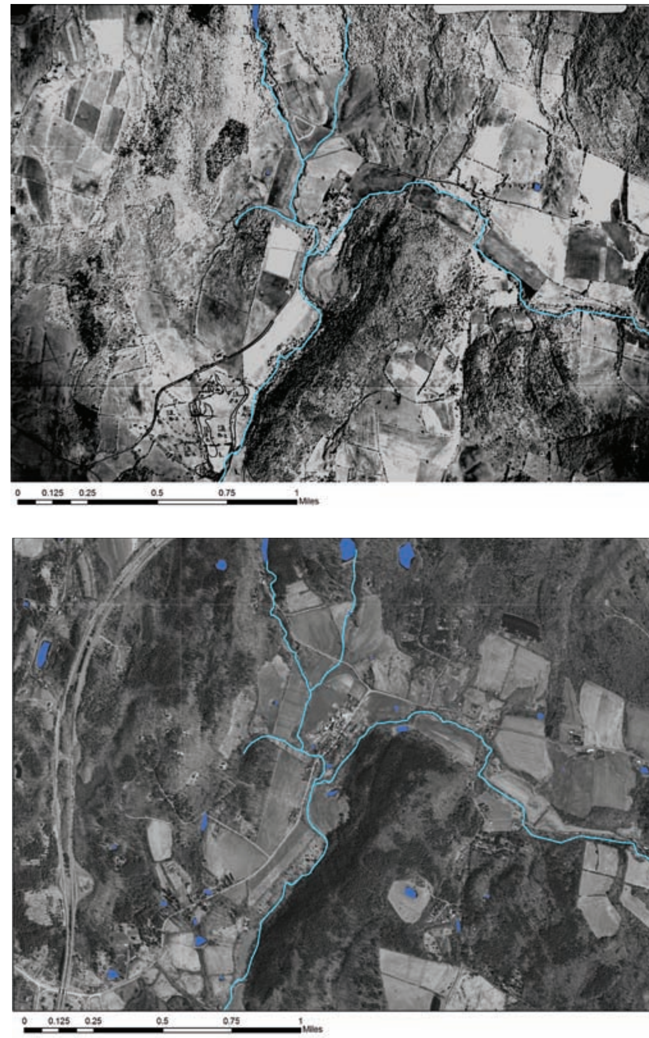
Figure 42. *DEC data on concentrations of various organic compounds and insecticides in aquatic macroinvertebrate tissue during the 1990s. These values are expressed as a percentage of the levels believed to cause ecological impacts, that is t o be 'of concern.' DDE is a DDT breakdown product, while dieldrin is a persistent pesticide. Dieldrin use in the United States ceased in the 1980s due to evident health risks. Pyrenes are products of the incomplete combustion of fossil fuels.* Data from Bode, Note 40

Creek. In contrast to its herbicide concentrations, the Roeliff Jansen Kill had relatively low insecticide concentrations, perhaps reflecting the relatively low population density of its watershed and the limited use of insecticides on corn. Lead arsenate was widely used as a part of Gypsy Moth control efforts (at least 20,000 lbs were applied for this in the eastern part of the County, mainly in the 1920s and 1930s) and as an insecticide in apple orchards. Heavy metals are considered under industrial pollution below.[40]

Physical Modifications of Aquatic Habitat One can conceive of two general categories of physical modifications: changes in the physical properties of the water itself (such as color, exposure to light, temperature, flow rate and suspended sediments) and changes in the stream bed (for example, in the muddiness of its bottom, in the presence of overhanging banks, in depth, in in-stream debris such as tree trunks). For the most part, we do not have historical records of these characteristics and so it is difficult to evaluate change. While it is easy to imagine how farming and subsequent clearing, for example, opened up stream corridors and increased stream temperatures, and how reforestation may have reversed some of that warming, we have little local evidence of these occurrences. Likewise, the effects of the recent proliferation of ponds in landscaping on hydrology is uncertain: our study of a ca. five-square-mile area around our home base found that open ponds went from three in 1948 to 33 in 2011 (Fig. 43). Based on these and other remote sensing data, we estimated that pond area in the County has increased dramatically over the past several decades, perhaps now exceeding historical levels of beaver pond extent (Figs. 44, 45). Beaver-made and human-made ponds differ in their hydrological location with the former occurring along streams and waterways and the latter more apt to be in shallow wetlands or more isolated locations; they can also differ markedly in their ecologies.

Industrial / Machine Contaminants

One of the dams which was removed during the 20th century was at Fort Edward on the Hudson about 40 miles north of Troy. While such dam removal may return water flow to more natural patterns and increase ecological connectivity for mobile organisms such as migrating fish, in this case, the 1973 removal also resulted in a pulse of contaminated sediments. PCBs had been used in production of transformers by two GE plants located near Fort Edward; during the process, an estimated 200,000 – 1,300,000 pounds of PCBs were released into the Hudson. PCBs are long lasting, toxic, and bioaccumulate. This means that as they are consumed by wildlife and as those animals are then consumed by others, tissue concentrations amplify so that toxic effects become apparent in those top predators (such as River Otters). Resident predatory fish in some sections of the Hudson are now considered too tainted to be fit for human consumption. Beginning in the mid 1950s, PCBs had already been contaminating lower reaches of the Hudson, including Columbia County, but the dam's removal released a large 'plug' of contaminated sediments into the River. At about the same time, GE began using the Dewey Loffel dump site in Nassau, Rensselaer County to dispose of PCB-contaminated wastes. PCBs leaked from this dump into surrounding waters, contaminating Kinderhook Lake and the Valatie Kill (Fig. 46). In the 1950s, lesser amounts of PCB-contaminated GE materials were apparently disposed of at the Bouchard Junkyard site along the Wyomanock in New Lebanon. GE and EPA have been conducting dredging to remove PCB-containing Hudson River sediments. The removal has been controversial, in part because some fear that the stirring up of these sediments will spread contamination further in the aquatic ecosystem. Recently, EPA remediation efforts also began at the Dewey Loeffel site.[41]



Figures 43a, b. *The location of ponds in a ca. five square mile area centered around Harlemville in northwest Hillsdale. Top shows ponds evident in a 1948 aerial of the Valley. Bottom shows ponds visible in a 2011 aerial shot. Pond numbers went from three in 1948 to approximately 33 in 2011.*

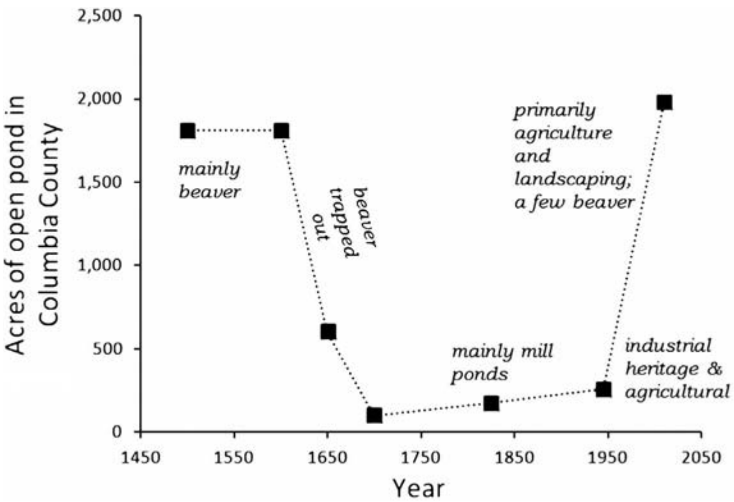


Figure 44. *A hypothetical graph of acreage of open ponds in Columbia County over the last 500 years. Aside from geological forces, ponds were created by beaver and by humans. As beaver were trapped out of the County, area in ponds probably dropped dramatically. Subsequently, ponds were dug for mills and, later, for agriculture. The current blooming of ponds can largely be ascribed to landscaping.*

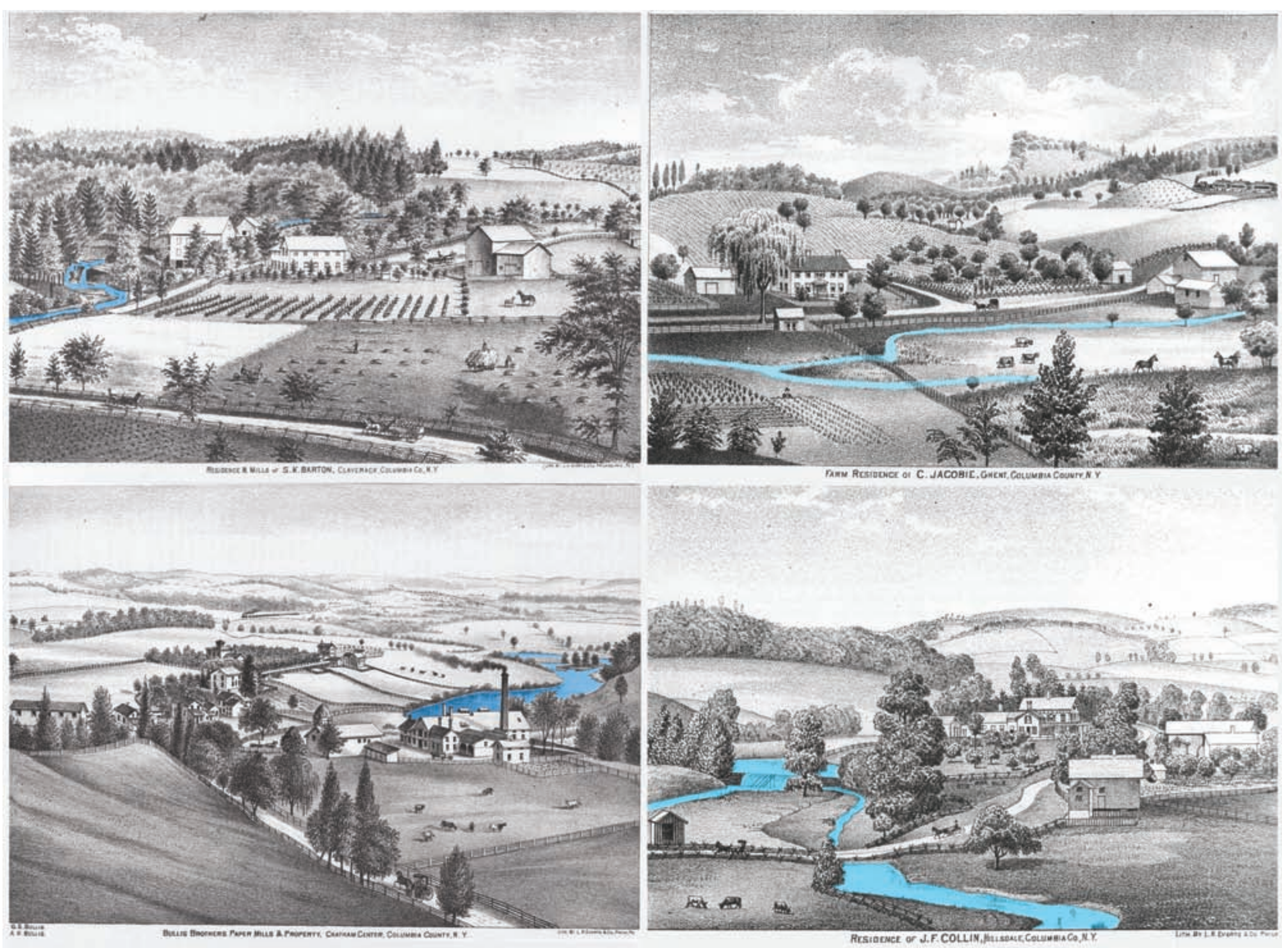


Figure 45. *Rural Columbia County scenes from the 1870s. These images, from Ellis' 1878 history of the County, show the lack of isolated ponds. Streams and in-course mill ponds are visible. Watering holes or landscape ponds are not. Water highlighting added.*

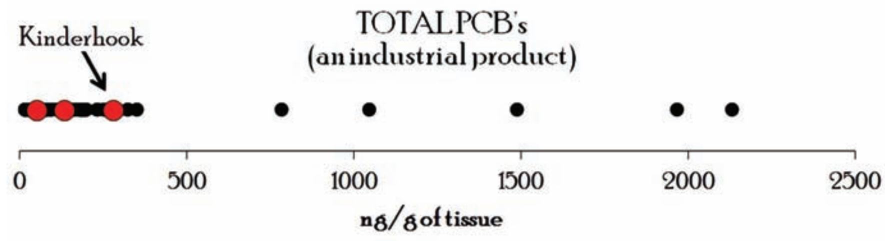


Figure 46. DEC data on PCB concentrations in the tissue of macroinvertebrates from Hudson Valley waterways; the red dots indicate Columbia County sites. All these data come from the 1990s. PCBs were used during the manufacture of electrical equipment, but were outlawed once the health risks became apparent. General Electric, a major PCB user, dumped PCBs at a pair of garbage sites in the upper Kinderhook Creek watershed. As this graphic suggests, PCBs then seeped into the Creek. Data from Bode, Note 40

Heavy metals can come from a variety of sources. They are naturally occurring but are intentionally or unintentionally concentrated through a variety of processes. They are of health concern because they can replace other metals naturally used by our bodies; the bioaccumulation of such replacement can cause severe physiological problems in humans and other animals. Two of the heavy metals of most concern are lead and mercury, both because they are frequently released by our activities and because of their health effects. Aside from their historical use in insecticides mentioned earlier (Fig. 47), metal works, papermaking, battery making, sludge application and dye production are also sources of heavy metal contamination. Around the home, old paint is a common source of lead contamination. In the upper Hudson, the Hercules/CIBA-Geigy dye plant, also near Fort Edwards, seems to have been a major source of lead and chromium contamination. The association of these metals with industrialization is indicated by the more contaminated tissues of creatures living in Kinderhook Creek, draining as it does areas affected by industries of the Capital District (Fig. 48).

These data on the tissue concentrations of stream-dwelling animals, collected by the government during the 1990s, can be supplemented by our own samples of sediments from 90 ponds around the County in 2006 (Fig. 49). While the majority of the ponds showed no marked heavy metal contamination, iron, lead, manganese and nickel reached high levels in some ponds (we did not test for mercury). The geographical patterns of the pond data did not match stream contamination patterns.

Applying the spray solution

***Figure 47**. Workers spray lead arsenate on forest trees to control a Gypsy Moth outbreak in the 1920s and 30s. Columbia County was considered the front line, and extensive spraying was conducted, especially in the eastern part of the County.*
Image from the 1929 annual report of the New York State Conservation Department.

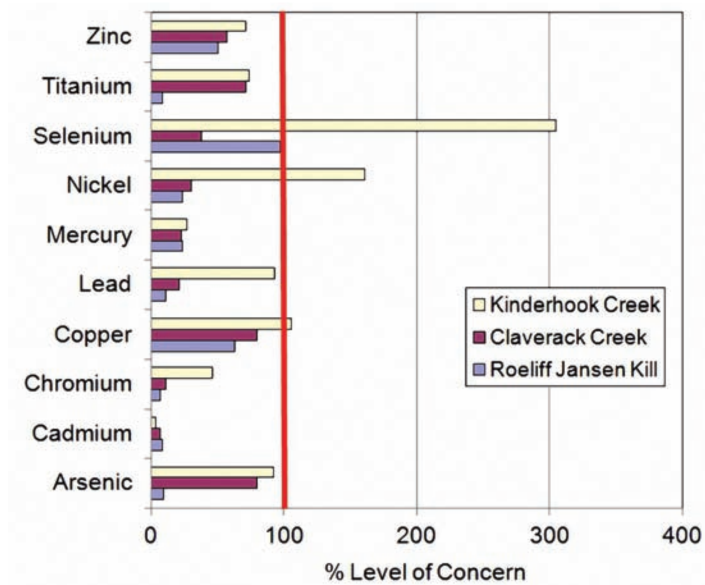


***Figure 48.** DEC data concentrations of various elements including several heavy metals in aquatic macroinvertebrate tissue during the 1990s. These values are expressed as a percentage of the levels believed to cause ecological impacts, that is to be 'of concern.' Selenium and nickel, while occurring naturally, are found at elevated levels around power plants, foundries and certain other industries.*
Data from Bode, Note 40.

It seems that contamination of the ponds probably resulted from a combination of very localized effects and perhaps aerial effects as well. Many pond contaminants did tend to covary, meaning that a pond with high lead levels was also expected to have higher than average levels of nickel, lithium, chromium, iron, phosphorus, cobalt and several other elements. The end of leaded gas has helped reduce rates of lead contamination in recent years.[42]

Relatively recently, researchers have realized the pervasiveness of mercury accumulation in ecosystems of the Northeast. Not only do aquatic organisms, long known to accumulate mercury, show high levels, but so too do song birds, bats and other predators of aquatic organisms (Fig. 50). This includes not only organisms living in or about wetlands, but also those which prey upon dragonflies, mayflies, stoneflies, midges, mosquitos and other insects which spend most of their lives as aquatic larvae. An important source of mercury in aquatic systems is the atmosphere; coal burning, probably the main source of atmospheric mercury in the Northeast, vaporizes naturally trapped mercury which subsequently is deposited on the downwind landscape. While mercury deposition is widespread, variation in weather patterns, source locations, and the biological processes which encourage mercury's incorporation into the ecosystem result in geographic variation. Although I know of no work from Columbia County, studies in the Catskills and Berkshires, while clearly indicating mercury bioaccumulation in song birds and other organisms, show levels which are low relative to values from other locations such as the Adirondacks or coastal Massachusetts. A study of mercury in New York State lake fish has suggested a similar pattern. However, mercury contamination is widespread through the Northeast, and we can hardly expect Columbia County to be immune from that.[43]

Drugs and 'Life-style Byproducts' As mentioned earlier, it can be a challenge to separate human sewage contamination from livestock contamination. The question is especially relevant in landscapes like ours where both sources are a reasonable possibility. One way that hydrologists have tried to distinguish between these two potential sources is by testing waters for caffeine or fabric

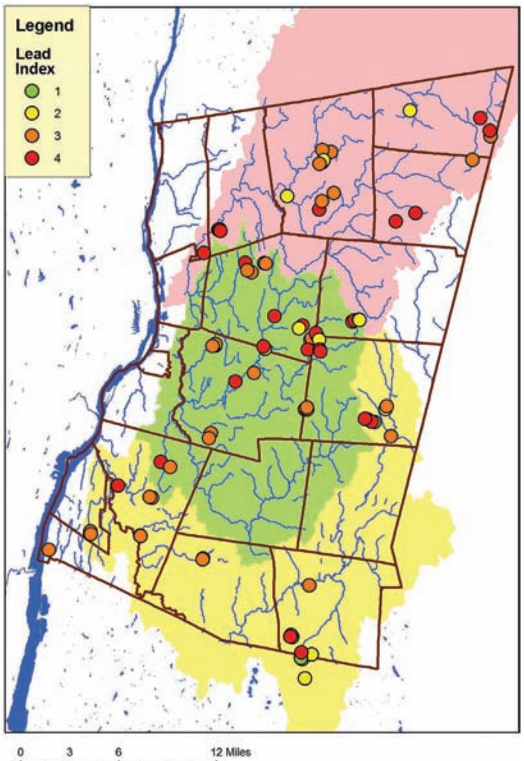


Figure 49. *Relative lead concentrations in the sediments of 90 ponds around Columbia County. Index level dots represent increasing contamination grades relative to ecological effects, from no impact (green) through likely heavy impact (red). Background colors indicate major watersheds.*

brightner. High levels of caffeine or brightner accompanying high levels of nutrients and/or microbes suggests human sewage is the primary source (or there are some pretty pepped up, clean cows!). These two types of chemicals are what might be termed 'life-style by-products;' together with other such compounds including drugs, synthetic hormones, and plasticizers (which add flexibility to plastics), they have made their way into our water supply. Aside from their potential utility as indicators of sewage sources, these chemicals are pollutants in their own right. For example, one relatively recent focus of water pollution research has been on 'hormone mimics.' These can derive from medicines and a variety of other chemicals (such as pesticides and plastics). By acting like hormones, such chemicals may disrupt sexual development in aquatic wildlife and conceivably in humans.[44]

We have no data regarding the presence of such chemicals in Columbia County waters, but reference to research elsewhere can at least highlight the issue. In one study of ground water across the country, plasticizers, insect repellants, flame retardant, and antibiotics were each detected in roughly one third of the 47 sites sampled. In a nationwide survey, nearly 90% of all stream sites sampled contained steroids, while plasticizers occurred in nearly two thirds of the samples. In Minnesota, DEET (the active ingredient in most insect repellants) was found in about three quarters of the lakes studies. Flame retardants, sunscreen constituents, and perfuming agents were found in about three quarters of the waste-water treatment effluents samples in the Catskills and Lower

Figure 50. *Non-aquatic organisms, such as this fishing Great Blue Heron captured on a stream-side game camera, consume aquatic organisms and bring aquatic pollutants into terrestrial systems. Bats and songbirds, frequent consumers of the winged adults of aquatic larvae, also spread the ecological impact of aquatic pollutants.*

Hudson Valley; antibiotics and disinfectants occurred in about half those samples, and hormones in at least one third. Many of these compounds were considered potent hormone simulators. An across-seasons study of reservoir waters by the NYC DEP found an array of such chemicals. All three reservoir systems studied had detectable levels of nicotine or its metabolites, cis-testosterone (a reproductive hormone, that may be at least partially a natural body product), and ibuprofen (an anti-inflammatory); the full suite of detected chemicals included DEET, an anti-anxiety drug, a barbiturate, and antibiotics. In most of these cases, observed concentrations are far below levels likely to cause any immediate effects on humans, although the consequences of long-term exposure are less clear. As with mercury, we have no Columbia County specific data, but 'circumstantial evidence' would strongly suggest the presence of such compounds in our waters.[45]

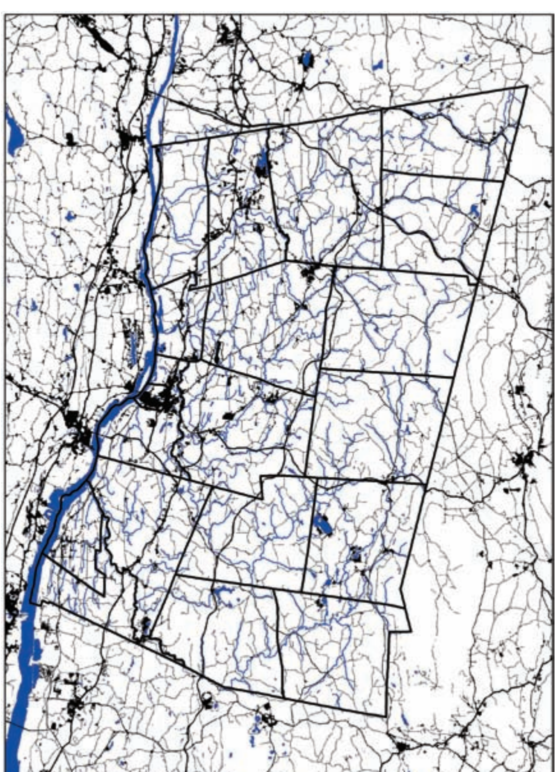
Impervious Surfaces Earlier, we discussed the many aquatic consequences of forest clearing; a modern-day equivalent, in terms of its varied effects, is the spread of 'impervious surfaces.' To speak of the amount of "impervious surface" in a watershed is to describe the amount of land covered by, essentially, waterproofing. Asphalt, concrete, houses, factories do not, for the most part, let water pass through them. Rather, water falling atop them washes across their surfaces until it finds permeable open ground or enters a waterway (Fig. 51). Impermeable surfaces can thus have at least two influences on our waters.[46]

Figure 51. *Rainfall on this asphalt parking lot accumulates in a drainage ditch that carries it directly into a nearby wetland.*

First, if you picture spraying water on a model landscape made out of plastic and on another made out of newspaper, you can imagine that the former would pool water or quickly send it dribbling off the edge of your diorama, while the latter would, at least initially, suck up the water that was sprayed atop it. The sponginess wouldn't be infinite, but it would be appreciable. The same general pattern holds if we compare a real landscape coated in asphalt and the like to one covered with, for example, forest. The forest soils will suck up much of the water that falls atop them, aided by the 'thirsty sponge' nature of plant roots. So, a key result of increases in impervious surfaces is that the water flow in area streams becomes much more "feast or famine" – when it rains, the water quickly floods down river channels in torrents; when it's dry, those channels quickly become parched. In contrast, a river through woodland will tend to peak less immediately and less dramatically during heavy rains, and it will tend to maintain a flow for longer during dry periods.

The second aquatic impact of impervious surfaces is, in some ways, not their fault. That is to say, if your asphalt and concrete were made of components that, themselves, leaked no chemicals to the waters that passed over them, then, provided their surfaces were kept clean, the water that eventually ran into brooks might be warmer for its passage over the asphalt, but no dirtier. However, in real life, impervious surfaces are the surfaces of human urbanization. They are ridden on by rubber shedding, oil-dripping cars; dashed with whatever chemicals the owner of the garage workshop wishes to toss on them; bedecked with the contributions of our pets. They are, in several ways, a reflection of an area's relative urbanization. When rain literally washes their surfaces, it often carries with it the dirt of human existence, unabated by any time spent decomposing in the soil.

"Impervious surfaces" has thus become shorthand for a variety of impacts on water quality associated with a (sub-) urbanized landscape. As the map of Columbia County suggests, little of the County is currently sealed by such surfaces (Fig. 52); other water management issues are currently more important for us. Nonetheless, as we zoom out to a more regional perspective, one realizes the evolution of the surrounding landscape, especially if one matches that with a map of population densities (Fig. 53 and Chap. 3, Fig. 26). Estimates for *per capita* water use in the USA are 100-150 gallons/day. While that includes all uses (e.g., washing, flushing, drinking), it is still staggering and helps one realize the challenges that human density poses to our water system.



Ironically, the generally rural but no longer highly agricultural nature of the County emphasizes the role of human sewage and residential development in influencing water quality. Although experiences such as the PCB dump in southern Rensselaer County highlight the need for vigilance, at present, residential development and its associated water use, chemical applications and habitat alteration are probably the primary determinants of our water quality. We are probably are own worst enemy.

Figure 52. *Impervious surfaces (in black) in Columbia County. Impervious surfaces refer to asphalt- and concrete-covered surfaces which are essentially impermeable to water. Impervious surfaces are correlated with urbanization and can directly alter water flows by accentuating run-off events. See Chapter 3, Fig. 26 for a map of impervious surfaces in the lower Hudson Valley.*
Data derived from *The National Atlas.*

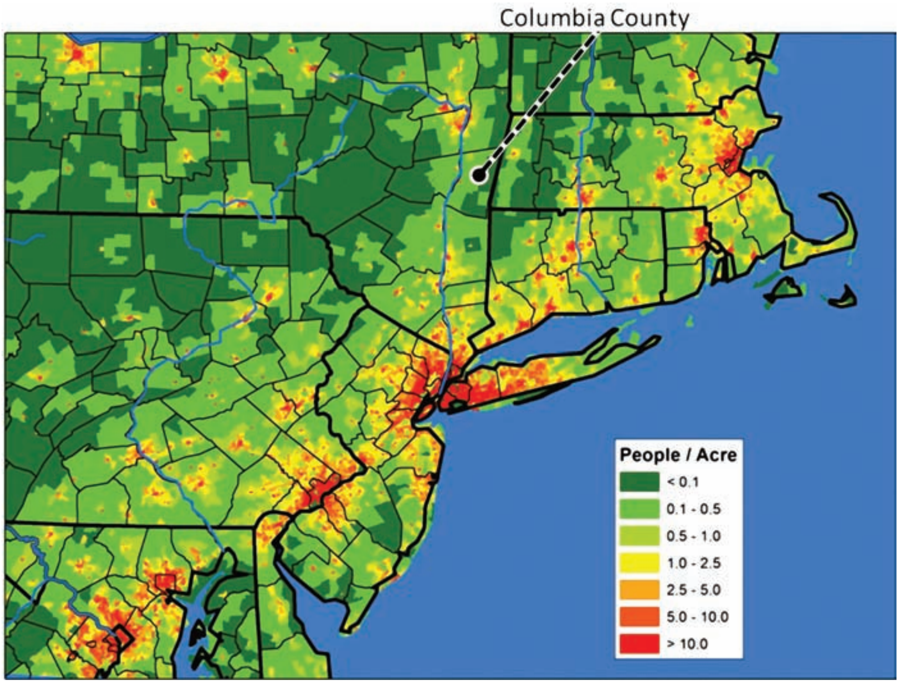


Figure 53. *Population densities in the Northeast. Columbia County is one of a ring of semi-rural counties at the fringe of New York City and the Capital District.* Data from 2010 US Census.

Internal Landscaping: Adjusting Human Expectations

In this chapter, we have reviewed something of the geological origins and human modifications of our waters. To a certain degree, such an approach gives the false impression that our waterbodies were plunked in place after the last glaciation and that subsequent change was mainly caused by human hands. However, we also need to be humble – humans have caused huge changes, but these waters also have life cycles of their own, aging and evolving according to inherent processes. Such processes create important niches for life, but sometimes run counter to our plans, predicated as they are on the immutability or at least controllability of our waters. For the sake of aquatic ecology, it is thus important to be aware of these natural changes in much the same way as it is important to know the native creatures who take advantage of them. In place of some prescription for the future, I close this chapter with the simple hope of sharing a little about 'water time'; internalizing that pace may well be decisive for the future of our waters.

We will start with ponds. In our region, as mentioned earlier, modern ponds are largely a human construct (Fig. 54). While most lakes and rivers date from at least the last glaciation, most current ponds were dug after European settlement. (Kettle ponds, created as till-covered glacial ice blocks melted, are an exception, but some of the remaining few have had their lives extended by human excavation for peat mining or other reasons.) Indeed, current rural landscaping seems to imply that no rural vista is complete without a pond. Unlike the beaver ponds which blinked on and off in the landscape as beavers built their dams and then moved on, our new ponds are envisioned as more permanent.[47]

As we sketched in our historical section, the motivations for pond construction have been varied (see Fig. 44 above). And yet, despite the evidence that our hand is necessary for their creation, for some reason, we expect ponds to be permanent. While we do expect to repair our other constructs – we know that the houses, fences, and roads, for example, need periodic upkeep – we seem startled to find that maintaining an unchanging pond might require work (Fig. 55). An aging pond is deemed unnatural.

However, most ponds do, naturally, grow old. It is likely that numerous ponds that once scattered our landscape after glaciations were slowly, and naturally, filled in. Ponds accumulate dead vegetation and aquatic organisms (Fig. 56). These materials release nutrients into the water, encouraging more growth, leading to higher rates of organic matter accumulation, to more nutrients, etc. etc. In ecological terms, this is the process of eutrophication that we mentioned earlier although, in this case, it is occurring without human intervention.

The naturalness of this process has been shrouded by the fact that it is often radically speeded up by human action. Our intentional or unintentional fertilization of adjacent lands (for example, by the application of lawn or farm fertilizers or by faulty sewage systems) primes the eutrophy pump, increasing in-pond algal and plant growth and so accelerating that cycle of organic matter build-up. To say that pond aging is natural does not excuse our contamination of natural waterways. In turn, the prevalence of that contamination should not lead us to perceive all change in natural systems as unnatural.

The speed of pond aging depends upon several different factors in addition to the rate of nutrient inputs; these include pond depth, exposure to light, water volume relative to perimeter, and water flow. Imagine an isolated and relatively shallow pond surrounded by forest and yet

Figures 54-56. *(Top) Pond construction like this has boomed over the past few decades as ponds became an expected part of rural residential landscaping. (Middle) Recently dug ponds often show the crystalline waters we expect. However, as biology begins to gather nutrients and nutrients seep in from the surroundings, greener waters can result. (Bottom) This vernal pool is collecting nature's debris in autumn. The rotting of leaves, branches and other bits of life releases nutrients into the water; these, in turn, feed other life.*

big enough to cause a substantial break in the tree canopy and hence receive ample sunlight. This pond receives nutrients in a variety of ways: leaf fall from the surrounding trees, in-water primary productivity (such as those green algae), and the growth of aquatic plants including floating pond weeds and emerging rushes. These plants capture nutrients from the air, soil and water. The shallow waters of our pond assure that rooted aquatic plants can grow throughout it and also mean that wind may regularly stir the brew, re-suspending nutrients that may have settled to the sediments. Especially if water flow (and hence nutrient outwash) is slow, nutrients will accumulate over time and the pond will gradually green and fill in. This is probably also a decent characterization of the aging process of many of our landscaped ponds except that grass clippings, lawn fertilizers, and leaking septic systems are supplementary sources of nutrients.

Contrast this picture with two other examples of still water: the lake and the vernal pool. The aging of these two kinds of water bodies probably also occurs but much more slowly. In lakes, a high volume of water relative to shoreline means that simple leaf fall is likely to be a relatively minor component of the lake's nutrient budget. Likewise, except near shore, the bottom is probably too deep to receive much sunlight and hence to be hospitable for rooted plants. Furthermore, greater depth means that nutrients are more likely to settle to the bottom and not be stirred back into the water by wind. Temperature stratification further reduces mixing, and deep-water nutrient trapping may be exacerbated by the fact that deep sediments are likely to have relatively little oxygen, a situation that slows their decomposition, and hence the liberation of nutrients. The larger surface expanse means that winds reach higher velocities (think of the white caps one sees on larger lakes); these winds can push duckweed and floating algae onto shore. The net result is that lakes age more slowly than most ponds.[48]

Vernal pools are, in some ways, the opposite of permanent lakes. The word "vernal" is derived from the Latin word for the Spring season. It is applied to these pools because they are seasonal, often being fullest in early Spring and frequently drying out completely in mid-Summer. Most vernal pools are relatively small, and the overhead forest canopy is usually relatively closed. During the growing season, the pool is often shaded, muting the exuberance of in-pool plant growth. The predominant source of nutrients is usually leaf fall. During the part of the year when there is no water, some leaves decompose in ways similar to those that fall on the dry forest floor. Terrestrial or flying insects come and go, feeding on the bacteria and fungi that break down the leaves. As a vernal pool again fills with water, another set of microbes, insects and other organisms continue their work which, in turn, becomes food for larger creatures: the dragonfly nymphs, tadpoles, and salamander larvae for example. Finally, as drying approaches again, many of the top predators leave the pond, walking, hopping, or flying away as adults. Others may have already been absconded with by terrestrial or semi-terrestrial predators such as raccoons, green herons, or garter snakes. This exodus probably represents a substantial outflow of nutrients and is in contrast to the situation in ponds or lakes where many (although not all) of the top predators are fish, Bullfrogs, or turtles who are likely to live, die, and poop in the water. Less retention of nutrients means that vernal pools are more like the forest floor, where leaves and other matter are broken down and incorporated into organisms living elsewhere rather than accumulating on-site. Nonetheless, visit a vernal pool in Spring, when it is full of water but the sun still reaches it through yet-bare tree branches, and you'll likely find it tinted green with algae.

These are stereotypes of complex ecological relationships, and the differences among lake, pond and vernal pool are surely not so cut and dry. Yet, perhaps this simplified summary gives you an idea of why the ponds such as we dig in our backyards are so apt to age before our eyes, and of why such aging is not completely unnatural. One of the central considerations for ecological pond management is approximating the natural aging processes. We should neither accept rampant eutrophication nor strive for immutability: neither extreme would be familiar to native pond life. If we want to minimize our ecological impacts, we need to calibrate our aesthetic ideals to ecological realities.

The natural wandering of streams and rivers is another uncomfortably variable component of our landscape (Fig. 57). In the same way that we have idealized visions of natural ponds as being crystal clear and uncluttered by vegetation, we may have misconceptions about streams. If you pour water onto a sandy beach and watch the path the water takes, you'll see that it does not trace a straight line as it erodes its little path to the sea, lake or pond. Instead, slight variation in the erodability of the sand, perhaps due to compaction or embedded sticks and stones, causes the water to waiver, 'ricocheting' off of one wall, digging more intensively into another. The result is a snakelike pattern typical of most natural streams and rivers, at least where they are not strictly confined by rocky channels, or in the case of unnatural rivers, by concrete walls. Such liveliness often does not sit well with the plans of humans. We plan our gardens, till our fields, construct our houses, and lay our roads under the assumption that the stream will be well behaved and stick to its course. We feel startled and perhaps betrayed when it does otherwise, when it behaves naturally.

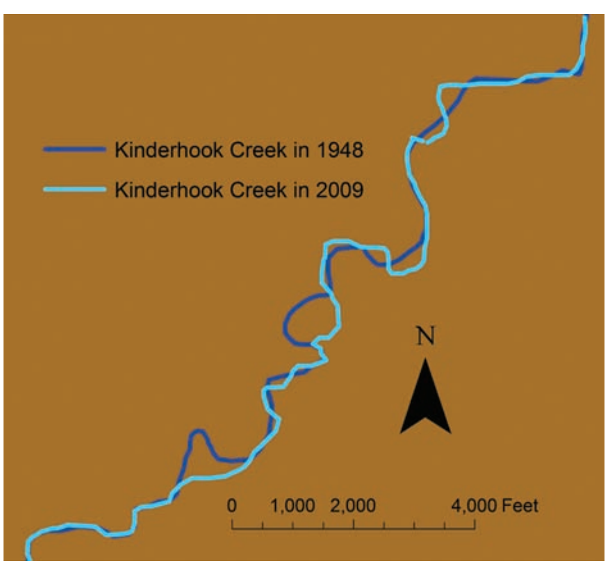


Figure 57. *The wandering of Kinderhook Creek's channel just north of Lindenwald. Despite our feelings to the contrary, such wandering is a natural part of stream life.*

Our stream or river is not a sleeping snake; rather, it constantly evolves over time. Picture what happens to the little stream down the sandy beach when, for example, water finally undercuts an embedded rock or wood: suddenly, the wall where the object once lay becomes easy ground for water's taking, whereas wherever that rock or stick eventually lodges downstream, the water suddenly hits a hard surface. The effects of give-and-take, ricochet and absorb, erosion and deposition, leave the stream snake writhing, at least in geological time, spurred occasionally by the hot poker of floodwaters.

Figure 58. *A bank of the Kinderhook in Chatham. The layers of rounded rock indicate past creek beds. Erosion has also created habitat for the Bank Swallows whose nests are visible in the less rocky layer above the cobble.*

One can perhaps convince oneself of stream wanderlust by inspecting the banks of a natural or semi-natural creek during low water. Where the water has cut into the bank, look for layers of relatively large, rounded rocks, known as cobble (Fig. 58). The size of rock that a stream can move is related to its velocity. Faster waters have more energy and can heave heavier stones. As water slows, either because the rain stops or because the water can spread across a wider surface, the bigger stones quickly drop out of the current. Hence, large cobble usually denotes areas in or very near a stream's main channel, and the embedded cobble in the stream bank marks the historic course of the creek. Likewise, oxbow lakes (or "ponds" in our case), evident in the aerial views of many of our streams, are direct historical records of such movement; they are former stream courses abandoned over time.

This 'natural behavior,' like the in-pond greening that might provide food for aquatic life, is associated with the creation of important ecological niches. For example, in many situations, some degree of bank erosion and channel wandering is natural. The resulting log jams and woody flotsam are probably integral parts of some stream ecosystems. Just as forest snags, i.e. standing dead trees, have been recognized as important parts of a natural forest's ecology because of the animals that nest or feed therein, so too are woody, in-stream debris piles important. Literal deadwood is rarely figurative deadwood in an ecological system. Snorkeling in our streams reveals that fish are by no means uniformly distributed across the stream course. Fish are scarce in some open runs, but numerous fish are often hiding in the shadows of underwater deadfalls or hovering below the miniature waterfalls or in the eddies they create (Fig. 59). Perhaps the fish are seeking shelter from predators such as larger fish, herons, Snapping Turtles, and Water Snakes; perhaps they find relief from relentless currents (imagine spending your life trying to avoid being washed downstream); perhaps they are breathing 'deeply' in minibonanzas of oxygen (those bubbling tumbles of water work just like fish tank pumps to

Figure 59. *In-stream habitat created by accumulated 'woody debris.' These branches and trunks, partially the result of upstream erosion, create pools and shelter that are important for fish.*

aerate the water), or perhaps they are feeding on the abundant invertebrates breaking down the wood and trapped flotsam. In any case, what may seem like the defense of a physical process (stream wandering) is also the defense of natural ecological conditions which are important to native plants and animals.[49]

Humans can speed-up stream wandering. By altering precipitation patterns (via climate change), by removing buffering wetlands along stream margins, by increasing sedimentation loads, by eliminating forests with their natural sponginess and bank-stabilizing roots, we have undeniably altered hydrology. For example, a relatively small and rocky mountain stream should generally flow clear, and dramatic increases in erosion usually indicate that something, often our land use, is awry. However, the realization of these important human effects needs to be balanced by the acknowledgement that streams are inherently dynamic places; indeed part of the reason that our actions have exacerbated flooding problems is because we have tried to eliminate, rather than live with, this dynamism. Again, 'natural management' involves moderating the work of our own hands while liberating the hand of natural processes.

In contrast to ponds and streams, vernal pools can dog our psyches not because of their mutability in the face of expected permanence, but rather the reverse – their permanence in the face of apparent ephemerality. Leo Kenney and Matthew Burne, in their lively guide to vernal pool animals, described vernal pools as "glorious puddles;" they are slight dips that seasonally accumulate water but that also, just like the puddles in the parking lot, essentially disappear when it is dry. Because of their come-and-go behavior, vernal pools can be hard to take seriously as habitat. Shallow, small, and seasonally invisible, they are easily effaced intentionally or accidentally. How many of us have mental maps of the puddles we know (unless they regularly appear in awkward places)? And yet vernal pools are ecologically rich microcosms, in part specifically because of their seasonally temporary nature.

As we alluded to when contrasting permanent ponds and vernal pools, the former can support fish and amphibians, such as Bullfrogs, Green Frogs and Red-spotted Newts, which depend upon year-round aquatic habitat. Regular drying eliminates vernal pools as reliable habitat for such creatures but, in doing so, opens it up to other organisms. Those fish and the amphibians of permanent ponds can be hungry predators. Their absence provides opportunities for otherwise impractical life styles. Indeed, there is a set of frogs, salamanders and invertebrates whose lives are shaped not so much by the need to escape in-water predators as by the developmental rush to capitalize on the vernal pool's potentially short water-holding season. Wood Frogs and Spotted Salamanders are flagship vernal pool species (Fig. 60). These amphibians spend much of their lives in upland forest, but early each Spring, they converge on vernal pools to breed in one short orgy usually lasting less than a week at any one pool. Having deposited their egg masses in the water, the adults return to the hills, and their progeny have perhaps three to five months to develop into terrestrial organisms. Tarry longer, and they risk desiccation. In contrast, it may take a Bullfrog or a Green Frog a year or more before they first hop onto shore (although neither species ever becomes as wholly terrestrial as a Wood Frog). The predominant role of predators in determining habitat suitability for many vernal pool organisms is demonstrated by the fact that they will also readily use permanent but fishless ponds as reproductive sites.

Aside from the amphibians just described, vernal pools are home to the aptly-named, finger-tip-sized "fingernail clams" which survive the dry season by clamming up deep in the mud. They can also harbor freshwater 'sea monkeys.' Along with X-Ray glasses, comic books used to offer "Sea Monkeys." "Just add water!", ran the advertisement, and amazing aquatic monkeys will appear. "Monkey" was a bit of advertising hyperbole, but some pretty odd-looking creatures do emerge. Fairy Shrimp, a

Figure 60. *Vernal pool vertebrate life (clockwise from above): Wood Frog eggs (being inspected by a Red-spotted Newt, not, in this case, in a vernal pool), an adult Wood Frog, Spotted Salamander eggs (l.) and Jefferson or Blue-spotted Salamander eggs (r.), an adult Jefferson Salamander, and an adult Spotted Salamander.*

Figure 61. *A vernal pool Fairy Shrimp swims in its usual, belly-up position. These tiny crustaceans have eggs (such as those visible on this female) which are able to withstand a pool's drying out. When water returns, the eggs hatch and the next generation comes to life.*

close relative of commercial sea monkeys, are tiny crustaceans, true relatives of the shrimp we eat (Fig. 61). In contrast to the amphibians already described, Fairy Shrimp survive the drying of vernal pools as hard-cased, tiny eggs. True to their press-agents' claims, one need only add water for them to come back to life, although the life that springs forth looks more Martian than monkey-like to me.

As unassuming and transient as they are, vernal pools thus hold their own ecological treasures, in part because of the very seasonality that tends to hide them from our notice. By ridding such pools' waters of those predatory fish and frogs, seasonal drying has produced a habitat that evolution has viewed as unique, and that we are apt to overlook. Apparently, the 'eyes' of nature see the world differently from our own; yet these are perspectives that, for the sake of our ecology, we would do well to align ourselves with more closely.

The work of beaver, the aging of ponds, the wandering of streams, and the evaporation of vernal pools are all natural movements that may intersect uncomfortably or inconspicuously with our own plans, but that deserve to be respected as part of the natural world. Just as surely as we may feel prompted to conserve charismatic places, such as a particular mountain, valley or lake, we need to consider conserving the natural processes that have made those places what they are.

Natural History Profiles: Dragonflies and Damselflies

Most of us know dragonflies and damselflies (collectively known as "odonates") as the winged creatures dashing across ponds or darting and swooping in the summer sky. We discuss these insects here because, like butterflies and many other insects, our so-called odonates undergo metamorphosis (although, if you want to be picky, butterflies have complete metamorphosis while odonates have incomplete metamorphosis; Fig. 62). In the case of butterflies, this means that the larvae, which we call caterpillars, look nothing like the winged adult butterflies that eventually emerge from the chrysalises. Similarly, young dragonflies look little like the winged adults. They are, in fact, unwinged, aquatic creatures with gills. One sees adults flying around pond, marsh or stream not only because they're

Figure 62. *A Brook Snaketail, a stream-dwelling species of dragonfly, emerges over about one half hour in late May along the banks of Kinderhook Creek. The pale, delicate teneral (lower right) will require a few hours before its colors emerge and its wings harden.*

hunting the smaller insects so often found over such water (many of whom also pass their early stages of development in the water), but also because they are looking to deposit their eggs in the water and re-initiate their life cycles. Both nymphal and adult odonates are predators, the first in the water, the latter in the air.[50]

When I first tackled dragonfly identification, it was part of a study of local ponds. These were, after all, the sorts of places I most associated with dragonflies. They did not disappoint: we found some 47 species around our County's ponds. However, since then my appreciation of these creatures has become more nuanced. Dragonflies and damselflies have come to remind me, ecologically, of salamanders. Just as one can group salamander species according to the waters they prefer (permanent ponds, vernal pools, streams, seeps, etc), so too can one group odonates by the aquatic conditions they favor (for example, lake, fishless wetland, river, stream or trickle). Being terrestrial organisms ourselves, most of us tend to think of life below the surface of a pond or stream as predominantly 'wet' with little need for additional descriptors except perhaps temperature. In fact, for creatures such as dragonfly nymphs, there are many other relevant environmental characteristics.

Water current speed, for example, plays a role in literally shaping water dwellers over evolutionary time. Those aquatic invertebrates that live in fast water tend to shelter under rocks or other large debris, burrow into the bottom, or cling tenaciously to rocks or other exposed surfaces; they tend to be flat and streamlined (Fig. 63). In response, nymphs in ponds or lakes don't need to be preoccupied with an evolutionary response to currents; they tend to be less compressed. As largely visual predators, water clarity and exposure to light are also important for dragonfly nymphs. Muddy water can also affect the functioning of the dragonfly nymph's gills, in much the same way that soot might clog our own lungs. Dragonfly nymphs, like fish and almost all other water-living creatures, breathe oxygen. Oxygen can dissolve in water, but the water's temperature, physical aeration (from rapids, for example), currents, and surface area relative to volume all affect how much oxygen a given water body contains. In addition, as one might imagine for creatures who spend most of their time creeping around on the bottom, the nature of that pond or stream bottom is very important – are there rocks to hide under? Is there mud to sink into? Sand to burrow into? Is there a hard, current-swept, rock bottom? Finally, aquatic community ecology also plays a larger role – if you introduce predatory fish into the picture, you favor a different set of odonates.

Figure 63. *This nymph lying in the palm of my hand is the relatively compact aquatic juvenile form of the Brook Snaketail shown in Figure 62.*

Figure 64. *Common Green Darners are one of our largest dragonflies. This is a partially migratory species – certain populations head south for the winter while others apparently stay put. They are voracious predators on flies and other winged creatures.*

We don't know exactly how each of the roughly 100 species of dragonfly and damselfly we have so far found in the County has responded to these various aspects of its environment, but, by profiling a few, select County residents, we can sketch some important aspects of these creatures' ecologies.

The **Common Green Darner** is, at least in form, the prototypical dragonfly (Fig. 64). These are large (ca. 3" long with a similar wing span), in-your-face insects whose wing rattle can be heard as they fly by. Both males and females have green bodies, but the former have a blue tail while the latters' tail is red. We have several other, similarly-sized darners in the County, however this Darner's forehead bears a distinctive black dot which reminds me of the Cyclops. The nymphs grow to be correspondingly large (exceeding 2" in length). At least occasionally, these are vertebrate eaters, with the nymphs said to tackle small fish and tadpoles, and adults reported to have at least attacked hummingbirds. One of the reasons that this adult dragonfly is so familiar is because it arrives early (I have seen one in mid-April), stays late, and not only flies around a variety of water bodies, but will also often take to open fields in search of prey. We found the Common Green Darner around more than a quarter of the 89 ponds we studied that first year. They are said to prefer fishless ponds (despite the fact that nymphs will eat small fish), but we saw no such preference during our study. However, we only recorded adult occurrences, rather than larval presence.

This is a still-water species which means you will usually not find their nymphs in streams or rivers – the bulky, sausage-like nymphs would probably have a problem battling strong currents. Occasionally, they are reported from slower waters. The best way of finding the nymphs, or at least former nymphs, is to look for exuvia. When a nymph is ready to emerge as a winged adult, it comes to the surface and climbs the stalk of a cattail or some other aquatic plant. Having found a suitable perch, its skin unzips down the back and the fresh dragonfly emerges through that crack. Once free of its former skin, wings and body are inflated with body fluid and a 'tender' young dragonfly gingerly begins to dry itself. The curing process may last a day, during which time the individual is a weak and hesitant flier. Exuvia are the shed skins these adults leave behind, still clinging to vegetation. They are hollow 'castings' of the nymph's shape and, once you have a search image, can often be found around pond edges. Before removing a presumed exuvia, make sure it really is empty. If you're lucky enough, you may sometimes find a nymph that has just risen from the water and is preparing to release its pent-up adulthood. These nymphs are usually much darker than the empty skins. The best thing to do if you find one of these is to make yourself comfortable and await the miraculous emergence of the adult. It is an experience you are unlikely to forget.

One of the main reasons that adults of this species are with us for so much of the year is that these darners are migratory, with a range apparently spanning Mexico to southern Canada. This is not our only migratory species – 15 or so additional dragonflies also migrate – but it is our best studied. Using mini-radios, body analyses (which can reveal at least the rough latitude of an individual's nymphal life), and observation summaries, researchers have shown that this species surges north in early spring and is one of the first adult dragonflies one sees. Those individuals breed and deposit eggs at their northern summer 'house'; these eggs develop rapidly, and adults emerge in time to head south before winter. The exact length of migration is not known, but a mean southern migration of around 550 miles and a maximum of over 1,500 miles have been estimated. The migratory movements mean that adults may arrive before local aquatic conditions encourage resident nymphs to emerge, and adults may fly later in the year than a 'responsible' resident dragonfly would trust that breeding, oviposition and some nymphal development could be accomplished. That said, not all individuals of this species appear to be migratory, and some overwinter as nymphs. Ardent pond watchers have noted two peaks of emergence for this species, one in early summer and one in late summer. Because migratory individuals could not arrive in May and give rise to new adults the following month, it is believed that there may be two populations of this species, one which is migratory and another which is non-migratory. Some have even suggested that because such timing largely rules out interbreeding

Figure 65. The Big Bluet is one of our largest bluets and, in the County, is only found close to the Hudson River.

between the two populations, incipient speciation might be underway. If you have a pond in your neighborhood, you might watch for evidence of these diverging lifestyles in this species.[51]

The **Big Bluet** is big, for a bluet (Fig. 65). Bluets are damselflies, the much daintier and generally smaller sister group of the dragonflies. At 1 ½" body length, this is our largest bluet, although not our largest damselfly. In contrast to the darners, you need to train your eye in order to even notice bluets. As the name implies, most bluets are a strong sky blue, but their bodies are slim and their wings fragile. Unlike dragonflies, who rest with flat, open wings, damselflies clasp their wings together when at rest, further reducing their already modest impression on the eye. Bluets occur most commonly around ponds, although a few stray onto flowing water. The Big Bluet is unique in that it is associated with coastal areas and large rivers. In inland Massachusetts, it has been found along the Connecticut River; in Columbia County, we have only found it at the Clermont Historical Site and the Stockport Conservation Area, both of which are near the Hudson River. In New York State as a whole, it is only known from the Hudson River watershed. Unlike any of our other damselflies, it occurs in brackish water, and is even said to favor tidal areas. Although it is our only species that seems to actively favor such areas, several species of dragonflies and damselflies, including at least two species of darners, have been reported from salt marshes.[52]

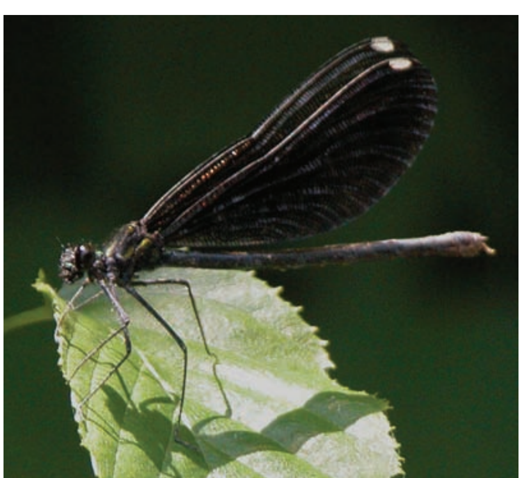


Figure 66. A female (note the white wing dot) Ebony Jewelwing hangs out in the speckled streamside shadows.

The **Ebony Jewelwing** may be our most commonly noticed species of damselfly (Fig. 66). It can be numerous, and it is widespread across eastern North America. It can be more than 2" long, with an emerald green body. However, what one first sees are the black wings, offset by a white, wing-tip dot in females. While some other odonates have black on their wings, none have wings so entirely dark. This species haunts the leafy banks of slow streams (or, at least, streams with ample backwaters), where its fluttering black wings resemble animated shadows. Unlike many now-you-see-them-now-you–don't odonates, this species usually has a leisurely flight that one guide described as "butterfly like." Pair that analogy with one provided by a different publication when describing the interactions of males – like "WWI flying aces squaring off" – and you have an idea of the unique flying behavior of this species.

This species provides a good illustration of our warped perceptions of odonate lives. Although individuals may live for nearly a year, most of us are only familiar with the 1-2 weeks that are spent as winged adults; it is as if we only knew a plant's flower, but did not see the green leaves that are the plant's day-in, day-out means of survival. Clearly, understanding the ecology of the nymph is crucial for comprehending a species' overall needs. What is known is that there appears to be but one generation of Ebony Jewelwings per year (in other words, an early wave of emergers doesn't subsequently produce a late-season generation), underwater debris piles seem to be favored habitat, and the diet of this species is relatively broad, with true flies and mayflies being the primary food. Beyond that, we seem to have little idea of what limits Jewelwing populations and ecology.[53]

Figure 67. *A relatively recently emerged Northern Pygmy Clubtail rests on rocks near a creek on Mount Lebanon.*

The **Northern Pygmy Clubtail** is a rare beast. It is a medium-sized, but delicately-built dragonfly with bold black and yellow markings (Fig. 67). It is confined to small, rocky, fast-moving creeks in the northeastern United States and adjacent Canada. We have seen it once, along just such a stream descending the hillside above Shaker Swamp in New Lebanon. Unlike pond odonates, which may have more than one generation, and the emergence of whose generations seem to be relatively spread out, many stream species seem to each have relatively synchronous, short emergences at any particular site. Furthermore, when not in the very act of emerging, adults can be hard to spot and even harder to catch. We, and it seems just about everybody else, know little about this species.

It is probable that the young of this species feed mainly on other creatures which, in turn, feed on detritus. "Detritus" refers to all the dead material – leaves, branches, dead creatures – that fall into a stream. In a wooded creek, leaves are certainly the mainstay. In a general sense, there are two main sources of energy for our aquatic communities: sunlight and debris (whose energy, of course, is also originally derived from sunlight). In a large, open pond, especially if its banks are devoid of trees, sunlight is the primary input, and food webs develop based upon the algae and aquatic plants that take advantage of that sunlight. In our small, forested creeks, sunlight is relatively sparse and water flows may wash away much of the algae. In these systems, the main input are those leaves from the shading trees; food webs build off of that. The stream-dwelling nymphs of Northern Pygmy Clubtail likely consume stoneflies and other leaf-shredding aquatic insects. If you cut down the surrounding forest, a wide range of changes occur, but one of them is the sudden removal of that important energy input. The entire stream ecology changes, and species like this dragonfly may not be able to survive.[54]

The **Sweetflag Spreadwing**, the last of our odonate profiles, defies the easy rules separating dragonflies and damselflies. While it certainly has the slim body of a damselfly, it rests with its wings only partially closed, neither completely flat like a dragonfly nor completely shut like a bluet or other 'traditional' damselfly (Fig. 68). It is, in fact, included with the damselflies, but provides a caution against simplification. Again, this is not a conspicuous creature. Its narrow, 1 ½" long body with subdued coloration is easy to miss, although its spreading wings add to its outline.

__Figure 68.__ As this one is doing, most Sweetflag Spreadwings perch with their wings partially open, neither fully closed like a bluet, nor flattened like a dragonfly.

__Figure 69.__ The spadix, or elongate flower cluster of Sweetflag, a wetland plant which seems to share habitat preferences with the Sweetflag Spreadwing. There are both native and exotic Sweetflag Species in North America; most of the Sweetflag now in Columbia County is probably the introduced species.

"Sweet Flag" is an aquatic plant that occurs in some of our well-vegetated ponds and other wetlands. This spreadwing's name is appropriate for at least two reasons. I chose this species to represent our denizens of fishless or, at least, shelter-providing ponds. Prior to the last two centuries, more of our ponds were probably fishless, although there may have been fewer of them in total. If they weren't actually fishless, then they were at least well-vegetated with an ample sprouting of aquatic and semi-aquatic vegetation, such as Sweet Flag (Fig. 69), whose in-water structures provided safe havens for odonate nymphs trying to escape hungry fish. As we already mentioned, removing such vegetation and introducing highly predatory fish like Large Mouth Bass exposed many aquatic animals to predation they could not survive. While this species may not be dependent upon Sweet Flag itself for protection, when fish are present, it almost certainly relies upon the likes of Sweet Flag for protection.

A look at the tip of a female Spreadwing's body reveals another link to such aquatic vegetation. Odonates have various ways of insuring that their nymphs reach the water. Many deposit their eggs in the water. One sometimes sees, for example, larger dragonflies kissing the top of the water with their tail tips. These are females depositing their sinking eggs. Others, such as some of the bluets, take the deep-diving approach, submerging themselves, wings and all, for up to an hour or more. During her dive, the female makes small incisions in underwater plant stems and deposits her eggs. Female Spreadwings have a large, sickle-like blade on their ovipositor. They use this to cut through the tough outer skin of the above-water portion of aquatic plants like…. Sweet Flag. The eggs mature therein and then the emerging nymphs flick and flip-flop until they fall into the water. Presumably, such a strategy helps protect both parent and eggs from aquatic predators (although, of course, exposing them to others).

Natural History Profiles: Non-Game Fish

There are perhaps 65 species of fish in our waters (Fig. 70). While some of these are what appear on the ends of our hooks, most are small, inconspicuous species known to the fisherman or woman, if at all, as bait. These are our minnows, shiners, dace, darters and the like. Knowing more about their ecologies may not provide much heft to your catch, but the distribution of these species does help illustrate patterns in the aquatic ecology of the County. We focus on stream/river fish for two reasons: first, we have relatively few native pond or lake fish – Large- and Small-mouth Bass, Northern Pike, Rock Bass, Bluegill, and Bullhead, for example, were probably not native to this region and were brought in by fishermen from elsewhere in North America; second, it is our flowing waters that transition so

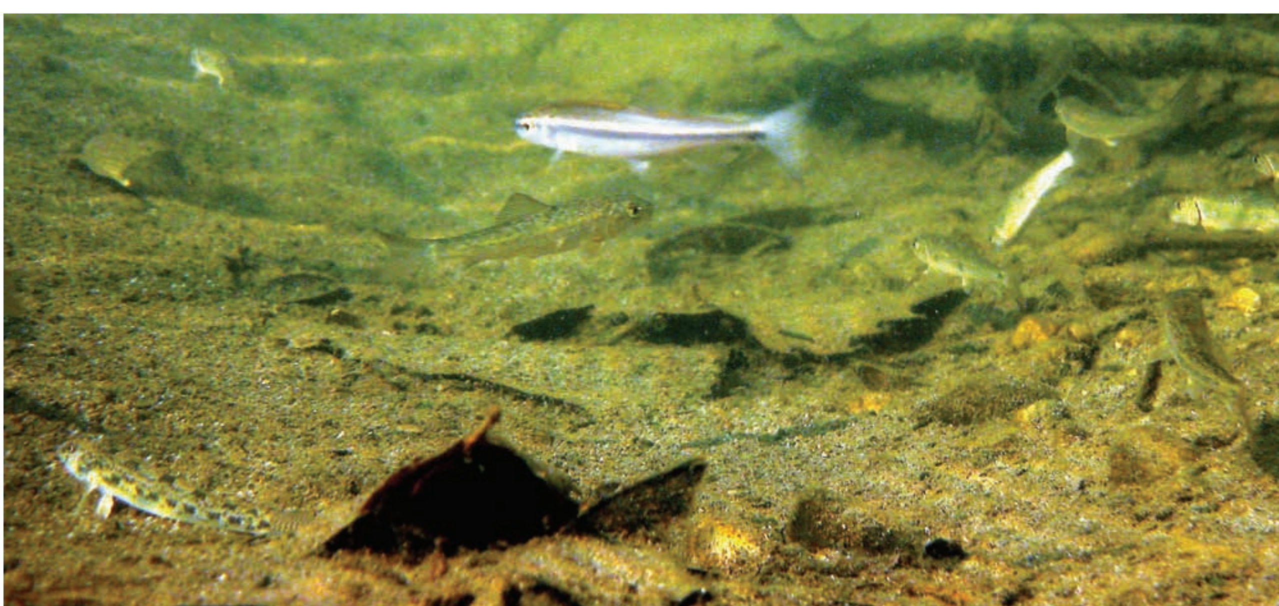


Figure 70. *A mixed school of fish swirls in the Kinderhook. While generally overlooked (except as bait), most of our fish are actually small – minnows, dace, darters and the like. Geographic variation in the diversity of these fish reflects subtle variation in the aquatic habitats of our creeks.*

dramatically across the County. As was alluded to in our discussion of the 'river continuum concept,' a rocky stream, gurgling down the foothills is a different aquatic environment from the slow, wide, muddy mouths where our larger creeks (warranting the name 'river' in some other locations) meet the Hudson. On the other hand, a pond in Austerlitz may not be so different from a pond near the banks of the Hudson.[55]

The five fish profiled below illustrate a bit of both the taxonomic and ecological diversity of our stream species; they have been chosen in order to span the gamut from headwaters to mouth.

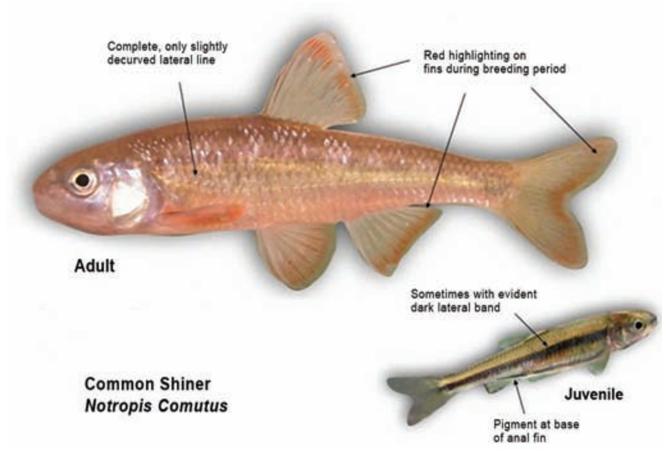


Figure 71. *Common Shiners are common and shiny. Young have a blackish line down their sides.*

The **Common Shiner** is just that, common and shiny (Fig. 71). It is found from the upper reaches of our creeks to the mainstem of the Hudson itself; it also occurs in lakes. It is relatively large for a minnow, reportedly reaching up to 8" in length, although 5-6" are probably the biggest we regularly see. It is a classical silvery minnow most of the time, but during the breeding season, the mature males acquire red-tinged fins and wart-like bumps appear on their heads (Fig. 72). Behavior and morphology suggest it is a relatively unspecialized species, inhabiting the middle portions of the water column and having an omnivorous diet which includes plants and animals.

Figure 72. *Common Shiners spawning in a tributary of the Agawamuck during their May breeding season. Males acquire bright red fins and warty heads.*

One of the obscure life history facts of these and many other fish are their seasonal migrations. While some freshwater fish may migrate for hundreds of miles, the migrations of this shiner are surely more modest though no less regular. Apparently, they over-winter in deeper pools, making spring-time migrations in time for the breeding season. There is one in-stream pool which I regularly pass where, in late May, I have seen them breeding and where, throughout most of the summer I can spot schools of this species. However, when ice first leaves in March, fish are nowhere to be seen in these waters. Presumably, they are still at their deeper haunts.

The **Slimy Sculpin** is a small (ca. 3" long) squat, bottom-dwelling fish (Fig. 73). It lives in the higher, faster, colder, smaller reaches of our waterways. I would not be surprised if it sometimes crosses paths with our Northern Pygmy Clubtail. It shares waters with the likes of Brook Trout and Eastern Blacknose Dace, although, so long as the flow is permanent, I believe it may reach into even smaller streams. Despite this limited distribution in the County, it has a wide geographic distribution, stretching up into Alaska and across the Bering Straits into Siberia. It can occur in glacial meltwaters and colonizes newly formed streams. Perhaps this was a 'periglacial' species, that is, one who colonized the glacial front lines; its present distribution may be formed partially by relictual populations left over from that era.

When I first stumbled across this species in a tiny rivulet, I initially thought it was a salamander because all I saw was its darting form as I flipped rocks. Living on the bottom of fast-moving headwater streams, it has a fusiform body shape with large front fins that serve to brace it as it rests on the bottom. Sculpin body shape is somewhat similar to that of fast cars, and for similar reasons: while the car is low and smooth in order to reduce drag and help it hug the road at high speeds, the Sculpin is, at least in part, also evolutionarily designed to cope with currents, albeit water currents largely not of its own making; it too is resisting being swept away by the 'winds' around it. Unlike most fish, it does not have a swim bladder, the gas filled organ that serves as variable ballast and lets them float in the water column. For a fish, the Sculpin is a 'land lubber,' although it doesn't leave the water.

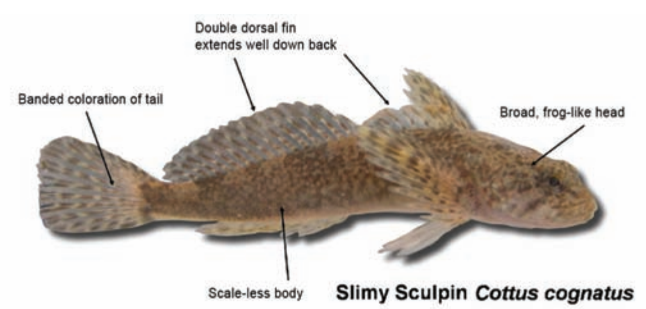


Figure 73. *The Slimy Sculpin is a flattened fish which scoots across the bottom of some of our smaller, cooler, rockier streams.*

For such a small and inconspicuous fish, the ecology of the Slimy Sculpin has been unusually well studied for reasons of association – those Brook Trout neighbors have been the focus of much study as a sport fish. The Sculpin has been included in some of that work out of interest that it might prey upon Brook Trout eggs, compete for food with young Brookies, and provide food for the older Trout. Negative impacts of Sculpins on Brook Trout have not been clearly demonstrated; egg predation, for example, seems to be occasional at worst. There probably is dietary overlap, but that may not limit either species. Sculpin feed on mayfly, caddisfly and true fly larvae; crustaceans; and other aquatic invertebrates. This is similar to Brook Trout, although the latter feeds in the water column, while Sculpins feed off the bottom. Unlike the Brook Trout, for which hundreds of thousands of hatchery-raised individuals have been stocked in the County, the Sculpin have been left to fend for themselves.[56]

The **Longnose Sucker** is a fish lover's fish, it is neither easy to identify nor particularly splashy in its shape or coloration (Fig. 74). Suckers in general are vacuum cleaner fish with downward pointing mouths but upward-, or at least forward-pointing eyes that let them suck from the bottom while being alert for potential predation from above. The resulting shape is something like the smooth if somewhat bulky lines of an Art Deco Locomotive. The White Sucker is the more familiar species, and it is frequently found in streams throughout the County. The Longnose Sucker looks very similar, although it is a somewhat leaner species, with a longer nose that projects beyond its lips and a more downward facing mouth. However, the most prominent difference is in the size (and hence number) of its scales: Longnose Suckers have more than 80 scales along their midline, while White Suckers have fewer. Because, to a large extent, fish increase the size rather than the number of their scales as they grow, this difference holds in fish of various sizes which, for the Longnose Sucker, can be up to 2' in length (although we have only seen individuals a quarter of this size).

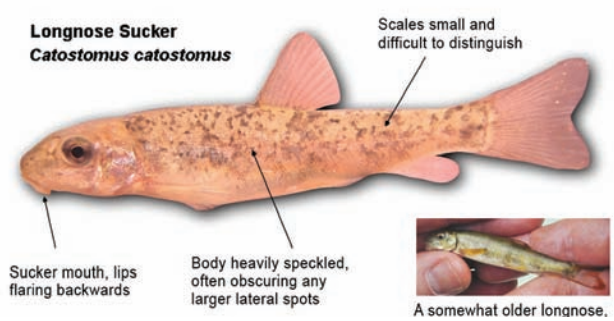


Figure 74. *The Longnose Sucker, while similar to our much more common White Sucker, is a more elusive species identified by its scale number and downward facing mouth. We know little about its natural history.*

This is what we call a 'foothills' species. In other words, it occurs neither in the smallest headwater streams nor in the broadest, slowest creeks. Its cousin, the White Sucker, is much more ubiquitous. Like the Slimy Sculpin, this fish is a boreal species and its range stretches into Siberia. The 'classic' Longnose Sucker life history is that of a fish which spends the majority of its life in cold, deep lakes and migrates into the shallows or into gravely streams in order to spawn. Recently hatched young then move back downstream to the lake. However, we have repeatedly found them as 5-6" long fish in a medium-sized creek near Hawthorne Valley Farm. Where do these come from? Nobody seems to know. Bob Daniels, who has studied New York fish for decades, says the fish is "so poorly known" that we are not even sure where it breeds or at what size – another local natural history mystery waiting to be explored.

It is fun to watch this species feed; in a gravelly situation, it will suck small rocks into its mouth, roll them around, and spit them out. It probably handles muddier bottoms in a similar way, sucking in the particles and eventually spitting out the undesired debris. In natural situations, such a feeding style appears to garner them numerous midge larvae (chironomid), the tiny, frequently red, wormlike creatures which often live in mud and silt; freshwater crustaceans, and the familiar mayflies, stoneflies and caddisflies also enter their diets. Their body form, while ideal for such ground snooping, is not suited for feeding in the water column or from the water surface; when we kept one of these in an aquarium, it had to wait patiently for food to settle while its minnow neighbors darted to the surface and intercepted food as it sank.

Figure 75. Yes, there is a Tessellated Darter in this photograph. As this one is doing, this species 'perches' on the sandy or muddy bottoms of our larger creeks, awaiting prey.

The **Tessellated Darter** is our lowlands representative. It occurs in the Hudson River and along the larger streams of western Columbia County; it makes its way east only along the mainstems of the larger tributaries in the New Lebanon and Harlem Valleys. This is a small (ca. 3") speckled fish of slow waters where mud or sand settle to the bottom (Fig. 75), and hence it becomes common along lower reaches where such conditions occur most often. It lacks a swim bladder and, like the Slimy Sculpin, perches on the stream bottom using its large fore fins. It is not, however, as low to the ground as the Sculpin, and its higher, seemingly more alert posture on sandy, open bottoms make me think of the fish equivalent of a Tiger Beetle. Tiger Beetles (like Robins) hunt visually with a run/pause, run/pause pattern, apparently because the periodic pauses make it easier for their eyes to pick-up the movement of small creatures in their surroundings. Darters do the same, but underwater, where they feed mainly on small invertebrates.

As is true of some other fish (such as the Sculpin), male Tessellated Darters tend their eggs until they hatch. While this action may, in part, protect the eggs from predators, the male also aerates the eggs by giving them a periodic 'dusting' and by mixing, and thus aerating, the water in their vicinity. Greater oxygen uptake can mean faster egg development. Another stream-fish characteristic illustrated by the Tessellated Darter is semi-isolation accompanied by morphological differentiation of populations. While it is easy to conceive of the interconnected populations of such lowland species at least within watersheds, it is also clear that, be they isolated by saltwater or by fresh-but-unsuitable waters (such as large rivers in the case of the Sculpin), fish populations may become demographic islands. Such appears to have been the case for the Tessellated Darter where at least two distinct forms, and areas of interbreeding, now exist in New York State. Researchers hypothesized that this pattern resulted from the glacier-induced isolation of populations during the last Ice Age followed by a postglacial reunion.

The Nature of the Place ~ Six

CONCLUSIONS: THE CRUCIAL PATTERNS OF PLACE

Our Place

As outlined in the preceding chapters, “place” is land and people – we would not have the forests, fields, soils or waters that we do were it not for both the attributes of the land – its topography, climate, geology, and wild plants and animals – and the ways in which people have interacted with the landscape – damming and undamming its flowing waters, constructing or limiting industry, harvesting, planting, building, preserving, exploiting….; there is virtually no place in the County where the formative powers of the human hand are not evident.

Humans have probably helped shape Columbia County since shortly after the last glaciation. From the perspective of precedence or long-term ecological networks, there is little cause to separate ourselves from the rest of nature. Our agriculture, industry, and settlements can be seen as the physical expressions of our niche in the same, albeit more modest way, that a Black Walnut roots on a hillside, taps nutrients, excites seed-dispersing squirrels, and, through its own biochemistry, discourages botanical competitors. And yet we are unique, at least to ourselves, because the human hand is our hand. Not only are our effects pervasive and often dramatic, they are our own doing.

Our attitude towards place has not always reflected acceptance of this responsibility for our actions. Analogous to certain modern perspectives on soils, we sometimes seem to seek liberation from the constraints of place and to seek its conversion into a neutral matrix whose ideal role is to be a receptacle for the uses we wish to apply to it. The basic idea behind this book is that such a one-way relationship would be a tragedy socially and ecologically. To the degree that information ever affects individual action or public policy, we hope that this book helps foster informed compassion for our place, both its people and its land.

In reviewing the preceding chapters and considering what they might mean for our understanding and love for this place, certain generalities become apparent. One of these is the historical strands which are woven through the landscape and which link people and land into definable regions; exploring those patterns as a way of closing will comprise the final section of this chapter and this book. However, before that, a few other themes are worth highlighting in brief:

- **In our relationship with the land and with each other, we have largely been reactive and piecemeal vs. predictive, systematic, and visonary.** One is hard pressed in these pages to find examples of foresight and strategic planning. Systematic advanced planning was probably most evident, although not necessarily admirable, during the initial periods of colonization as the Dutch West Indies Company and then the British government attempted to envision and implement specific plans of colonization. The reasons for the subsequent lack of such an approach are clear enough: nobody knows the future and the actions of individual economic actors are the basis of our capitalist system. Neither crystal balls nor economic revolution are being suggested, but a forward-looking, system-sensitive vision of Columbia County's future could play a substantial role in creating a County-level self-consciousness. Absent that, we will likely tack whichever way the winds take us.

  The power of such visions, and concurrent movements and shifts of public values, should not be underestimated; this comes down to believing in ourselves and our abilities to be meaningful social actors. While much of our landscape history has been a reflection of the incidental effects of actions focused on other objectives than the health of place, it has not been a completely unconscious path. Many people – local, national and international – have influenced regional humanity's conscious relationship to the land and to itself. They have had tangible impacts on what we see around us today, even if many of us do not know their names. They have been sparks which influenced the values of many people and which, in turn, translated into public and personal changes in our treatment of each other and the land. The lesson is surely that well-founded convictions, if joined to accurate knowledge and to adept and respectful sharing, have a huge potential to shape the future work of our hands and hence the future cultural and ecological landscape.

- **New York City is part of Columbia County.** In terms of state geopolitics, while Columbia County has historically shared a county with Albany, it has never done so with New York City. And yet, arguably, New York City has had the more profound effect. As we look at our evolving relationships to place, our changing relationships with 'The City' have played an important role. From initial 17th century wheat shipments down the Hudson, through the wheat-based, export economy of 18th century manors, through hay and rye straw for 19th century City horsepower, through rail-supplied fresh fruit and milk, to today's economy of providing food (the niche market farms rely largely on City-based buyers), second homes, and services to City wage earners, Columbia County's economy and hence land use have been strongly influenced by the desires and needs of the New York City population. While the relationship has been bittersweet – for example, City buyers support local agriculture while driving land prices out of reach of most start-up farmers – and a clash of urban and rural cultures does occur, these complexities are probably nothing new. Working forward will mean being conscious of changes, such as high-speed rail service to the City, which are likely to alter these relationships, and also explicitly recognizing and seeking to smoothen cultural clashes. New ideas and resources are and have been a boon and challenge to the County. Some of the same urban-rural interactions also occur within the County between the urbanity of the City of Hudson and the ruralness of the rest of the County.

- **An ecological aesthetic should play a larger role in shaping our land use.** It has been fairly easy in these pages to point out how different fashions have influenced our land: lawns, manicured ponds, 'parkified forests,' confined streams, and so on. It is less easy to point out general movements that have been based on a widespread ecological aesthetic. Our senses of beauty and practicality don't always recognize the habitat requirements and rhythms of the various species and natural processes that surround us: although lawns are tidy, they harbor few native plants and animals; ponds without aquatic vegetation and stocked with predatory fish are poor habitat for many of our native amphibians and dragonflies; removing forest understory provides open, park-like vistas, but destroys forest regeneration and many wildflowers; landscaping is predicated on a stable landscape, but streams are naturally unstable. Such a tint to our perceptions extends beyond recreational landscaping to production landscape norms: what is our ideal of a 'good farm' and to what degree are natural habitats part of that vision? Changing these perspectives will require working at the interface of ecological understanding, human comfort, and the day-to-day requirements of human production and living. This will always be a dialogue but, until now, with notable exceptions, fashion has largely trumped ecological understanding.

An interesting special case involves what might be called 'green engineering': construction specifically designed to minimize energy consumption and reduce environmental impacts, primarily impacts on water and air quality. The norms for such work have become codified in various certifications, some of which have acquired a certain appeal among home builders. Air and water quality is important for all organisms not just us, and minimizing energy use can be very beneficial for a variety of reasons. We do need 'green cities' and engineering, but much of this book has been about the non-human life on our land, and the inherent rights of many of those organisms is not often emphasized by formal, high-profile efforts at green engineering (although siting characteristics are considered by some). A new green-certified house placed in a vernal pool or on a heretofore uncleared ridgetop, for example, is hardly without ecological impact. Indeed, none of our construction is without impacts, and we need to strive towards such admirable engineering goals while being conscious of the habitat impacts any of our building has on other organisms.

Finally, we need to incorporate an ecological aesthetic into our overall landscape-scale visions, not only our parcel-sized visions. The former should include the latter, but the latter doesn't often consider the former. The question becomes not just how do I manage my land, but also how do I collaborate with others to create a more ecologically sound landscape? While never reaching the county scale, early efforts by various farm communities, including the Shakers, to harness their natural resources for production did involve consciously planning multi-farm landscapes. In such systems it was, for example, important that access to the wetlands supplying nutrient-rich cattle forage (which might eventually become nutrient-providing manure) was adequately distributed across farming entities. More recently, the Harvard Forests' Wildland and Woodlands program has tried to bring a landscape-scale vision to forest conservation and management at the scale of Massachusetts. Can we come up with a coherent county-wide vision of production and conservation in our own landscape, one that identifies our regional roles in both natural resource use and conservation?[1]

Our 'middle ground' of a landscape that values the needs of human and non-human life will not miraculously appear without effort. Good-will can motivate it but knowledge will feed it. We need to be true to the ecology of the land as best we understand it and carefully question any aesthetic or economic decisions we make, even if we deem them beautiful or assume they're 'benefitting the land.' Land aesthetics are the various emotional tugs that influence how we want the land to look; those images of the land are malleable – our conception of beauty can, as various landscape architects are trying to demonstrate, incorporate a greater respect for and understanding of natural ecology. Once it does, the tension between considerations of beauty and of ecology decreases because the former slowly transforms into the latter.

- **Enjoy, have fun, inspire**. There are difficult and potentially painful land use decisions that sometimes must be made and that are easier to write about than participate in. Yet our County has an enthralling human history with abundant resources for the formation of new social understandings and applications. We have a diversity of plants and animals, familiarity with which can add new colors to and expose new patterns in our landscape; we have a diversity of human cultures, each bearing their own revealing traditions and insights into human relationship with place. Compassion for the land doesn't just mean working towards understanding; it also means reveling in being part of it and inviting others to join in.

- **Today's Columbia County is unique in time and space.** Trite but true. This book has tried to celebrate what is unique about our place. Our forests are home to a diversity of plants and animals of northern, southern, and sometimes even Prairie persuasions. Our fields, aside from harboring those Prairie tints, have a long, still-evolving history of use. Our soils are amongst the longest continually cultivated soils in the Northeast and bear the imprint of agricultural evolution from the indigenous 'Three Sisters' through the organic movement. Our waters are tainted by industry, agriculture and development, and yet are more ecologically-intact and biodiversity-rich than many so close to the urbanizing Eastern seaboard. Our human population has that mix of rural and urban roots we mentioned earlier. As the historical aspects of this book have illustrated, we are also unique in where we are in history: new transport and communication systems, new perspectives on farming, growing evidence of climate change, a local service economy embedded in a global economy… each period is a unique combination of factors which influence time and place. In truth, every place and time is unique for those who live there and then; however, if, in viewing our own homelands and times, we forget that simple truth, the value of place vanishes. The section that follows provides one approach to describing and beginning to portray our particular uniqueness.

Ecocultural Regions: Mapping the Intertwined Threads of People and Land

In the preceding chapters, we have tried to illustrate how human actions and the land's own potential have resulted in what we see around us today, and, to some degree, what we are likely to see in the future. In the brief words above, we have tried to emphasize why we believe that knowing place, as defined culturally and ecologically, is so important. In closing and as a way of summarizing the weave of that relationship, we have constructed (for they are constructs) seven ecocultural regions describing patterns in human culture and the land's inherent qualities (see Fig. 1). These are nebulous, fuzzy-bordered generalities which, while perhaps wrong in some ways, may help you look at the County's

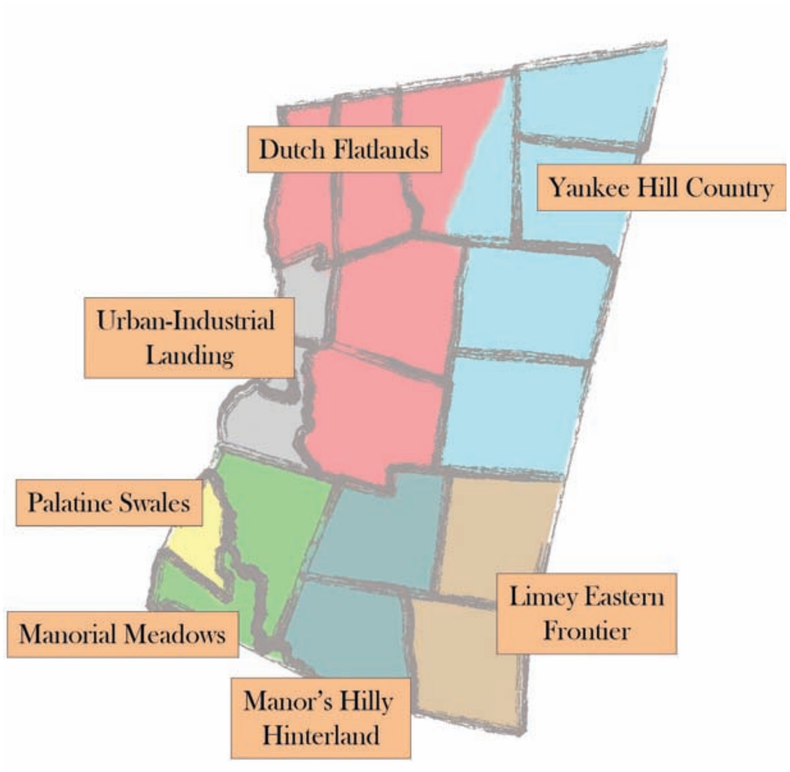


***Figure 1**. A sketch of Columbia County's eco-cultural regions. These were identified based on shared aspects of human and natural history, and physical conditions. Boundaries should be viewed as very fuzzy.*

patchwork in a new way and consider potentially new futures.

In creating our regions we have tried to look for patterns in the overlapping layers of geology, ecology, and past and current socio-economics, topics we've covered in this book. Because so many statistics are summarized by town, towns remain the basic building block of our regions. Although this is largely a pragmatic choice, the original process of town delineation did, consciously or not, reflect certain cultural and landscape features. In some cases, they were the residents' approximations of the ecocultural regions relevant to them at the time (i.e., boundaries between existing cultures or between then-relevant ecologies). In a similar way, county and state boundaries are not completely artificial – given their huge influence on early travel, it should not be surprising that the Hudson separates us from Greene County and the Taconics mark a state boundary. Even when they were largely arbitrary, subsequent human land use demarcated them: the Dutchess County/Columbia County border (once the south border of the Livingston Manor) can still be traced in aerial photographs as a line of field edges and fence rows.

In considering the human and natural histories of these regions, please take the above map of the ecocultural regions and mentally superimpose it on the numerous historical maps already presented throughout this book. The few remaining maps that we do present in this chapter (Figs. 2-7) overlay the regions on our modern cultural and ecological landscape; as you read the regional descriptions, you can refer to these figures for present-day context. In the regional descriptions, we consciously harken back to historical or ecological details discussed in more depth in the relevant habitat chapters.[2]

Dutch Flatlands The Dutch Flatlands are comprised of the towns of Stuyvesant, Kinderhook, Claverack and Ghent. The western half of Chatham probably also best fits here. This is a swath of relatively

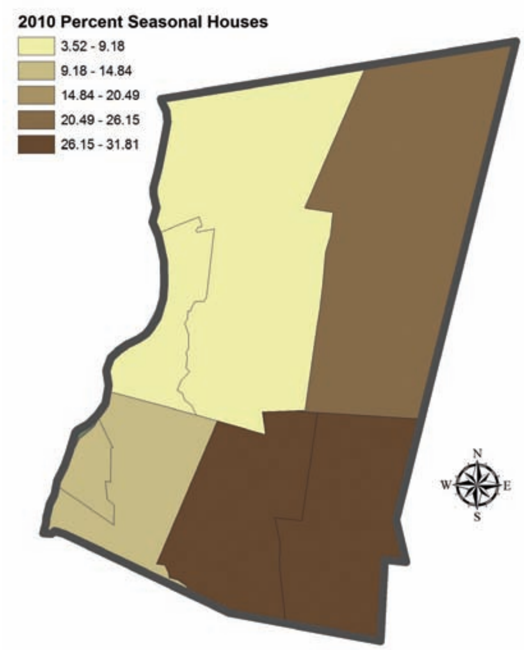


***Figure 2**. The percent of all housing units that were deemed to be of "seasonal, recreational or occasional use" in the 2010 census summarized by eco-cultural region. In general, second homes were found in the eastern half of the County, presumably because of lower population densities, more forest, and scenic hills.*

flat lands in the northwest and central portions of the County. Except for Stuyvesant, most of the land is covered by glacial till, and much of it has been classed as prime agricultural soils. The Dutch first settled in the northwest portion of the County for good reason. Aside from the good soils, there was easy access to the main route of transportation, the Hudson River. Drops along the main stem of Claverack and Kinderhook Creeks provided ample sites for textile and paper mills. As befits the good soils, this was the core of Columbia County grain growing in the 17th and 18th centuries, and, in the later 19th century and throughout the 20th century, corn-based dairying and commercial fruit growing.

Because of the early and extensive agricultural development of this region, we know relatively little about its original natural history. As we have mentioned, the sandy soils north of Kinderhook apparently underlay pine plains that reached north into Rensselaer County. Oak and hickory probably dominated on most of the remaining forest land. The somewhat drier conditions typical of the Hudson Valley portion of the County may have made Native American and lightning caused fires more common in this region.

Although some farmland abandonment occurred here, abandonment was less extensive than elsewhere. Nearly 6% of the region remains in farmland, less than in the Limey Eastern Frontier and the Manorial Meadows, but more than twice that of any remaining region. It has some of the most extensive grassland, with nearly 1/5th in grass. Today, the flat lands and proximity to the Capital District make the northern portion of this region a prime location for commuters' homes. Around half of the resident workers in the northern portion of the region work out-of-county, and two-thirds of those travel to the Capital District. After the Urban-Industrial Landing around Hudson and Greenport (see below), this is the most densely settled region of the County. The Route 9 corridor provides an easy path for the expansion of population and commercialization around Troy and Albany. If Tech Valley or similar regional development initiatives based in the Capital District spur additional population growth, this region might be the first to experience additional development pressure. Perhaps because of this intensive use for agriculture and now for residential settlement, conserved land is relatively sparse in this region, although unique freshwater tidal areas along the Hudson have been

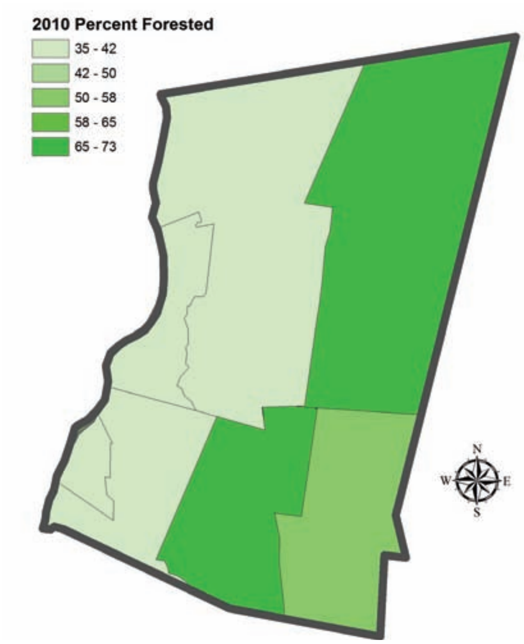


Figure 3. *The percent of all land classified as being forested by the 2010 USDA's aerial photograph-based crop mapping, summarized by eco-cultural region. The Yankee Hill Country and the Manor's Hilly Hinterland had the highest forest coverage with about two-thirds or more of their surfaces in forest. These are the hilliest, most thin-soiled regions and were among the first regions of the County to experience extensive abandonment of farmlands. The Limey Eastern Frontier also has forested hills, but its Harlem Valley contains rich farmlands.*

designated as protected natural areas by various state and private entities.

The Yankee Hill Country The Yankee Hill Country includes the towns of New Lebanon, Canaan, Austerlitz, and Hillsdale. The eastern half of Chatham also lies within this region. The hills here are the Taconics, which form the County's boundary with Massachusetts. Bedrock and glacial till cover the majority of the surface. Steeper slopes have encouraged erosion, so soils are thinner, and prime agricultural soils are limited largely to the valleys.

These lands are home to our most boreal creatures. Red Spruce and Hobblebush creep into the more northerly portions. Breeding birds more typical of the Adirondacks, Catskills or Appalachians, such as Canada, Black-throated Green, Black-throated Blue and Blackburnian Warblers, and the Dark-eyed Junco, occur here. Cooler mountain creeks are home to Brook Trout and Slimy Sculpin.

For the most part, this region was settled by New England Yankees moving in from the east. They found relatively fertile land in the valleys of New Lebanon and Hillsdale. Uncertainty over private land claims (including those of Rensselaer's so-called Lower Manor) and border-line disputes caused confusion which encouraged squatters to arrive and lay claim. Many of these claims were eventually legalized. In the early 1800s, Shaker settlement along the border with Berkshire County created a hub of agricultural and manufacturing activity. The thin soils and hilly country were most suited for pasture, and this area, together with Clermont, was the core of the County's sheep raising during the 19th century; cattle numbers (but not specifically dairy cows) were also relatively high. Streams, though relatively modest, have good incline, and so small saw and grist mills were common, together with some limited attempts at textile and paper production. In addition to clearing for agriculture, portions of the forest were cut over for charcoal to feed nearby iron foundries, although the distribution and extent of that clearing remains something of a mystery.

Farmland abandonment came early to the Hill Country. Between 1875 and 1930, loss of improved acreage approached 50% in some towns. Much of that farmland has now reverted to forest and, as a consequence, this region, together with the Manor's Hilly Hinterland (see below), is one of the most forested parts of the County. At present, the Hill Country is relatively thinly settled. Forests, low population densities and scenic views (especially along ridge tops) have attracted second home owners and urban émigrés; this was home ground for various early 20th century literary figures out of New York City. Residents in the northern portion of the region tend to work out-of-county (in the Capital District or in Berkshire County) and family median salaries are relatively high. In general, cultural and economic ties to Massachusetts are strong. Extensive forests and thin settlement have made this good ground for the establishment of natural areas and a mosaic of state forest and conservation easements is increasing especially on the higher ground. At the same time, those forests and scenic views have made this area especially appealing for the construction of second homes and country estates, although in New Lebanon the loud and decades-old speedway may have reduced second home development and hence kept land price relatively low.

The Urban-Industrial Landing We have included the City of Hudson itself and the surrounding areas of Stockport and Greenport in this region. This is Hudson River shoreline whose soils are dominated by finer deposits (clays and sands vs. coarse glacial till) derived from Glacial Lake Albany. The area is relatively flat, but there are steep drops down to the Hudson.

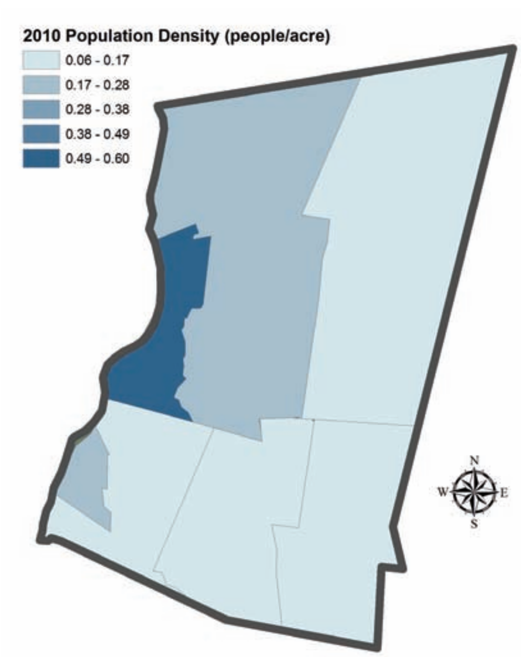


Figure 4. The population density according to the 2010 census summarized by ecocultural region. The Urban-Industrial Landing has the densest population. The Dutch Flatlands contains several large villages and Capital District commuter communities.

As was true along much of the Hudson, American Indian settlements occurred here where good fishing and rich soils made for productive village sites. Later, this stretch of Hudson River shoreline was settled by the Dutch, but density seemed to remain relatively low compared to the adjoining Dutch Flatlands. It may have been this lack of early settlement that allowed 'Claverack Landing' to develop into what is now the County's capital and biggest city, Hudson, when Quaker entrepreneurs chose the site for development around 1783. By 1820, human density was at least twice that of most other regions. Initially, the areas of Greenport and Stockport were important agricultural regions; only later did they become partially subsumed by the more industrial and urban aspects of Hudson.

In part because of the now relatively extensive human development in this region, it is hard to know what pre-European habitats were like. Enticing glimpses of inland ecology may be found near Olana and along the Claverack Creek, where Beaver, nesting Blue Heron, and one of our few known Leopard Frog populations occur within city limits. Box Turtles, which are a more southerly species, occur at least as far north as Hudson and Prickly Pear Cactus was historically reported from this area. The forests were probably oak and hickory dominated, but Northern White Cedar and Hackberry are surprisingly common along the riverbanks. Clay meadows form interesting wetlands in this region, but it is unclear how many such meadows existed historically. The freshwater but tidal shoreline of the Hudson is a globally rare habitat, and home to certain unusual plants and animals. While these wetlands stretch north and south along the banks of the Hudson River, the North and South Bays which flank the City of Hudson are important components.

Haying, perhaps happening at least partially on the Hudson tidal flats, was an important early component of agriculture, and the nearby river meant any production could be easily sent down to New York City or up to Albany. Agriculture faded in importance, but outlying areas were important 19th century locations for grape and apple growing. Hudson became a substantial commercial port town and included a minor whaling industry. As its shipping importance faded and as steam power became established, large textile mills were founded. These joined water-powered mills already located to the north of the City. Clay deposits provided resources for brick-making, and the limestone of Becraft Mountain led to the establishment of cement production.

Hudson has the most ethnically diverse human population of any region in the County. There are substantial African-American, Hispanic, and Asian populations. Few residents work outside of the County. Although manufacturing has largely faded, government, service and retail employment remain important. Incomes are the lowest of any region: the 2010 per capita income for Hudson was only about 50% that of Chatham or Hillsdale (the towns with the highest incomes). As the location of the only Columbia County stop on passenger rail service to New York City, Hudson and portions of the population in and around Hudson have close ties to the City. The potential arrival of high-speed rail might have a profound effect on this region. Commercial development is stretching north and east from Hudson.

Manorial Meadows The towns of Clermont and Livingston were the heart of the Livingston Manor, the semi-feudal domain granted to Robert Livingston in the late 1600s. As with other patents, farmers of this area did not own their land, but rather had access to farmland in return for rent provided to the Manor lord. The Crown purchased part of the Manor in 1610 as land for the settlement of Palatine Germans; this later became Germantown (see below). Livingston and Clermont are relatively flat and well-watered. Fine, lacustrian-derived soils predominate, and much of the area is considered 'prime agricultural soils.'

This is probably the warmest region of the County, and its growing season is some three weeks longer than in the Yankee Hill Country. More southerly plants such as Flowering Dogwood, Tulip Tree, and

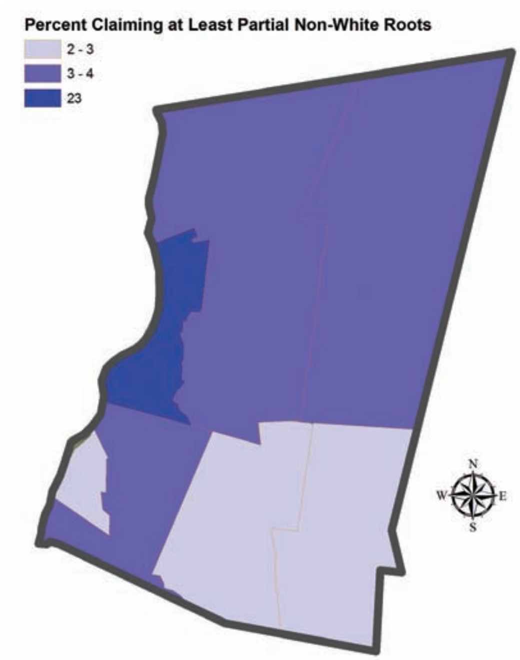


Figure 5. The percent of all reported ethnicities that were non-white according to the 2010 census, summarized by ecocultural region is in and around the City of Hudson. Note that the map color steps are very unequal.

Hackberry become particularly common here, although the forests are still oak and hickory dominated.

Agriculture on these lands during the 19th and 20th centuries somewhat paralleled that of the Dutch Flatlands, with the land being cleared relatively early and grain being a common crop. However, unlike on the Flatlands, Robert R. Livingston's fascination with sheep resulted in the region's early participation in the 'sheep boom,' and the Manorial Meadows also produced substantial hay, probably from the cutting of tidal meadows and upland swales. The growing of small grains evolved into corn growing, and silage-based dairying. This was supplemented by fruit growing. By the end of the 20th century, production agriculture seemed to have faded in Clermont, where fruit growing and dairying were notably lower than in Livingston; horse farms have, however, become more common in this town. As a whole, the Manorial Meadows region has one of the highest amounts of cropland, but also the second lowest median family income (after the Urban-Industrial Landing).

The Palatine Swales Germantown was originally part of the Livingston Patent, but was settled by German Palatine emigrants in 1710 as part of an effort to establish a production center for "naval stores" (i.e., pine pitch used in making tar). Although this venture soon failed, settlers did receive ownership of their lands unlike the rest of the Livingston Patent's tenants who had to wait until the nineteenth century (or later, if they became renters). This distinct cultural origin and tenure arrangement, together with the fact that the lands were inherently more poorly suited for farming, produced a distinct historical trajectory that seems to warrant separating this town from the rest of the Manor.

Glacial till appears to be more common in this region than in the surrounding towns of Clermont and Livingston, and prime agricultural soils are rarer. The land is relatively flat, but gentle north/south ridges formed by the underlying bedrock result in a series of wetter, richer swales. As befits the warmer grounds, the forests tend to include some of the more southerly trees and shoreline biodiversity mentioned in our discussion of the Manorial Meadows. Indigenous settlements may have been relatively common, and, on drier, warmer lands, may have encouraged more frequent fires. A County-wide map of lightning occurrence indicates that it tends to be particularly common in this region, again hinting at the possibility of fires.

That this region's land use was somewhat distinct is suggested by Spafford's 1813 comment that "By a timely economy of forest trees, the lands in this town are remarkably well supplied with timber, and no Town on the tide waters of the Hudson has groves of equal value." As with the Manor, hay was a 19th century agricultural staple, but sheep were rarer, and grains and dairying more common. Dairying lost relative importance to fruit production in the 1900s. Germantown never had much industry nor is it particularly close to a larger city. With the decline of orchards in the County, Germantown's economy has suffered. At present, this region has the highest percent cover of grasslands and the second highest coverage of developed lands (after the Urban-industrial Landing); cultivated cropland is relatively rare.[3]

The Manor's Hilly Hinterland The modern-day towns of Taghkanic and Gallatin composed the center portion of the Livingston Manor. The region is located on hills that stretch southwest from the Taconics and has neither the good limey soils of the Harlem Valley (see below) to the east nor the lake-derived soils of the Manorial Meadows to the west. These towns thus experienced relatively poor agricultural conditions in terms of both soil quality and land tenure arrangements.

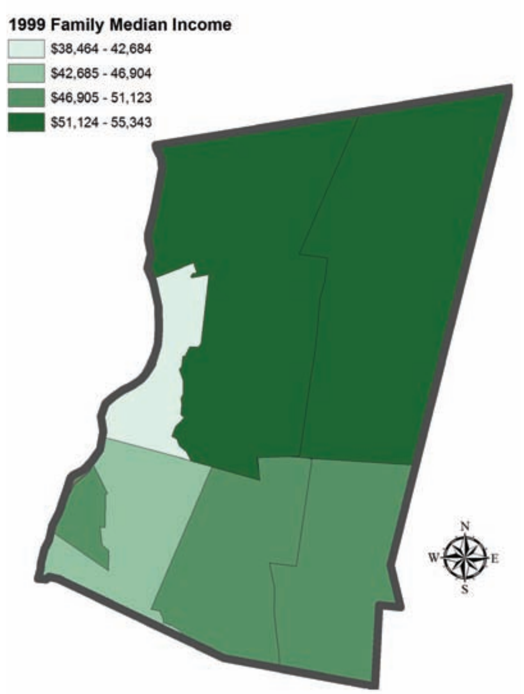


Figure 6*. The median family income in 1999 (the most recent year for which census data were available at the time of writing), summarized by ecocultural region. The "median income" refers to the income equal to or greater than that reported by half the families. The northern portion of the County, perhaps because of its access to the Capital District and Pittsfield, had relatively high income levels.*

Ecologically, this hill country presents something of a mix between the more boreal elements of the higher and more northerly portions of the Taconics and the more southern elements that creep in from Dutchess County. This is, for example, the only region in the County where we know that Marbled Salamanders, a southerly species, occur. Likewise, the Worm-eating Warbler, generally a more southerly bird, occurs in the southern part of the County. Neither the shoreline nor limestone-loving organisms of the Manor's other sections are common here.

Although home to one of the earliest iron forges in the County, little industry developed in this region. Perhaps stimulated by the poor soils, three of the County's five plaster mills were found in this region; 'plaster mills' ground gypsum (a sulfurous lime) into a powder that was used as a fertilizer. As with the Limey Eastern Frontier, agriculture was initially slow to develop in this area. Unlike in the Eastern Frontier, subsequent development was also not particularly strong and the maximum extent of improved acreage was the lowest of any region. Today it is the most forested region of the County. Relative population density has never been high. The wooded hills, low population density, and easy access from the Taconic State Parkway have now encouraged the spread of second homes. Such access also means that attractions like Lake Taghkanic State Park are frequented by New York City day trippers. Local job opportunities are few, and more than half the residents work out-of-county.

The Limey Eastern Frontier The towns of Ancram and Copake in the southeast portion of the County are located on relatively good agricultural soils because of the flattish lands of the Harlem Valley and the underlying calcareous bedrock. (To call soils “limey” is to say they contain much limestone and, since limestone is calcium carbonate, such soils can also be called ‘calcareous’; in any case, their near-neutral pHs tend to provide good growing conditions.) The early colonial settlement and development of these towns may have been hampered somewhat by the tenure system of the Livingston Manor and by the long uncertainty over the location of the boundary with Massachusetts. Hills to both the east and west somewhat isolated these lands. In 1820, this was the most sparsely-settled portion of the County, and human density was around 2/3rds that of most of the rest of the County (with the Hinterland having only slightly higher densities and Hudson having almost four times the density).

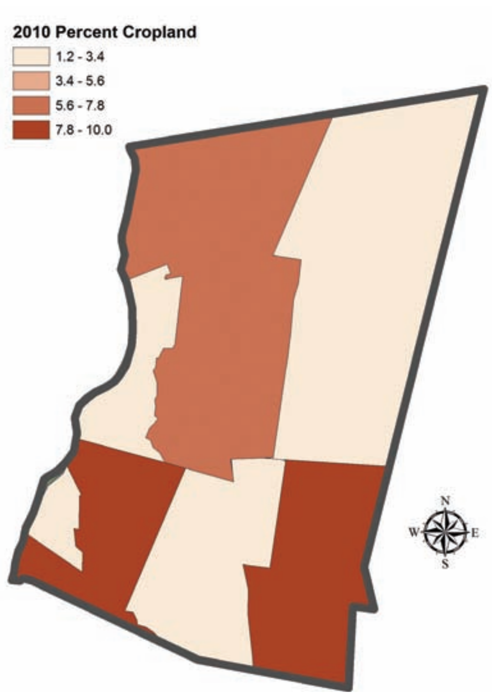


__Figure 7__. The percent of all land classified as being in some sort of crop other than hay by the 2010 USDA’s aerial photographic assessment of crops, summarized by ecocultural region. Non-hay cropland is highest in the southwest and southeast portions of the County, with the central flatlands following.

This is one of the most biodiverse areas of the County (outside of the Hudson River shoreline) because of both the high hills of the Taconics and the limestone valleys, the latter favoring a distinct set of rare plants and animals. The calcareous wet meadows (or ‘fens’) are home to several rare plants and even the nationally-endangered Bog Turtle. The New England Cottontail, a species under consideration for endangered species status, is also known from this area.

Although agriculture was slow to develop, the good soils and rail connection to New York City, established in 1852, helped this region become one of the core dairy lands of the County in the late 19th century; a role that has continued until the present despite the end of railway service. As with the Hill Country to the north, these lands did participate in the sheep boom of the first half of the 19th century, and beef cattle and pigs were also relatively common in the early agricultural economy. Iron and lead mines helped spur initial industry, but there was relatively little additional development. The only currently functioning paper mill in the County (the Schweitzer-Mauduit Ancram mill) is, however, located here.

Most recently, the hills, scenic rural vistas, and relative proximity to New York City have encouraged second home development, and horse farms have become particularly common in Copake. This remains one of the most agricultural regions of the County. Nearly half the workforce works out-of-county, most commonly in Dutchess County. Given its good soils, long agricultural history, continued low population density, and relative accessibility (via Route 22) from New York City, the future viability of niche farming may play a substantial role in shaping the development of this region.

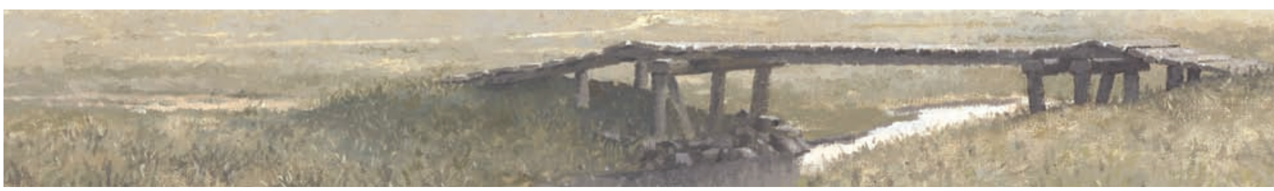
Conclusions

These regions, though defined by history and ecological geography, are still with us today, although perhaps not with the sharpness of distinction that held when we were a less mobile society. Nonetheless, despite our mobility, far corners of the County are rarely our destination, and recreational and professional travel often takes us to more distant and exotic venues. As a result, while no part of the County can be considered isolated in a global sense, many parts are, effectively, isolated from each other. The goal in describing these regions is not to prove their existence, but rather to stimulate thought about land and cultural textures which have affected and continue to affect the character of place.

Each of the regional profiles is a story of sorts – stories which lead up into the present and wait for us to carry on. As we write those stories, how do we, harkening back to the first part of this chapter, derive shared visions that are more proactive than reactive in terms of fostering a productive and ecologically rich landscape? How do we value our cultural diversity including that of urban and rural populations? How do we incorporate an informed respect for non-human nature into our aspirations? And, finally, how do we enjoy our task so much that our enthusiasm is infectious?

The descriptions of habitats in the previous chapters and the ecocultural regions outlined here are information tools which we hope can contribute to deepening love for this present County and to making visions for its future more realistic and more passionate. There will likely be a Columbia County well after each of us has gone and once the pages of this book have yellowed. We will not be here, but the traces of how we stood on this land during our lifetimes will be, written as forest life that we used and nurtured, field ecologies that we worked and cared for, soils and histories that we respected and vitalized, living waters that we harnessed and freed, and cultures that influenced us and that we influenced. We will be remembered for what we accomplished in our search for the best of human nature.

Figure 8. *Looking east into Columbia County from the overlook at the Catskill Mountain House. Columbia County lies in the haze beyond the River. Time will tell.*



Notes and Index

NOTES CHAPTER ONE

1. A rich, if dense, source of information on local geology is *The Rise and Fall of the Taconic Mountains* (2006) by late New York State paleontologist Donald Fisher. The Titus's *The Hudson Valley in the Ice Age: A Geological History & Tour* (2010) touches on various aspects of the County's geology.

2. This account is doubtless oversimplified. The exact distribution and draining dynamics of glacial lakes in the Hudson Valley are matters of debate, although there is some general agreement that a glacial lake lapped the County's shores. For one interesting description of these lakes, see the paper of E. Uchupi and colleagues, 'Drainage of late Wisconsin glacial lakes and the morphology and late quaternary stratigraphy of the New Jersey-Southern New England continental shelf and slope' (2001) in *Marine Geology* volume 172, pp. 117-145. Aspects of glacial Lake Kinderhook are described in Warren and Stone's 'Deglaciation stratigraphy, mode and timing of the eastern flank of the Hudson-Champlain lobe in western Massachusetts,' pp. 168-192 of *The New York State Museum Bulletin #455* (1986), and in *The Wisconsinan Stage of the First Geological District, Eastern New York*, edited by Caldwell. These are available on-line.

3. Andrew Hamilton's work on the biogeography of leafhoppers provided my introduction to this. His recent paper, 'Unraveling the enigma of an Atlantic Prairie' (2012) *Northeastern Naturalist* volume 19 (sp6), pp. 13-42, provides a nice overview. His on-line book chapter at www.biology.ualberta.ca/bsc/english/grasslandsbook/Chapter8_ACG.pdf also helps describe this idea.

4. See Rogers McVaugh's *Flora of the Columbia County Area*, New York (1958) for a discussion of this biogeographical evolution and many other aspects of Columbia County plant life. That volume is available on-line at purl.org/net/nysl/nysdocs/3475833; its index was, for some reason, published separately and is at purl.org/net/nysl/nysdocs/26493717.

5. See Christopher Lindner, 'The earliest thirteen millennia of cultural adaptation along the Hudson River Estuary,' 2011, pp. 65-76 of *Environmental History of the Hudson River*, Robert Henshaw editor.

6. The source for much of this paragraph and good portion of this section is William Starna's *From Homeland to New Land: A History of the Mahican Indians, 1600-1830* (2011); a digital copy of this report is available on the Martin van Buren Historic Site's web site (www.nps.gov/mava/historyculture/upload/From-Homeland-to-New-Land-Final-Report.pdf) and has also been published as a book. Hendrick Aupaumut recounted Mahican oral tradition of arrival from northwest of their Hudson Valley location; his account can be found in Electa Jones' *Stockbridge: Past and Present* (1854), on-line at archive.org/details/stockbridgepast00jonerich. Other key references are the detailed works of Shirley Dunn, *The Mohicans and Their Land 1609-1730* (1994), *The Mohican World, 1680-1750* (2000), and *The River Indians: Mohicans Making History* (2009). *Before Albany* (2007) by James Bradley is an admirable book focusing on Dutch Native American interactions in the Capitol District during the 17th century. Joel Grossman provided important consultation on this section.

7. A copy of van Rensselaer's report is available starting on page 306 of *Van Rensselaer Bowier Manuscripts* (1908), edited by de Laer. It is available on-line at archive.org/details/vanrensselaerbo00rensgoog.

8. In addition to the sources in note 6, these estimates also come from Snow and Lanphear's 1988 'European contact and Indian depopulation in the Northeast: The timing of the first epidemics,' on pp. 15-33 in

the journal *Enthnohistory*, volume 35. Dunn, page 257, in *Mohicans and their Land* (1994), cites the 1845 remarks of John Quinney, the Mahican speaker. Consistent with the lower estimates, Timothy Dwight in his *Travels in New-England and New-York* (London edition of 1823, vol.2, p. 366) cites "one of the tribe" as stating, "Before they [the Mohicans] began sensibly to diminish, they could furnish on any emergency a thousand warriors; and of course consisted of about four or five thousand persons; probably, however, not more than four thousand."

9. A brief cultural history of the beaver is available in Müller-Schwarze's *The Beaver: Its Life and Impact* (2011). Two books which explore this period of coexistence are White's intriguing *The Middle Ground: Indians, Empires, and Republics in the Great Lakes Region, 1650-1815* (1991) and Richter's *Facing East from Indian Country: A Native History of Early America* (2003).

10. The depopulation estimate was from Snow and Lanphear (see note 8). The classic exploring the diverging European and Native American relationships to land is William Cronan's *Changes in the Land* (1983). Various works, such as Frazier's *The Mohicans of Stockbridge* (1994), have explored the Stockbridge Mission.

11. Ruth Piwonka provided important guidance on this section about manorial society. Important references include Kim's *Landlord and Tenant in Colonial New York: Manorial Society 1664-1775* (1978), Ellis' *Landlords and Farmers in the Hudson-Mohawk Region, 1790-1850* (1964), Brooke's *Columbia Rising: Civil Life on the Upper Hudson from the Revolution to the Age of Jackson* (2010) and Grace's 2002 UW-Madison dissertation, *Agricultural Gentility as a Revolutionary Social Vision: The Livingston Family and New York Manor Class, 1660-1813,* and Benjamin's *History of the Hudson Valley* (2014).

12. Livingston and Penney's 1987 paper 'The breakup of Livingston Manor' in volume 4, #1, of the *Hudson Valley Regional Review* chronicles the dissolution of the Livingston domain. It is available on-line at www.hudsonrivervalley.org/review/pdfs/hvrr_4pt1_livingstonandpenney.pdf.

13. Key secondary resources for understanding the County's agricultural history include Ellis' *History of Columbia County, New York* (1878), Martin Bruegel's *Farm, Shop, Landing* (2002), and Peter Stott's *Looking for Work* (2007). We have summarized the County's agricultural history in our paper 'Ecology in the field of time' (2011), on pp. 165-182 in *Environmental History of the Hudson River*, edited by Robert Henshaw. The early reference to wheat sales comes from Danckaerts' 1680 account published in *Journal of Jasper Danckaerts* (1913) James and Jameson editors, on-line at archive.org/details/journalofjasperd03danc. The agro-archeology of field shape in New England is explored in an interesting paper by McHenry, 'Eighteenth-century field patterns as vernacular art,' pp. 107-123 of *Common Places: Readings in American Vernacular Architecture* (1986) edited by Upton and Vlach.

14. For the 1769 account see chapter 11 of *The Hudson River from Ocean to Source* (1902) by E.M. Bacon. The 1813 quote comes from the first edition of Spafford's *A Gazetteer of the State of New York*. The Northeast's role in the slave economy, both in terms of economically supporting the West Indies slave trade and in terms of cotton commerce, has been treated in works such as Farrow, Lang and Frank's *Complicity: How the North Promoted, Prolonged, and Profited from Slavery* (2006) and Albion's *The Rise of New York Port* (1936). In 1845, five Columbia County towns had at least one cotton mill. In 1855, there were a total of 12 mills, producing more than one quarter million dollars worth of cotton cloth. As will be discussed in Chapter 4, slavery itself also existed in the County.

15. Robert Livingston published his *Essay on Sheep* in 1809; it is on-line at archive.org/details/essayonsheepthei-00livi. *Visible Heritage* (2000) by Ruth Piwonka and Roderic Blackburn in part documents the wealth that grew during this period. Stott's work (see note 13) is a key resource for this period.

16. The 1860 quote is from Thomas French's *Gazetteer of the State of New York* (1850). Harvest numbers are from the Federal Census of that year. The large apple orchard reference comes from Lintner, p. 11, *First Annual Report of the State Entomologist* (1882); the orchard, belonging to one Mr. McKinstry, reportedly spanned 330 acres and contained 26,000 trees.

17. Aside from Stotts (see note 13), the *Agricultural Manual of New York State, Arranged by Counties* (ca. 1920), edited by E. van Wagner provides an interesting, if boosterish, early 20th century description of agriculture in the County.

18. Stotts' book (see note 13) provides a core history of manufacturing in the County. This is supplemented by employment information from State and Federal censuses and by William F. Fox's 'History of the lumber industry in the State of New York,' in the *Sixth Annual Report of the Forest, Fish and Game Commission of the State of New York* (1901).

19. Manufacturing information is derived primarily from Stotts (see note 13).

NOTES CHAPTER TWO

1. Two book-length publications give a nice overview of life's, and especially plants', return after the last glaciation: *After the Ice Age* (1991) by E.C. Pielou and *Forests in Peril* (2002) by Hazel Delcourt. Kudish, in the *Catskill Forest: A History* (2002), suggests a role for Native Americans in propagating nut trees in that region; similar suggestions have been made for the hickories of the Champlain Valley.

2. The information in this paragraph and in the figure is derived from publicly available pollen core data that can be found at www.ncdc.noaa.gov/paleo/pollen.html. Using these data, I created rough averages across pollen cores from sites in or near Columbia County.

3. The tree distributions are from the digitized range maps created by Elbert Little Jr. of the Forest Service. These maps are available at http://esp.cr.usgs.gov/data/atlas/little/. An intriguing, historically-minded paper on forest tension zones in the Northeast is Charlie Cogbill's article, 'The forests of presettlement New England, USA: spatial and compositional patterns based on town proprietor surveys' (2002) *Journal of Biogeography* volume 29, pp. 1279-1304.

4. The historical forest ecology study is *Reconciling the Effects of Historic Land Use and Disturbance on Conservation of Biodiversity in Managed Forests in the Northeastern United States* (2005) by L. Howard, J. Litvaitis, T. Lee and M. Ducey. Their map is, in turn, based on *A Forest Atlas of the Northeast* (1968) by H. Lull, The classics are Lucy Braun's *Deciduous Forests of Eastern North America* (1950) and A.W. Kuchler's 1964 *Potential Natural Vegetation of the Conterminous United States*.

5. The southern Hudson work is by Pederson and colleagues, 'Medieval warming, Little Ice Age, and European impact on the environment during the last millennium in the Lower Hudson Valley, New York, USA' (2005) in *Quaternary Research* volume 63, pp. 238– 249.

6. One of the best accounts of early native life along the Hudson, and one of the most explicit descriptions of woodland burning, comes from the accounts left by Adriaen van der Donck, a 17th century Dutch official, who wrote *A Description of New Netherlands*, which has been published in various editions, older translations of which are available on-line at www.americanjourneys.org/aj-096/summary/index.asp. A good discussion of the evidence for fire in the region is 'Fire on the New England landscape: regional and temporal variation, cultural and environmental controls' (2002) by T. Parshall and D. R. Foster in the *Journal of Biogeography* volume 29, pp. 1305–1317.

7. Chelsea Teale's Ph.D. dissertation is entitled, *Informing Environmental History with Historical Ecology: Agricultural Wetlands in New Netherland, 1630-1830* (2013) Pennsylvania State University. The Highlands (a rocky strip of land extending from northeastern Pennsylvania through southern New York and into northwestern Connecticut) work mentioned is Emily W.B. (Russell) Southgate, 'Forest history of the Highlands,' pp. 107-131 of *The Highlands: Critical Resources, Treasured Landscapes*, (2011), R.G. Lathrop editor.

8. The data quoted here are primarily from weather service records that we accessed through CLIMOD, a climatic database maintained by Cornell's Northeast Regional Climate Center; unfortunately, it is a subscription-only service. Details of our floodplain forest work were presented in two reports, *The Plant and Animal Diversity of Columbia County, NY Floodplain Forests: Composition and Patterns* (2009), and *Floodplain Forests of Columbia and Dutchess Counties, NY: Distribution, Biodiversity, Classification, and Conservation* (2010), both by Claudia Knab-Vispo and Conrad Vispo and available from our web site or by request.

9. James Macauley published his three-volume *Natural, Statistical and Civil History of the State of New York* in 1822. Three other books that help us think about the interaction of forests and American history are *American Canopy: Trees, Forests, and the Making of a Nation* (2012) by Eric Rutkow, *Americans and their Forests: A Historical Geography* by Michael Williams (1989), and Gordon Whitney's *From Coastal Wilderness to Fruited Plain: A History of Environmental Change in Temperate North America from 1500 to the Present* (1994).

10. The quotation comes from an 'Essay on the various modes of bringing land into a state fit for cultivation and improving its natural productions' by James Headrick, published in the second volume of the 1800 edition of the *Communications to the Board of Agriculture* in London.

11. Whitney's book (note 9) provides a good summary of potash production and history. Alexander Coventry's diary, mentioned in detail later in this book, exists as a typed manuscript entitled *Diary of an Immigrant*. A copy is available at the Columbia County Historical Society. The 18th century work referred to is *American Husbandry* published by an anonymous author in 1776.

12. Whitney (note 9) gives estimates of early fuelwood consumption. Samuel Deane, in his *Georgical Dictionary* (1822), provides a more intimate account.

13. *House Histories* (1989) by Sally Light and *A Building History of Northern New England* (2001) by James L. Garvin discuss the woods used in regional structures. Coventry's diary is cited in note 11.

14. Various sources describe the activity of the Copake Iron Works, and the Friends of Taconic State Park (which contains the remains of the Iron Works) is a good place to start, their web site is www.friendsoftsp.org/. A museum exists on the site in Copake Falls. Statistics come from reports available from that page,

Ellis' *History of Columbia County*, *New York* (1878), and *The Charcoal Blast Furnaces, Rolling Mills, Forges, and Steel Works of New York in 1867* by Neilson (1867). Conversion factors are from Williams (see note 9), Hough (1878 – 1884, 4 volumes) *Report upon Forestry,* and Russell's *Long Deep Furrow* (1976). There are various sources of slop in our calculations including the fact that '1 ton' of iron was not always 2000lbs. However, since we are only shooting for ball park figures here, we have not been too concerned with precision. Good references on iron working include the work of Robert Gordon's (2001) *A Landscape Transformed : The Ironmaking District of Salisbury, Connecticut*; Edward Kirby's (1999) *Echoes of Iron*; and *200 Years of Soot and Sweat: The History and Archeology of Vermont's Iron, Charcoal, and Lime Industries* (1992) by Victor Rolando.

15. Jared van Wagenen, Jr. in *The Golden Age of Homespun* (1953) describes the charcoal making process, including the preference for elm. Kudish (see note 1) describes clear cutting of hardwoods for charcoal in the Catskills. Russell (see note 14) states that oak and hickory were preferred. The Salisbury account is in Christopher Rand's book, *The Changing Landscape: Salisbury, Connecticut* (1968). Intriguing photos of the post-charcoaling landscape are available from the Cornwall (CT) Historical Society (www.cornwallhistoricalsociety.org/exhibits/forests/iron.htm). The Copake Iron Works accounts come from volume 6 (1885) of the *Journal of the United States Association of Charcoal Iron Workers*, primarily from an article by H.P. Harris on pp. 49-53. This journal is available free on-line at quod.lib.umich.edu/m/moajrnl/browse.journals/char.html. Long-time Copake resident Bill Miles emphasized that charcoal cutting in that town was likely patchy, reflecting the relatively small scale of any one operation.

16. The average number of tanneries is based on census data for the County: there were 34 tanneries in 1810, declining to 6 by 1865. The estimate of bark cords used per tannery is based upon hides reportedly tanned in 1810 and an estimate of bark cords per skin from 'Tanbark tycoons: Palen family Sullivan County tanneries, 1832-1871' by David S. Rotenstein in volume 15 (1998) of *Hudson Valley Regional Review*, pp. 1-42. The cords of bark per acre comes from a detailed account by G.E. Walsh of the Pennsylvania hemlock bark industry on pp. 222-223 of volume 9 (1896) of the journal *Garden and Forest* (available on-line at archive.org).

17. Peter Stotts' *Looking for Work* (2008) is referenced.

18. The article mentioned is 'Abandoned farm land in New York' by L. M. Vaughan, in the *Journal of Farm Economics* volume 11 (1929), pp. 436-444.

19. The dating of the arrival of the blight to the County comes mainly from the US government report *Control of the Chestnut Bark Disease* (1911) by H. Metcalf and J.H. Collins and the Cornell Ag. Experiment Station Report, *Endothia Canker of Chestnut* (1914) by P.J. Anderson and W.H. Rankin. Less clear is how long it took for the live trees to disappear. An article in the *Salem Press* (Washington Co.) for April 3rd, 1924 gives a dozen years as the time for essentially all the mature Chestnut trees to die in that region. Given that there was a cluster of early infections near Saratoga, the disease probably reached Washington County at roughly the same date as Columbia.

20. For more on tree diseases see *The Dying of the Trees* (1997) by C. Little and *Diseases of Trees and Shrubs* (2005) by W. Sinclair and H.H. Lyon.

21. The most up-to-date, New York-specific material on Emerald Ash Borer is available through www.dec.ny.gov/animals/7253.html, and http://www.nyis.info/?action=eab. For a national perspective, see pest.ceris.purdue.edu/map.php?code=INAHQJA.

22. Both sites in note 21 also provide information on Hemlock Wooly Adelgid. The US Forest Service description of Hemlock Wooly Adelgid (na.fs.fed.us/spfo/pubs/pest_al/hemlock/hwa05.htm) seems particularly complete.

23. The University of Vermont has a nice set of web pages on the Asian Longhorned Beetle, including a summary of host preferences; see www.uvm.edu/albeetle/ and associated links.

24. The best source for accessible information on the ecology of worms are the pages of Worm Watch programs around the continent such as Great Lakes Worm Watch, www.nrri.umn.edu/worms/forest/index.html, and Worm Watch Canada, www.naturewatch.ca/english/wormwatch/. Useful printed materials include the easy-to-use booklet by Cindy Hale, *Earthworms of the Great Lakes* (2007) and the denser *Biology and Ecology of Earthworms* (2013 and earlier editions) by Clive Edwards and colleagues.

25. A great resource for understanding and following sustainable forest use in the Northeast is the magazine *Northern Woodlands*, northernwoodlands.org/. The book *More Than a Woodlot*, written by their former editor, Stephen Long, is a good one-volume resource.

26. Columbia County data are derived from New York and U.S. census. *Wildlands and Woodlands: A Vision for the New England Landscape* by David Foster and colleagues presents a nice overview of the current status of forests in New England; it's available on-line at www.wildlandsandwoodlands.org.

27. Amielle Dewan's research is available through the NY DEC's Hudson River Estuary Program. USFS Forest Inventory Assessment data can be downloaded from the report web page of that program apps.fs.fed.us/fido/.

28. The data on fragmentation come from the USFS Forest Inventory Assessment's Landscape Dynamics study, www.fs.fed.us/ne/fia/studies/LDS/.

29. The report mentioned here is by M. Glennon and K. Kretser (2005), *Impacts to Wildlife from Low Density, Exurban Development: Information and Considerations for the Adirondack Park*. WCS Adirondack Program Technical Paper No. 3. It is available on-line; the figures cited here are largely based on work conducted by David Theobald at Colorado State University.

30. "Road ecology" was the topic of an issue in the open-access journal, *Ecology and Society*. See this link: www.ecologyandsociety.org/issues/view.php?sf=41

31. The paper referenced here was 'Housing developments in rural New England: effects on forest birds' by Daniel Kluzal and colleagues. It appeared in the journal *Animal Conservation* (2000) volume 3, pp. 15–26.

32. Because of recent windpower development, there are now reports available looking at the ecological impact of ridgeline development. Somewhat ironically, these projects to supply clean energy have elicited more ecological study than the piecemeal partitioning of ridgelines for residential development. While the uses are not equivalent (windmills don't house cats, and houses usually aren't equipped with huge, rotating booms), the physical impacts of development on the ground are not dissimilar.

33. Some of the most regionally-relevant work on the ecology of 'ancient forests' and, by contrast, newer forests comes from the work of David Foster and colleagues at the Harvard Forest; many of those publications are available free, on-line at harvardforest.fas.harvard.edu/research-publications. Kathryn Flinn, who started her career at Cornell and is now in Pennsylvania, has been exploring some of the same questions in the Mid-

Atlantic region; her publications are also available for free on-line at kathrynflinn.wordpress.com/publications/.

34. The study alluded to is by R. Pendall, *The Upstate Paradox Sprawl without Growth*. (2003) The Brookings Institution Survey Series, available on-line at www.brookings.edu/research/reports/2003/10/demographics-pendall/.

35. For a discussion of thinking about future ecologies based upon past ones and the idea of no-analogue communities, see the last section of Hazel Delcourt's *Forests in Peril* (2002). John Williams at the University of Wisconsin-Madison, has done much recent work on ancient plant communities and their relevance to today; the web site of this lab, www.geography.wisc.edu/faculty/williams/lab/Publications.html, includes links to numerous articles. *The Changing Nature of the Maine Woods* (2012) by Andrew Barton and colleagues also provides a stimulating discussion of these issues.

36. The Forest Service's *Climate Change Atlas* is available at www.nrs.fs.fed.us/atlas/. Jerry Jenkin's *Climate Change in the Adirondacks* (2010) provides a well-illustrated overview of not just forest change, but also much of the socio-economics surrounding regional climate change issues.

37. Learning to identify trees can add a new dimension to woodland hikes. If you observe the trees as you wander, you will get a better appreciation of the 'ecological topography' of your landscape. Many of the forest distinctions in our landscape are relatively dramatic, and they can tell you something about the geology, climate, and history of the land where you are standing. There are few quicker links to a land's biography. You'll need a good tree guide. My favorite for our region is the old *Peterson Guide to Trees and Shrubs of the Northeast* (1958); the illustrations are basic but functional. I supplement this with Farrar's *Trees of the Northern United States and Canada* (1995). This has good illustrations and identification tips but few shrubs. A long-time favorite has been Harlow's *Trees of Eastern United States and Canada* (1942), an older publication but well done and spiced with information on wood use. There are many tree guides out there, and most probably work well once you understand their style. If you can also learn twig, bud, and bark characteristics, you will not only be able to identify trees in January, but you will also have more clues at all times of year (for example, even in winter, dead leaves are often present on the ground; and during summer, many of the twig and bark characteristics remain). Core and Ammon's *Woody Plants in Winter: A Manual of Common Trees and Shrubs in Winter in the Northeastern United States and Southeastern Canada* (1958) is schematically illustrated but useful; there are others. *Bark: A Field Guide to Trees of the Northeast* by Wojtech (2011) is a fun opening onto another way of looking at trees. With all of these guides, time invested in learning the system that the authors devised to help you is well-spent — there are certain sets of characteristics whose appreciation can quickly help you distinguish patterns midst the confusing diversity of forest trees.

38. For a discussion of these and other clues to past land use, see Tom Wessel's two intriguing books, *Reading the Forested Landscape* (2005) and *Forest Forensics: A Field Guide to Reading the Forested Landscape* (2010).

39. George Emerson's 1846 work was *A Report on the Trees and Shrubs Growing Naturally in the Forests of Massachusetts*. A store of original documents concerning the arrival of the Palatine Germans and their attempts to extract 'navel stores' are available in volume 3 (1850) of O'Callaghan's *Documentary History of New York*.

40. Vermont plant distributions come from *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont* (2000) by Elizabeth Thompson and colleagues.

41. The 'prescient observer' referred to was Rensselaer County resident and former editor of the DEC's magazine, Pieter W. Fosburgh, who, in his 1959 book *The Natural Thing* commented, "I can't help wondering at times if reforestation, as an economic proposition, hasn't been oversold, or at least misleadingly advertised to the general public. I've seen too many plantations, all over the Northeast, put in with a burst of enthusiasm, patriotism, and great expectations – and then left to take care of themselves when the time comes for somebody else to take care of them." The statistics on trees come from p. 222 of State of New York Conservation Department's *Seventeenth Annual Report* (1927).

42. The account of Shaker tanner Fred Sizer was published in H. Dussauce's *A New and Complete Treatise on the Arts of Tanning, Currying and Leather Dressing* (1868). Dussauce, although billed as chemist to the Conservatoire Impérial des Arts et Métiers, Paris, apparently resided in New Lebanon for quite a few years and worked for the Tilden Company. For more on Hemlock history and ecology, see the excellent book, *Hemlock* (2014), by David Foster and colleagues.

43. Relative rot resistance information comes from 'Relative durability of native woods,' technical note 173 of the Forest Product Laboratory; available on-line at www.fpl.fs.fed.us/documnts/fpltn/fpltn-173.pdf.

44. An excellent regional guide to plant ecology, including that of the cedars, is Neil Jorgensen's *Sierra Club Naturalist's Guide: Southern New England* (1978).

45. A good guide to eastern oaks is the *Field Guide to Native Oak Species of Eastern North America* by John Stein and colleagues, it was published by the Forest Service in 2003 and is available online at www.fs.fed.us/foresthealth/technology/pdfs/fieldguide.pdf.

46. See Emerson (note 39).

47. The 19th century quote is from the *5th Report of the US Entomological Commission (Insects Injurious to Forest and Shade Trees)* by Alpheus Packard (1890). Ephraim Felt, NYS entomologist, published a treatise on our galls, *A Key To American Galls*, in 1918. The information on gall use in dyes comes from *The Encyclopedia of Insects* by Resh and Cardé (2003).

48. The New Jersey moth work referred to was done by Jonathan Moulding and James Madenjan, and published in 1979 in the *Proceedings of the Entomological Society of Washington* volume 81, pp. 135-144. For an overview of moth declines, see the on-line article, 'Moth decline in the Northeastern United States,' by David Wagner. It explores change in the CT moth fauna. It was published in volume 4 (2012) of the *News of the Lepidopterist's Society,* and is available at http://nationalmothweek.org/wp-content/uploads/2012/07/Moth-Decline.pdf.

49. For a popular discussion of masting see 'The mystery of masting in trees' by Walter D. Koenig and Johannes M. H. Knops, in *American Scientist* (2003) volume 93, pp. 340-347.

50. A summary of current research on self-medication in grazing animals can be found at www.extension.usu.edu/behave/.

51. For information on the early Maple Syrup industry in New York, see *A History of Agriculture in the State of New York* (1933) by Ulysses Prentiss Hedrick. The 2007 maple syrup statistics are available at the USDA-NASS website.

52. *Lichens of North America* (2001) by Irwin Brodo and colleagues provides a nice introduction to the diversity and ecology of our lichens, including a discussion of bark preferences. Closer to home, *Macrolichens of New England* (2007) by James and Patricia Hinds is a good regional resource (although the Sugar Maple lichen mentioned is not considered a macrolichen and hence is not included in that guide).

53. The historical records and maps are derived from various sources. Primary among them are Dekay's *Zoology of New York* or the *New York Fauna, part 1 Mammalia* (1842); Gerrit S. Miller, Jr.'s 'A preliminary list of New York mammals' in the *Bulletin of the New York State Museum,* volume 6, #29 (1899); William Hamilton, Jr.'s *The Mammals of the Eastern United States* (1943); J.O. Whitaker, Jr's unpublished *Mammals of New York*; C. Hart Merriam's *Mammals of the Adirondack Region* (1884); James Macauley's *Natural, Statistic and Civil History of the State of New York*, volume 1 (1829); Edward Mearns' "A study of the vertebrate fauna of the Hudson Highlands" in the *Bulletin of the American Museum of Natural History*, volume 10 (1898), and A.K. Fisher's 'The mammals of Sing Sing,' an article which appeared in the *Portland NY Observer* in 1898.

54. While pertaining primarily to Massachusetts, the paper entitled 'Wildlife dynamics in the changing New England landscape' by David Foster and colleagues and published in the *Journal of Biogeography* (2002) volume 29, pp. 1337–1357, is a good summary of evidence from a nearby locale; it's available on-line. The discovery of the Claverack Mastodon is described in the book *American Monster* (2000) by Paul Semonin. Sources for early mammal ranges include Kurtén and Anderson's *Pleistocene Mammals of North America* (1980) and *The Mastodons, Mammoths and Other Pleistocene Mammals of New York State* (1922) by Hartnagel. It has been suggested that Bison roamed as far east as southern New England; bones have reportedly been found along the Coast of Massachusetts (see Glover Allen's 1920 article 'Bison remains in New England' in volume 1, pp. 161-164 of the *Journal of Mammalogy*).

55. See Fosburgh (note 41); for information on early Elk distribution and ecology see *Elk of North America: Ecology and Management* by Jack Ward Thomas and Dale E. Toweill (1982). Their residence in the Adirondacks and points east is debatable.

56. Sources are Ebenezer Emmon's *Report on the Quadrupeds of Massachusetts* (1840); Audubon and Bachman's *Quadrupeds of North America* (1851/1854); Ernest Thompson Seton's *Lives of Game Animals* (1929) vol 3, part 1; and Dekay (see note 53).

57. Sources are William Hornaday, *The American Natural History* (1914) volume 2; *American Animals* (1902) by Stone and Cram; Seton (see note 56); and Gladfelter's (1984) 'Midwest agricultural region,' pp. 427-440 in *White-tailed Deer: Ecology and Management* (1984), edited by L.K. Halls.

58. The Powys information comes from his unpublished diary, courtesy of Kate Kavanaugh and the Powys Society. Unless otherwise noted, articles cited are from the *Chatham Courier*.

59. For an example of a deer park discussion see www.en.wikipedia.org/wiki/Medieval_deer_park.

60. Much has been written about the impact of deer browsing on both wild and cultivated plants. As early as 1937 Pearce published 'The effect of deer browsing on certain western Adirondack forest types' in the *Roosevelt Wildlife Bulletin* volume 7, number 1. The Forest Service document, *Impacts of White-Tailed Deer Overabundance in Forest Ecosystems: An Overview* (2008) by Tom Rawinski is a useful summary; it is available on-line at www.na.fs.fed.us/fhp/special_interests/white_tailed_deer.pdf. The web page deerinbalance.org/deer-overabundance-research/ provides a nice collection of relevant papers.

61. One of the most dramatic illustrations of the impact of deer browsing are deer exclosures, that is, fenced-in portions of the forest from which deer browsing is excluded. The differences can be dramatic. Many of the experiments reviewed in the above sources are based on this approach. For one detailed description of biomass differences, see chapter 2 (which is in English) of the on-line University of Laval thesis *Réponses des Plantes de Sous-bois au Retrait Expérimental du Cerf de Virginie dans les Forêts du Sud du Québec* (2009) by Amiele Collard (theses.ulaval.ca/archimede/fichiers/26196/ch02.html#d0e442); not all plant groups were denser in the exclosures but the majority were.

62. For an account of the history of the Eastern Cougar, see the book *The Quest for the Eastern Cougar: Extinction or Survival?* (2011) by Robert Tougias.

63. For a description of the Connecticut Cougar and its wanderings, see the on-line Sept./Oct. 2011 issue of the *Connecticut Wildlife Magazine*.

64. The Rhinebeck Lynx report is from Miller (see note 53); the Hillsdale sighting is from *Our Animal Neighbors* by Alan and Mary Devoe (1954). A review of Canada Lynx distribution in the Northeast is McKelvey and colleagues' 'History and distribution of Lynx in the contiguous United States' (1999) in pp. 207-264 of *US Forest Service General Technical Report RMRS-GTR-30WWW*; available on-line. Adirondack biologist Jerry Jenkins questions whether there were ever established Lynx populations in the Adirondacks.

65. On-line sources for the Eastern Coyote discussion include the 2010 article by Jonathan Way and collaborators entitled 'Genetic characterization of eastern 'coyotes' in Eastern Massachusetts' in volume 17 of the *Northeastern Naturalist*, pp. 189-204 (on-line at www.easterncoyoteresearch.com/downloads/GeneticsOfEasternCoywolfFinalInPrint.pdf); this is followed immediately by a response from Steven Chambers, 'A perspective on the genetic composition of eastern Coyotes.' The following site provides an extensive list of relevant references: www.wolf.nrdpfc.ca/publications.htm.

66. The article 'Red Fox' (1999) by Dennis Voight, pp. 379-392 in *Wild Furbearer Management and Conservation in North America, Section IV: Species Biology, Management and Conservation* (on-line publicdocs.mnr.gov.on.ca/view.asp?document_id=10160) provides a detailed summary of the discussion around the interaction of European and North American Red Fox at a time when these were considered distinct species plus some good natural history. See 'The origin of recently established red fox populations in the United States: translocations or natural range expansions?' by Mark Statham and colleagues in the *Journal of Mammalogy* volume 93, pp. 52-65 (2012) for a modern, DNA-based refutation of the idea that most Eastern foxes are European. It is available on-line.

67. *The Beaver: Its Life and Impact* by Dietland Muller-Schwarze (2011) provides a nice summary not only of ecology but of distribution history and density. Local information comes primarily from the digital archives of the Chatham Courier available on-line at www.fultonhistory.com.

68. Aside from Muller-Schwarze's book (see note 67), density information comes from an unpublished summary of beaver demographics very kindly supplied by Nira Salant.

69. The archives of the *Chatham Courier* were our main source (see note 67). I also thank Nancy Kern and Joe Bopp for useful input. The possibility that true Jack Rabbits existed in New York State but that the animals so described in Columbia County were actually European Hares is supported by page 365 of the *Annual Reports of*

the Forest, Fish and Game Commissioner of the State of New York for 1907-1908-1909 (1910). Snowshoe Hare were also sometimes termed Jack Rabbits. The most current information on the New England Cottontail is available from the USFWS, www.fws.gov/northeast/indepth/rabbit/index.html.

70. Various sources discuss the effects of climate change on our mammals. Two useful books are Jenkins' (see note 36) and Barton's (see note 35). On-line resources include 'Climate: forecast for wildlife' by Eric Nuse on pp. 8-12 of the Jan/Feb 2008 edition of the *Wildlife Journal* (www.wildlife.state.nh.us/Wildlife_Journal/ WJ_sample_stories/WJ_a08_Climate_Change.pdf) and *Maine's Climate Future: An Initial Assessment* (2009) edited by J.I.Jacobson and colleagues (http://climatechange.umaine.edu/files/ Maines_Climate_Future.pdf). David Abel's (19 April 2012) *Boston Globe* article, 'Climate shift could help struggling N.E. species' summarizes some of the potential benefactors (www.bostonglobe.com/metro/2012/04/19/some-new-england-species-may-benefit-from-warming/zfTyDskCWFLbrmQMVUQREO/story.html). The Wildlife Management Institute's 2007 report, *Adapting to Climate Change: Agency Science Needs to Adapt Game Management to Changing Global Climate*, provides a good, focused discussion (www.seasonsend.org/documents/Adapating%20Game%20Management%20to%20Climate%20Change,%20WMI.doc).

NOTES CHAPTER THREE

1. Field type surface area is taken from Agricultural Census data (www.agcensus.usda.gov/Publications/2007/index.php) and remote sensing land use classifications such as those of USGS's National Land Cover Database (NCLD) and USDA; both these data sets are available on-line through datagateway.nrcs.usda.gov. These remote sensing classifications tend to be coarse, but do provide one with a general idea of land cover composition.

2. The interactions of plant community, precipitation, and temperature were graphically portrayed in the biome diagram published by respected ecologist Robert Whittaker in his 1975 *Communities and Ecosystems* book; Joseph Craine and Andrew Elmore refined that diagram. Implicit in this discussion is the fact grasslands appear not only *where* temperature and precipitation are right, but also *when* it is right. During historical warm and/or dry periods, grasslands may have expanded. There is evidence of this during the Medieval Warm Period (a ca. 500 year long period of greater warmth centered around 1000 AD or so) in western North America; however, although fire frequency did increase in the Hudson Valley during this period, no increase in grass pollen was detected in sediment cores; see Pederson and colleagues' (2005) 'Medieval Warming, Little Ice Age, and European impact on the environment during the last millennium in the lower Hudson Valley, New York, USA' in *Quaternary Research* volume 63, pp. 238– 249.

3. The role of fires in maintaining grasslands has been covered extensively. Perhaps most apropos is *Fire in North American Tallgrass Prairies* (1990) by Collins and Wallace, a collection of papers on how and why fire is important to these prairies. Closer to home, the savanna-like Albany Pine Bush, not quite field, not quite forest, is also maintained by fire; see Barnes' *Natural History of the Albany Pine Bush Albany and Schenectady Counties, New York* (2003). The 2005 article 'Fire in the tallgrass prairie' by Reinking on pp. 32-38 of the January edition of the magazine *Birding* is a nice summary and is on-line at www.suttoncenter.org/caffeine/uploads/files/publications/2006%20Reinking%20Birding.pdf. *Grasslands of Northeastern North America* (1997) edited by Vickery and Dunwiddie, includes discussion of the role of fire in maintaining eastern grassland patches.

4. These sand barrens are discussed in more detail in other chapters, however the botanical data come from the 1840 flora around the Kinderhook Academy, published by Woodworth on pp. 208-210 of the *53rd Annual Report of the Regents of the University of the State of New York*, cited by Rogers McVaugh in his *Flora of the Columbia County Area, New York* (1958).

5. The County forest fire data are from the annual reports of the Department of Conservation. The statewide data comes from Recknagel's *The Forests of New York State* (1923).

6. The beaver meadow calculation is based on reported beaver colony densities, the average pond/meadow size per beaver colony, and the assumption that a beaver pond lasts about 10 years and the following meadow, in one form or another, for about another 20 years. Nira Salant provided a very useful summary of literature values from her work with Doug Bain and Mark Green. While I used what seemed to be the most likely figures, work in the Adirondacks by Wright and colleagues (2002, in the journal *Oecologia* volume 132, pp. 96-101) suggests that much higher densities might be possible in our region. Using their figures, a staggering 22,000 acres of beaver meadow can be estimated for the County. However, as a percent of land area, that would still be below the Minnesota values.

7. Andrew Hamilton, a student of spittle bugs and leaf hoppers, has proposed the biogeographic idea of a long narrow prairie-like band south of the receding glaciers; this idea is outlined in his paper, 'Unraveling the enigma of the Atlantic Prairie,' (2012), *Northeastern Naturalist* volume 19, pp. 13-42; it is available on-line at ag.udel.edu/delpha/8740.pdf. For a summary of prairie decline, see Samson and Knopf's article 'Prairie conservation in North America' (1994) in *Bioscience* volume 44, pp. 418-424. This paper was apparently expanded into an edited book, Samson and Knopf's *Prairie Conservation* (1996).

8. The 1830s land use map has been described and analyzed by Brian Hall and colleagues in the paper, 'Three hundred years of forest and land-use change in Massachusetts' by B. Hall, G. Motzkin, D.R. Foster, M. Syfert and J. Burk (2002), *Journal of Biogeography* volume 29, pp. 1319-1335. Brian kindly provided access to the data for Berkshire County so we could make the map shown in Fig. 6. Books such as Gordon Whitney's *From Coastal Wilderness to Fruited Plain* (1996) and Percy Bidwell and John Falconers' *History of Agriculture in the Northern States: 1620-1860* (1925 and reprints) give descriptions of early meadow management. *Looking for Work* by Peter Stott, while focused more on industry than agriculture, provides ample details of regional farming activity in the County. Alexander Coventry's diary is available as a type-written 2850 page manuscript entitled *Memoirs of an Emigrant*, copies of which are available at the Columbia County Historical Society and some regional libraries. Chelsea Teale's recent dissertation, *Informing Environmental History with Historical Ecology: Agricultural Wetlands in New Netherland, 1630-1830* (2013, Pennsylvania State University), on wet meadows and Dutch agriculture provides an extensive survey of the role of wet meadow agriculture in Hudson Valley colonial farming.

9. Horatio Spafford, who apparently lived part of his life in Columbia County, published two editions of his *Gazeteer of the State of New York*, one in 1813 and another, lengthier version, in 1824. Compiled from the reports of local informants, it is full of local color.

10. The Farmscape Ecology Program has published two reports on the floodplain forests of Columbia County, both of which are available free from our web page, hvfarmscape.org.

11. The fur trade and beaver ecology have been reviewed by various authors. Two particularly useful books are *The Fur Trade in Colonial New York* (1974) by Thomas Elliot Norton and *The Beaver: Its Life and Impact* (2011) by Dietland Muller-Schwarze.

12. Our own work on the organisms in and around wet meadows in the County is available as a 2006 report, *Ponds of Columbia County: Patterns in their Biodiversity, Thoughts on their Management*, available on our web site. John Torrey published his two-volume *A Flora of the State of New-York* in 1843.

13. The ratio of upland hayfield and pasture vs. moist meadow clearly depended on the geography of a given region. Flats along the Hudson and our major tributaries provided opportunity for freshwater meadows, although I have so far found few specific accounts of such use. In New England at least, the transition to upland meadows was well underway during the second half of the 18th century.

14. A good review of birds and grasslands in the East is provided by Peter Vickery and Peter Dunwiddie's *Grasslands of Northeastern North America: Ecology and Conservation of Native and Agricultural Landscapes* (1997). *The Second Atlas of Breeding Birds in New York State* by Kevin J. McGowan and Kimberley Corwin is one of the best regional sources of bird ecology in relationship to changing land uses. Haying and grassland bird breeding are obviously in potential conflict; a good survey of how to mitigate that conflict can be found in the NRCS publication, *Management Considerations for Grassland Birds in Northeastern Haylands and Pasturelands* (2010) by Noah Perlut and colleagues, on-line at www.nysenvirothon.net/Referencesandother/Management_Considerations.pdf.

15. The two nineteenth century works cited are *The Natural, Statistical and Civil History of the State of New York* (1829) by James Macauley and Zaddock Thompson's *History of Vermont, Natural, Civil and Statistical* (1842). Kent's quotation comes from *The Birds of Dutchess County New York: Today and Yesterday* (2006) by Stan DeOrsey and Barbara Butler. The English work referred to is Michael Shrubb's intriguing *Birds, Scythes and Combines: A History of Birds and Agricultural Change* (2003).

16. Torrey's work is cited in note 12. Bidwell and Falconer (note 8) describe aspects of historical grassland agronomy; Charles Flint's *Grasses and Forage Plants* is available in various nineteenth century editions and describes many of the grasses used.

17. The quote is from Elon Eaton's *Birds of New York* (volume 1, 1910); this book also contains county-by-county summaries of bird abundances.

18. The information on the Connecticut Valley comes from Aaron Bagg and Samuel Eliot, Jr.'s *Birds of the Connecticut Valley in Massachusetts* (1937).

19. Agricultural statistics come from Federal censuses. Initially, the agricultural census was included in the general decennial census, but it later came to be a separate census. Digital copies of these censuses are available at www.agcensus.usda.gov/Publications/Historical_Publications/index.php.

20. Emmons's haying data are from volume 1 of his *Agriculture of New York* (1843); see Chap. 3, note 58, for Powys source; Shaker journals were transcribed by Jerry Grant of the Shaker Library and Samuel Johnson, with support from the Shaker Swamp Conservancy.

21. The suggested role of evolving haying in orchid abundance comes from personal communication with Rogers McVaugh, the late author of the *Flora of the Columbia County Area, NY*.

22. Sharon Stichter wrote extensive recommendations on field management for butterflies for the Massachusetts Butterfly Club; that information is available on-line at www.naba.org/chapters/nabambc/butterfly-conservation.asp. Sharon's *Butterflies of Massachusetts*, www.butterfliesofmassachusetts.net is also a great resource for applied butterfly ecology. The Midwest mowing recommendations come from Ann and Scott Swengel's work, available on-line at www.naba.org/chapters/nabawba/resources.html. Our own report on openland butterfly conservation is available on our web site.

23. Bidwell and Falconer (note 8) provide a brief summary of nineteenth century sheep agro-economics, and John Schelebecker's *Whereby We Thrive* (1975) provides general economic context. However, a definitive text is Chester Wright's *Wool-Growing and the Tariff* (1910) which is available in a free digital version on-line.

24. The quote is from volume 2 (1914) of Eaton's *Birds of New York*.

25. Whitney's work is cited in note 8.

26. The cited paper is by H.P. Cooper, J.K. Wilson and J.H. Barron; it was published in 1929 in *The Journal of the American Society of Agronomy* volume 21, pp. 607-627.

27. In North America, the interaction of cattle health, behavior and grazing patterns is being most actively explored by Joe Provenza and colleagues at Utah State University, on-line at extension.usu.edu/behave/.

28. John Godman's *Mastology* (1826) provides an interesting early glimpse of American mammals, including the hungry Woodchucks. Early to mid-19th century descriptions of insect communities can be found in the work of Asa Fitch (New York's first state entomologist) and Thaddeus Harris' classic *A Report on the Insects of Massachusetts, Injurious to Vegetation* (1841); subsequent editions bore the title *A Treatise on Some of the Insects Injurious to Vegetation*. *Our Birds in their Haunts* by J. Hibbert Langille (1884) gives evocative descriptions of birds in the nineteenth century agricultural landscape; Langille was based in western New York State. Alexander Wilson's pioneering *American Ornithology* (ca. 1810) contains many colorful descriptions of birds in the early 19th century landscape.

29. Peter Kalm's *Travels in North America* (1770) is full of natural history observations. The economic value of birds was a topic of many nineteenth century ornithological authors including DeKay's avian volume of the *Natural History of New York* (1844) and Peabody's *Report on the Birds of Massachusetts* (1840). Later authors, including Chapman in New York and Forbush in Massachusetts built on these foundations; Forbush's *Useful Birds and their Protection* (1907) is a detailed compilation that is still available inexpensively from used book stores.

30. Torrey's work is cited in note 12. Darlington's *American Weeds and Useful Plants* (1859) is an everyman's botany and mixes information on weeds with that on useful medicinal herbs.

31. Coventry's diary was cited in note 8. The information on widow's allotments, together with much other early information on Columbia County agriculture can be found in Martin Breugel's *Farm, Shop, Landing: The Rise of a Market Society in the Hudson Valley, 1780-1860* (2002).

32. See note 10.

33. Various early authors comment on the 'pest' aspect of Passenger Pigeons; recent papers describing the probable interactions of Passenger Pigeons and mast include Joshua Ellsworth and Brenda McComb's "Po-

tential effects of Passenger Pigeon flocks on the structure and composition of presettlement forests of Eastern North America" (2003), published in *Conservation Biology* volume 17, pp. 1548-1558, and David E. Blockstein and Harrison B. Tordoff's 'A contemporary look at the extinction of the Passenger Pigeon' (1985) in *American Bird* volume 35, pp. 845-851; both publications were available on-line at the time of this writing.

34. The information on cornfield use by wildlife comes from Todd Gosselink and colleagues, who published the paper 'Temporal habitat partitioning and spatial use of Coyotes and Red Foxes in East-Central Illinois' (2003) in the Journal of *Wildlife Management* volume 67, pp. 90-103; Gehring and Swiharts' 'Home range and movements of Long-Tailed Weasels in a landscape fragmented by agriculture' (2004) in the *Journal of Mammalogy* volume 85, pp. 79-86; and 'Body size, niche breadth, and ecologically scaled responses to habitat fragmentation: Mammalian predators in an agricultural landscape' (2003) by the same authors in *Biological Conservation* volume 109, pp. 283-295.

35. Several book-length treatments of the lawn phenomenon exist, including *Redesigning the American Lawn* (2001) by Bormann and colleagues, Steinberg's (2007) *American Green: The Obsessive Quest for the Perfect Lawn*, and Jenkins'(1994) *The Lawn: A History of an American Obsession*. Tom McSheffery's (2004) term paper, 'The American lawn – The ultimate monoculture,' on-line at mch2o.com/images/Penn%20State/Cultural%20Ecology/American%20Lawn.pdf, provides a short, readable summary of lawn history. Cristina Milesi and colleagues have done detailed work estimating the extent and evolution of lawns in the US; the 2005 paper by her and her colleagues, 'Mapping and modeling the biogeochemical cycling of turf grasses in the United States' (2005) is the source for current estimates of lawn area; it was published in *Environmental Management* volume 36, pp. 426–438. Milesi's work is summarized at earthobservatory.nasa.gov/Features/Lawn/. The article, 'Turfgrass revolution: Measuring the expansion of the American lawn' (2003), by Robbins and Birkenholtz in *Land Use Policy* volume 20, pp. 181–194, provides a case study of lawn history and management (including all the agrochemicals) in one Ohio county, and is the source for the estimate of annual lawn expansion. The role of televised golf in promoting lawnification is outlined in 'The Augusta syndrome,' a blog posting by safelawns.org at www.safelawns.org/blog/2012/03/the-augusta-syndrome-45-years-later-is-golf-the-environments-worst-nightmare/.

36. Unless otherwise noted, data in this section are from the US Census, New York State Census, and from USDA and NLCD (National Land Cover Database) land use maps.

37. Pesticide data are from the 2005 PRL (Pesticide Reporting Law) report, available from the DEC web page, www.dec.ny.gov/docs/materials_minerals_pdf/prl2005.pdf. The following Cornell site provides maps and more detailed data for the same time period, pmep.cce.cornell.edu/psur/.

38. Data are from NLCD estimates published in 2005 (and probably reflecting land use around 2000).

39. Data are from NLCD's land use change GIS layer, which compares 2001 data with 2005 data.

40. Two case studies from neighboring states provide perspective on development and nature: *Hands on the Land: A History of the Vermont Landscape* (2002) by Jan Albers and *Changes to the Land: Four Scenarios for the Future of the Massachusetts Landscape* (2014) by Jonathan Thompson and his colleagues.

41. A variety of resources were used in this section. For current identification and understanding, the standard wildflower books in our packs are *A Field Guide to Wildflowers: Northeastern and North-central North*

America (1998) by McKenny and Peterson and *Newcomb's Wildflower Guide* (1989) by Newcomb. If you connect best with photographs, then *Wildflowers in the Field and Forest: A Field Guide to the Northeastern United States* (2006) by the late and lamented Steven Clemants and Carol Gracie might be most suitable. In our lab, Gleason and Cronquist's *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (1991), the *Illustrated Companion* to that work (1998) by the Holmgrens and, most recently, Haines' *Flora Novae Angliae* (2011) have been the most heavily used. Rogers McVaugh's *Flora* (note 4) serves two purposes – it is still a valuable resource for understanding today's plants, but it has also become a historical resource depicting a past landscape. We have posted our own plant list for the County on our web site.

A string of regional floras extends back in time, each giving its own glimpse of the botanical world where and when it was written. The ones we have referred to in writing this plant section are Norman Taylor's *Flora of the Vicinity of New York* (1915; the "vicinity" includes Columbia County; this provides estimates of abundance and descriptions of habitat); Hoffmann's (1922) 'Flora of Berkshire County, Massachusetts,' in the *Proceedings of the Boston Society of Natural History* volume 36, pp. 171-382 (again, this includes habitat and abundance information); House's *Annotated List of the Ferns and Flowering Plants of New York State* (1922; habitat and abundance information); *Catalogue of the Flowering Plants and Ferns of Connecticut Growing without Cultivation* by Graves and colleagues (1915, habitat, abundance and some use information); Darlington's *American Weeds and Useful Plants* (1859, a great historical compendium with substantial use and culture information); Eaton's *Manual of Botany for North America* (1836; while continental in scope, Eaton was born in Columbia County and lived much of his adult life in Troy; some specific regional information on plant distributions is thus included in this book); Rev. Chester Dewey's *Report on the Herbaceous Plants of Massachusetts* (1840, Dewey was a Berkshire County resident, this book includes information on habitat and use; see also the plant list published in volume one of *A History of the County of Berkshire, Massachusetts*, which he co-authored in 1829); John Torrey's *Flora* (1843, primarily abundance and habitat with some cultural information); *Rural Hours* by Susan Fenimore Cooper (1850; not a flora *per se*, but a natural history journal with ample botanical references from in and around Cooperstown, by James Fenimore Cooper's daughter); Peter Kalm's *Travels in North America* (1770; a travelogue but full of valuable botanical information); *An Address on the Botany of the United States… to Which is Added a Catalogue of Plants Indigenous to the State of New York* by Jacob Green (1814; mainly a list but with some cultural introductory remarks; valuable as an early source on New York State plants); and *Florula Bostoniensis* (1814; one of our earliest floras, containing a list and some abundance and habitat information) by Jacob Bigelow. Several other early local floras are available. These are often just lists, however they help us paint the picture of what was present at a particular time. Most relevant perhaps are Woodworth's "Botanical report" on pp. 208-210 of the *53rd Annual Report of the University of the State of New York* (1840; Woodworth taught at the Kinderhook Academy and published lists derived from his work with classes); Stebbins' list of Hudson plants published on p. 33 of the appendix of the 1830 edition (volume 1) of the *The Transactions of the Albany Institute*; Gordinier and Howe's *The Flora of Rensselaer County, New York* (1898); Harrison's 'Trees and shrubs of New York' (1887, actually a list of wild woody plants around New Lebanon) in *Swiss Cross* volume 2, page 63; Lyman Hoysradt's 'Catalogue of phaeogamous and acrogenous plants growing without cultivation within five miles of Pine Plains, Duchess Co., N.Y.' (1875), published as a supplement to volume 6 of the *Bulletin of the Torrey Botanical Club*; and Wright and Hall's *A Catalogue of Plants Growing without Cultivation in the Vicinity of Troy* (1836).

In addition, there was a hot bed of 19th century medical botany in New Lebanon – the Shakers cultivated, collected and imported a variety of plants for their retail medicine business, and Tilden & Co. expanded on that business. While these efforts were national and commercial in scope, materials describing those businesses do give us a glimpse of medical botany during that period, spiced with local history. Numerous catalogues and descriptions were created by those businesses, two useful ones available on-line are *A Catalogue of Pure Medicinal Extracts Prepared in Vacuo at the Steam Works of Tilden and Co*. (1852) and the concisely titled *A Catalogue of Medicinal Plants, Barks, Roots, Seeds, Flowers and Select Powders, with their Therapeutic Qualities and Botanical Names; also Pure Vegetable Extracts prepared in Vacuo: Ointments, Insipissated Juices, Essential Oils, Double Distilled and Fragrant Waters, &c, &c, Raised, Prepared, and Put up in the Most Careful Manner*, by the United Society of Shakers at New Lebanon, N.Y. (ca. 1850).

Finally, several historians have reviewed the history of plant introductions in the Northeast or United States, prominent among them is Richard Mack, his papers include 'The commercial seed trade: An early disperser of weeds in the United States' (1991) in *Economic Botany* volume 45, pp. 257-273; 'Plant naturalizations and invasions in the eastern United States: 1634-1860' (2003) in *Annals of the Missouri Botanical Garden* volume 90, pp. 77-90; and 'The United States naturalized flora: Largely the product of deliberate introductions' (2002), written together with Erneberg and published in *Annals of the Missouri Botanical Garden* volume 89, pp. 176-189. Gade's paper on weeds, 'Weeds in Vermont as tokens of socioeconomic change' (1991) in *Geographical Review* volume 81, pp. 153-169, provides an interesting socio-historical take on Vermont weeds. Chapter 5 of Kevin Dann's *Lewis Creek Lost and Found* (2001) gives one a gut feel for being a botanist at the time of the railroad-mediated influx of plants. Chelsea Teale tackled ornamental plant introductions in the Hudson Valley in her 2011 paper, 'The introduction and naturalization of exotic ornamental plants in New York's Hudson River Valley' on pages 183-194 of the *Environmental History of the Hudson River*, edited by Bob Henshaw. Lastly, one paper stands as both historical retrospective and history itself: In 1832 de Schweinitz read his paper entitled, 'Remarks on the plants of Europe which have become naturalized in a more or less degree, in the United States,' which appeared in the 1836 *Annals of the Lyceum of Natural History of New-York* volume 3, pp. 148-155.

42. Aside from the works of Mack, noted above, Spencer Barrett explicitly tackles weeds as crop-seed mimics in his paper, 'Crop mimicry in weeds' (1983) in *Economic Botany* volume 37, pp. 255-282.

43. The oft repeated tale of plantain being called "Whiteman's Footprint" apparently originated (or, at least, found early citation), in Peter Kalm's book (note 41), where he quotes noted botanist William Barton's recounting of this tale. Barton was also the befuddled early botanist. Darlington (note 41) describes the confusion arising from its similarity to Red Clover seed. Bigelow (note 41) is the source of the "refrigerant" quote (presumably meaning that it refreshes and heals).

44. Darlington (see note 41) is a wealth of information here; Torrey (see note 12) is quoted out of the second volume of his flora of New York. Kalm is cited in note 41. The diary of Scottish MD Alexander Coventry will be explored in our soils chapter. Coventry lived near Stockport around 1790, and provided a detailed glimpse of life during this period. A copy of his diary is available at the Columbia County Historical Society Library.

45. Darlington and Torrey (see note 41) both comment on what must have been the 'mint julep' social phenomenon. Dewey, in his *Flora of Massachusetts* (see note 41), comments on peppermint in Berkshire County, while Mack's works (see note 41) are the source of the earliest citations.

46. References are in note 41. Mack discussed the early invasives in some detail. Two additional works of William Darlington are cited, his *Flora Cestrica* (1837) and his *Memorials of John Bartram and Humphry Marshall* (1847), from which the Bartram quote comes.

47. See Mack and Teale (both cited in note 41) for descriptions of the 19th century landscaping market.

48. Grace Greylock Niles' *Bog Trotting for Orchids* (1904) is an orchid-bedecked botanical romp around New England and Eastern New York. *Our Native Orchids* by W. Hamilton Gibson and Helena Dewey Leeming Jelliffe was published one year later. *Wild Orchids of the Northeast* by Brown (2007) is our current field guide. Orchid conservation issues are briefly summarized in the paper, 'Conserving our native orchid heritage – The what, how and when behind the North American Orchid Conservation Center' (2012) by Whigham, in *The Native Orchid Conference Journal* volume 9 #4, pp. 24-31. Arthur Harrison's piece, 'Woodland tramps,' appears in *Picturesque Berkshire* (1893) volume 1.

49. The late New York State botanist, Richard Miller, wrote an impassioned plea for deer control in the *Newsletter of the New York Flora Association* (1997, volume 8 #2, p. 3), citing, in part, the steep decline he had observed in wild orchids.

50. The railway quote is from *Nature's Garden* by Neltje Blanchan (1900). The New England Flora Society web site (gobotany.newenglandwild.org/) provides easily accessible information on these and other regional species.

51. The current attempt to ride cowboy on the *Solidago* taxonomy confusion is the work by Semple and colleagues, *The Goldenrods of Ontario* (1999). The introductory quote, emblazoned on the inner cover, is the important observation that "Goldenrods do not cause hayfever!" (The native Ragweeds do; but that is another botanist's headache.)

52. Aside from the references given in note 41, Peter Mark's paper, 'On the origin of the field plants of the northeastern United States' (1983) is particularly relevant here because he explicitly evaluates answers to the question of whence the field flowers; it appears in *The American Naturalist* volume 122, pp. 210-228.

53. As with the wildflower section, this set of profiles is based upon regular reference to a key set of resources. For the identification of butterflies on the wing (I highly recommend butterfly stalking with a camera), there are several good guides out there. For our region, my main reference is *Butterflies of the East Coast* (2007) by Cech and Tudor. Measuring 8.5 x 11 inches, it's not really a field guide, but, for my first couple of seasons at least, I lugged it around in my backpack. It was worth the effort. More recently, I found *The Connecticut Butterfly Atlas* (2007) by Jane O'Donnell and colleagues; this book is more portable and features a photograph of each species' caterpillar; it is not, however, quite as useful for identification. Jeffery Glassberg's *Butterflies through Binoculars*, the edition for the Boston-New York-Washington Region (1993), is another handy manual. I find the pictures a bit small, but that may just be my aging eyes. The most recent edition to my bag is *Butterflies of North America* (2003) by Brock and Kaufman; its clear pictures are helpful, but the continental diversity it contains can bewilder beginners. Caterpillars have warranted their own field guides, two for the Northeast are Wagner's *Caterpillars of Eastern North America* (2005 and including moths) and *Caterpillars in the Field and Garden: A Field Guide to the Butterfly Caterpillars of North America* (2007) by Allen, Brock, and Glassberg.

There are a variety of on-line resources. T*he Butterflies and Moths of North America* (www.butterfliesandmoths.org/) provides useful basic descriptions, pictures and range maps not just for butterflies, but also for moths. *The Massachusetts Butterfly Guide* is full of helpful ecological information (www.massaudubon.org/ butterflyatlas/allbutterflies.php). Sharon Stichter's recently launched *Butterflies of Massachusetts* site (see note 22) is a great source of regionally-relevant natural history. Just like wild flowers, butterflies are very seasonal. Furthermore, one year can be quite different from the next in terms of who is common. Because of this, knowing what others are seeing can help you determine what you could be seeing. Members of The North American Butterfly Association (NABA) regularly contribute their sightings, and many of these are from the Northeast (www.naba.org/sightings/sightings.html). Xerces, the insect conservation society, has a fun website (xerces.org) with information on the conservation of butterflies and other insects. Our own information on butterfly diversity in the County is available on our web site. A nice basic introduction to New York butterflies is *Learning about Butterflies* (1981) by Klass and Dirig, on-line at entomology.cornell.edu/cals/entomology/extension/youth/upload/Learning-About-Butterflies-139-M-9.pdf

Aside from these 'field resources,' several other modern and historical publications were used to compile context and background. *Butterflies of New Jersey* (1997) by Gochfeld and Burger is valuable for its focus on history and conservation. Likewise, Handfield's *Le Guide des Papillons du Québec*, (2011, 'version scientifique'), provides a nice summary of literature relating to at least our more northerly butterflies (and moths). The two editions of the *Peterson's Field Guide* to butterflies of the East are both useful, Klot's 1951 edition was a ground breaker and has historical value; the 2nd edition, written by Opler and Malikul in 1992 provides a useful summary. Arthur Shapiro's *Butterflies and Skippers of New York State* (1973) is a very helpful snapshot of New York's fauna. William Forbes' two butterfly publications, his 1960 *Lepidoptera of New York and Neighboring States Part IV* and his section on Lepidoptera in the 1928 *List of the Insects of New York* provide useful historical information, the earlier work is particularly useful because it specifies New York state locales for each species. *How to Know the Butterflies: A Manual of the Butterflies of the Eastern United States* by Cornell professors John and Anna Comstock (1904) provides some lively descriptions and New York observations.

Samuel Scudder, Thaddeus Harris and Asa Fitch were a trio of 19th century, northeastern entomologist who, to a greater or lesser degree, focused on butterflies. Samuel Scudder was the most preoccupied with butterflies, and his tome, *Butterflies of the Eastern United States and Canada* in three volumes, was self published in 1889. It contains detailed descriptions and summaries of natural history and distribution information (plus some poetry selections!). He wrote a variety of more accessible works, many of which are available inexpensively on-line, including *Everyday Butterflies: A Group of Biographies* (1899) and *A Brief Guide to the Commoner Butterflies of the Northern United States and Canada* (1893). Thaddeus Harris and Asa Fitch were authorities on the economically important insects of Massachusetts and New York, respectively. While butterflies weren't their sole focus by any means, Harris' *A Treatise on Some of the Insects Injurious to Vegetation* (published, in this form, posthumously in 1862) and Fitch's various *Reports* as State Entomologist contain sections of important butterfly information. Fitch was followed in his post by Lintner who, while focusing primarily on other organisms, did publish two years' (1869-70) worth of his intriguing 'Calendar of butterflies' for several sites in and around Albany; the tables are in his 1872 'Entomological Contributions' on pages 48 (for 1869), and 157 (for 1870), published as an appendix to *23rd Annual Report of the New York State Cabinet of Natural History*. These were numeric surveys taken at various points across the flight season; they are some of our earliest regional quantitative butterfly data. Maynard's *Butterflies of New England* is a nicely illustrated text that helps describe butterfly abundance and distribution at that time.

54. While each species moves to a different drummer, weather systems which influence the movement of one migrant will often also affect the movement of another. Hence, the 'live' maps of Monarch migration at www.learner.org/jnorth/monarch/ may be helpful for understanding Painted Lady movements as well.

55. It's worth pointing out Sharon Stichter's informative post at www.butterfliesofmassachusetts.net/regal-fritillary.htm; it details the frustrated attempts at reintroduction. Xerces.org also has a summary page on this species. In addition to ample consideration in the other resources mentioned in note 54, David Wagner and colleagues published 'Status update and life history studies on the Regal Fritillary (Lepidoptera: Nymphalidae)' in *Grasslands of Northeastern North America* (1997) pp. 261-275, edited by Vickery and Dunwiddie. *Regal Fritillary (*Speyeria idalia Drury*): A Technical Conservation Assessment* (2007) by Selby is also a good summary.

56. The quote comes from Fitch's 'Thirteenth report on the noxious, beneficial and other insects of the state of New York' (1870), in the *Transactions of the New York State Agricultural Society* volume 29, pp. 495-566.

57. Same source as note 56.

58. Quote is from Glassberg's butterfly guide (note 53).

NOTES CHAPTER FOUR

1. Two general soil books that have influenced my views of soil's definition are *Soil Genesis and Classification* by Buol and colleagues (1989; much more recent editions are now available) and *Building Soils for Better Crops* (2009) by Fred Magdoff and Harold van Es. An overview, together with many local details, is provided by the *Soil Survey of Columbia County* (1989), published by the USDA.

2. See this collection of videos assembled by the Virtual Soil Science of BC Consortium, www.youtube.com/playlist?list=PL387C9E97597F9D8C. The Rocky Mountain scenery, while not illustrative of our landscape immediately prior to the last glacial, can help us remember that the Taconics once were even higher.

3. While Columbia County forms something of a vacant donut hole in this work's coverage, the 1986 New York State Museum publication, *The Wisconsinan State of the First Geological District, Eastern New York*, edited by Caldwell, provides a good regional consideration of 'recent' glacial movements. 'The Hudson River Valley: geological history, landforms, and resources' by the late Les Sirken and Henry Bokuniewicz, chapter 2 in *The Hudson River Estuary* (2006) provides a somewhat larger-scale overview. Various chapters in the Titus' *The Hudson Valley in the Ice Age* (2012) explore Columbia County glacial geology, these include chapters 10 and 11 on Glacial Lake Albany and deltas, respectively, and chapter 22 on drumlins.

4. For a detailed biography of Lake Albany, see 'Onshore record of Hudson River drainage to the continental shelf from the late Miocene through the late Wisconsinan deglaciation, USA: synthesis and revision' (2010) by Scott Stanford, in *Boreas*, volume 39, pp. 1-17. For some dramatic graphics, see this Woods Hole page www.whoi.edu/main/news-releases/1995-2004?tid=3622&cid=2078.

5. For one window onto the physiology and geology of mineral licks see *Mineral Licks, Geophagy, and Biogeochemistry of North American Ungulates* (1985) by Jones and Hanson.

6. See last work in note 1 for discussion of "prime" soils.

7. Joel Grossman and John Hart of the NY State Museum provided ample input during the writing of this section. The timing of agriculture's arrival to the Hudson Valley can be framed by local and regional evidence. One of Dr. Hart's papers, 'Evolving the three sisters,' provides a nice overview. It was published in *Current Northeast Paleoethnobotany II* (New York State Museum Bulletin 512, 2008), edited by J. P. Hart, pp. 87-99. This publication and others are available on-line www.nysm.nysed.gov/staff/details.cfm?staffID=37. For a nice geographic overview and a discussion of the cultivated and semi-cultivated food plants, see Nancy Asch Sidell's 'The impact of maize-based agriculture on prehistoric plant communities in the Northeast' on pp. 29-51 of the same publication.

8. Documents and accounts of colonist settlements on opened Native American land can be found in Ellis' *History of Columbia County, New York* (1878), Spafford's *Gazetteer of the State of New York* (1824) and Shirley Dunn's *The Mohicans and Their Land 1609-1730* (1994) and *The Mohican World 1680-1750* (2000). For accounts of late pre-contact indigenous settlements in the County, see Rugenstein's 'Evidence for settlements along the Kinderhook' in *Mohican Seminar 3: The Journey, an Algonquian Peoples Seminar* (2009), edited by Shirley W. Dunn; the Columbia County Historical Society's Columbia County *History and Heritage* magazine, Winter 2003; and Asch Sidell's article cited in note 7.

9. Mulholland's 'Territoriality and horticulture: A perspective from prehistoric New England,' pp. 137-166 in *Holocene Human Ecology in Northeastern North America* (1988) edited by G.P. Nicholas. It is cited and discussed in Brian Donahue's thought-provoking book on early colonial agriculture, *The Great Meadow: Farmers and the Land in Colonial Concord* (1996).

10. The Goldkrest site is described (and even illustrated) in J.W. Bradley's *Before Albany: An Archeology of Native-Dutch Relations in the Capital Region 1600-1664* (2007), pp. 10-11. A drier, but more detailed report is the paper by Largy and colleagues (1999) 'Corncobs and buttercups: Plant remains from the Goldkrest Site,' pp 69-84 in *Current Northeast Paleoethnobotany*, edited by J.P. Hart. Binzen, in 'The river beyond the mountains: Native American settlements of the Upper Housatonic during the Woodland Period,' comments on possible explanations for the lack of known contact-period Native American settlement sites in western Massachusetts; his article is on pp. 7-17 of *Mohican Seminar* 2 (2005), edited by Shirley Dunn.

11. Starna's *From Homeland to New Land: A History of the Mahican Indians, 1600-1830* (2012) (www.nysm.nysed.gov/staffpubs/docs/20359.pdf) provides a concise summary of what is known about Mahican land relations; Bradley (see note 10) and Dunn (her first two books are listed in note 8) provide useful data and interpretation. Lindner, 'The earliest thirteen millennia of cultural adaptation along the Hudson River Estuary,' pp. 65-76 in *Environmental History of the Hudson River* (2011) edited by Robert Henshaw fits information on the contact-period Hudson River indigenous peoples into what we know about their longer historical context.

12. The Aupaumut quote comes from *Stockbridge Past and Present* (1854) by Electa Jones.

13. Accounts of Hudson's 1609 voyage come from his own journal and that of shipmate Robert Juet. Unfortunately, Hudson's journal was apparently lost after an 1821 auction of the Dutch West Indies archives (see www.ianchadwick.com/hudson/hudson_00.htm), and his words are only available as extracts in a work on the New World by the Dutchman de Laet. Those extracts together with translations of other early Dutch documents, including van der Donck's, can be found in Jameson's *Narratives of New Netherlands* (1909). The most rigorous translation of van der Donck's important work is the recent translation by Goedhuys,

Description of New Netherlands (2010), edited by Gehring and Starna. For information on the agronomics of the 'three sisters,' see Jane Mt. Pleasant, 'The science behind the three sisters mound system,' pp. 529-537 in *Histories of Maize* (2006), edited by John Staller. Ceci's 1975 article, 'Fish fertilizer: A Native North American practice?,' *Science*, vol. 188, pp. 26-30, makes the case against the widespread use of fish as fertilizer by Native Americans. However, subsequent work, including the archeological recovery of fish bones from corn mounds, strongly suggests that, while perhaps not as widespread as once believed, fish were used as fertilizer. See, for example, Ferguson's (2010) University of Massachusetts - Boston thesis entitled, *A Macrobotanical Analysis of Native American Maize Agriculture at the Smith's Point Site* (gradworks.umi.com/1480789.pdf). The thesis also mentions the use of ash and tests for the possible use of midden soil. Certainly, ash was extensively used by Europeans as a fertilizer, and Native Americans apparently burnt land, after fallowing, in order to revitalize it. The degree to which they collected and then fertilized with off-field ash may be unknowable.

14. Starna and colleagues discuss the use of pesticides in their paper, 'Northern Iroquoian horticulture and insect infestation: A cause for village removal' (1984), published in *Ethnohistory*, volume 31, pp. 197-207.

15. See Aupaumat (note 12) and van der Donck (note 13); southern New England information comes from the work of Peter Thomas in the *Maelstrom of Change: The Indian Trade and Cultural Process in the Middle Connecticut River Valley, 1635-1665* (1979), a University of Massachusetts - Amherst thesis.

16. The use of fire by Native Americans has been a matter of extensive debate with the two poles – widespread, ecologically-powerful fires vs. sporadic inconsequential fires – seeming to dominate center stage. Reading over the discussions, it seems clear that Native American-set fires did occur, but it also seems clear they did not occur everywhere, both because Native American populations were very low in some areas (such as the colder, hillier country farther from flats and rivers) and because some areas (for example, moist deciduous forest) were more difficult to burn. The distribution of fires may have varied over time, as climate changes affected both the distribution of people and of fire-proneness. Van der Donck (see note 13), as quoted, clearly describes fires set along the banks of the Hudson; and this is the drier, hotter part of the County. In his blog (curtinarchaeology.com/blog/2010/07/28/forest-burning-and-clearing-by-hudson-valley-indians-1000-years-ago/), regional archeologist Edward Curtin summarizes some additional evidence from the west bank of the Hudson. Parshall and Foster, in their 'Fire on the New England landscape: Regional and temporal variation, cultural and environmental controls' (2002) *Journal of Biogeography* vol. 29, pp. 1305-1317, reviewed historical accounts and sediment-core charcoal records from around the Northeast. They concluded that burning was concentrated along coastal dry lands and at in-shore sand plains. While such a pattern might discount the landscape-scale influence of fire, it also seems evident that, in those lands that did burn, such as pine plains and sand barrens, repeated fire may have played a key role in maintaining a certain type of vegetation. This has been clearly demonstrated at the Albany Pine Bush. The Stockport Creek information comes from the 2013 Columbia University thesis of Sanpisa Sritrairat (academiccommons.columbia.edu/catalog/ac:155508) entitled *Multiproxy Analyses of Past Vegetation, Climate, and Sediment Dynamics in Hudson River Wetlands*. Coventry's diary (see note 22) mentions burning. The fire causation data come from the annual reports of DEC's predecessors, the Forest, Fish and Game Commission, the Conservation Commission, and the Conservation Department. For the period between 1897 and 1950, I found and analyzed data for 32 years. While the number of forest fires in each county was often reported, fire causation records were either summarized by forest section (i.e., Adirondacks, Catskills, and elsewhere) or presented for the

entire state. I thus do not have specific causation data for Columbia County. The .5% value quoted is for the Catskills, although the percentage in a given year and location ranged as high as 13% in the Adirondacks in 1911, and as low as 0% for the Catskills and 'elsewhere' during several years.

17. Aside from the references mentioned in the text, the wikipedia article on van der Donck is extensive and helpful, en.wikipedia.org/wiki/Adriaen_van_der_Donck.

18. Cohen's *The Dutch-American Farm* (1993) describes the origins and practices of the Dutch farm in America although his reference for earliest techniques remains largely van der Donck.

19. See also Lemon's classic, *The Best Poor Man's Country* (1972), p. 173, for a discussion of early manuring or lack thereof, albeit among the German and British of southeastern Pennsylvania. The quote is from Rev. Joan Michaelius. His letter can be found in various sources including on p. 187 of Barstow's *Explorers and Settlers* (1912). Jan Folkert's paper 'Kiliaen van Rensselaer and agricultural productivity in his domain: A new look at the first patron and Rensselaerwijck before 1664,' pp. 294-308 of *A Beautiful and Fruitful Place* (1996) edited by McClure-Zeller, provides a good description of agriculture during this period; it includes an explicit discussion of soil exhaustion and manuring.

20. This quote (from p. 278) and other accounts come from the *Van Rensselaer Bowier Manuscripts* (1908), translated and edited by van Laer.

21. While I will make minimum explicit use of them here, two books that deal with soil and this period of American history and hence are inspirational are Stoll's *Larding the Lean Earth* (2003) and Cohen's *Notes from the Ground* (2011).

22. Alexander Coventry's diary was transcribed and distributed as a typescript entitled, *Memoirs of an Emigrant: The Journal of Alexander Coventry, M.D.*; a copy of this transcription is available at the Columbia County Historical Society Library. For an interesting discussion of the role of agricultural reform in the ambitions and ideals of Robert Livingston, see David Grace's 2002 University of Wisconsin thesis, *Agricultural Gentility as a Revolutionary Social Vision: the Livingston Family and the New York Manor Class, 1660-1813*. Britain's agricultural revolution, involving both enclosure and agronomic innovation, provided something of a model for societal improvement led by a landed class. As Livingston's political aspirations faded, he devoted himself to 'leading from the field' by promoting not just agronomic but also industrial (e.g., the steam boat) innovations that he believed would promote the well-being of citizens and thus stabilize the new country. For a description of the role of the elite in encouraging agricultural innovation in England, see Thirsk's *Alternative Agriculture: A History* (1997).

23. In 1790, the population density of the US as a whole was estimated at 4.5 people/mi^2 (US Census, www.census.gov/population/www/censusdata/files/table-2.pdf), while that of England was around 160 people/mi^2; see Wrigley and Schofield *The Population History of England 1541-1871* (1989) table A3.1. Population density maps for this era (e.g., USA: www.census.gov/history/img/1790-b.jpg; England: www.geog.cam.ac.uk/research/projects/occupations/britain19c/population/populationdensity1801.png) show that population density varied dramatically across the landscape. However, it appears that not just urban but also rural densities tended to be higher in England, although probably not as dramatically as indicated by total density.

24. For another New York reference to sending manure down river, see *Transactions of the New York Agricultural Society*, vol. 29, 1869, p. 180, where one Mr. Faxton of Oneida states, that "In old times he had seen

hundreds of loads of manure drawn out in the winter on to the ice on the Mohawk River, so that when the ice melted it might be carried off."

25. There were repeated references to soil exhaustion in this era. See, for example, Strickland's 1796 'Observations on the State of America,' published on pp. 128-167 of volume 2 of the *Communications to the Board of Agriculture* (London, 1800); anonymous' description of New York farming in chapter 10, pp. 126-131, of volume 1 of *American Husbandry* (1775); and p. 126, Dr. S.L. Mitchell's 'Oration' (pp. 1-24, of *The Transactions of the Society for the Promotion of Agriculture, Arts and Manufactures*, volume 1, 1796). New England farmers also brought a different mind-set in terms of land tenure. As Grace (note 22) points out, New England believed in the independent farmer ideal, whereas 'tenant' was less of a bad word in New York.

26. For a regional view of slavery in the Hudson Valley, see 'Contested ground: Hinterland slavery in colonial New York' (2009) by A.J. Williams-Myers in *Afro-Americans in New York Life and History*, vol. 33 pp. 91–137. See also, 'These enemies in their own household: Slaves in 18th century New York' by Davis on pp. 171-180 of *A Beautiful and Fruitful Place* (1996).

27. Based on Livingston's production figures and using then-current prices derived from Coventry, one can estimate that such farmers produced approximately 130£ worth of grain (i.e., corn, oats and wheat; I use £ here as the unit of currency, don't worry about its actual value – just consider the relative gains). Of this, the family of five would consume perhaps 60£'s worth (based on Bruegel's probates), leaving around 70£, of which, if this were a tenant farm, some 5.3£ might go to rent and, perhaps 5£/yr for additional help (depending on family composition, a tenant might well try to do most work within the family, yet extra help might be hired during harvest). There were certainly additional costs: potentially some seed purchases (although seeds could be saved) and equipment repair (if not done on-farm). This would leave a bit less than 60£ as clear profit from grain growing. Using Livingston's semi-independent calculation of profit per acre, we come to about 47£ for 40 acres of cultivated land, but this assumes extensive use of paid labor. Likewise, if we assume that rent was approximately on 1/10th of production value, then the average Rensselaerswyck rent of 5.3£, implies a total production of 53£ (although it's not clear if this was calculated before or after family consumption). Using some of the same primary information, Ellis, in his important *Landlords and Farmers in the Hudson-Mowhawk Region, 1790-1850* (1946), provides a nice description of some of the motivations causing the differences between American and British farming during this era.

Animal production is a bit more difficult to estimate. For the most part, it might be safe to assume that, on the majority of farms, livestock largely paid their way in kind, providing food and labor rather than cash. The notable exception was probably the mentioned role of dairy production in a woman's income, although recorded gains are relatively small (less than .5£; however, Coventry's records may be very incomplete). In sum, it seems reasonable to estimate that a farmer of a 130 acre farm, during a decent growing season, may have made perhaps 50-70£s of profit per year.

28. Conveniently, in 1796 Thomas Robertson published *Outline of the General Report on the Size of Farms*, a survey of British farm size. His figures can be used to calculate farm sizes of roughly 10-20 acres in England, depending upon what you take as the rent per acre. Clearly, British farms were smaller than their North American counterparts. Conversely, average yields were probably greater, concurrent average British wheat yields (see Overton and Campbell's 'Production and productivity in English agriculture 1086-1871' in the proceedings of the 14th International Economic History Congress [2006] table viii; this is a translation of their 1996 'Production et productivité dans l'agriculture anglais, 1086-1871,' in *Histoire et Mesure*, vol. 11,

pp. 255-97) were more than 20 bu/acre vs. about 10 bu/acre estimated by Livingston; oats produced an estimated 32 bu/acre in England vs. 20 bu/acre stateside (the English produced almost no maize). British rent/acre was correspondingly about .7£/acre, while values cited by Livingston or derived from Rensselaerswyck records (see Humphrey's 1996 Northern Illinois University dissertation, *Agrarian rioting in Albany County, New York: Tenants, markets and revolution in the Hudson Valley, 1751-1801*, Table 2) convert to about .05-.2£/acre. The currencies were probably not directly equivalent and retail values differed, but these numbers seem to support the idea that, on a per acre basis, British farmland was expected to produce more money.

29. For a discussion of "commons" lands and on-the-ground practice, see 'The evolution of individual property rights in Massachusetts agriculture, 17th–19th centuries' (1985) by Fields in *Northeastern Journal of Agricultural and Resource Economics*, vol. 14, pp. 97-109. For a broader discussion of land tenure in early Northeastern agriculture, see chapter 5 of the classic, *History of Agriculture in the Northern United States 1620-1860* (1925) by Bidwell and Falconer. John Brooke's *Columbia Rising* (2010) includes sections on late 18th century "land politics" in Columbia County.

30. In 1808 and in the County as a whole, about 31% of the farmers were tenants, with a high of 56% within the Livingston Manor in the southeast corner of the County; 14 years later, the average was 39%, with a high of 68% in the same region. For a detailed discussion of tenancy and manors in the Hudson Valley, see Kim's *Landlord and Tenant in Colonial New York: Manorial Society 1664-1775* (1978).

31. During the early cohabitation of colonists and Native Americans on the land, free-ranging livestock (and, to some extent, livestock in general) was one of the most disruptive aspects of colonial farming for indigenous farmers, as explored in Anderson's *Creatures of Empire* (2004).

32. Wildlife is perhaps one of the few explicit physical commons remaining in our society. Noted wildlife ecologist Valerius Geist has written a stimulating paper, 'Triumph of the commons' (2004) on the great benefit that this commons arrangement has had for North American wildlife conservation. It was published on pp. 5-11 of vol. 12, #6 of *Wild Lands Advocate*.

33. The agricultural necessity vs. social pain of enclosure is debated amongst historians. The Wikipedia entry on enclosure, en.wikipedia.org/wiki/Enclosure, provides a good summary. For the ecological consequences, see chapter 4 of Shrubbs' *Birds, Scythes and Combines* (2003).

34. For two regional takes on this debate, see Wermuth's (2001) *Rip van Winkle's Neighbors* and Martin Breugel's *Farm, Shop, Landing: The Rise of a Market Society in the Hudson Valley, 1780–1860* (2002). The latter, given its Columbia County focus, is a rich source of insight into practices in our County.

35. See for example discussion on p. 59 of John Brooke's book (see note 29).

36. See Bildwell and Falconer (note 29), pp. 134, 196-197 for discussion of international trade during this period.

37. For a discussion of manors and wheat as a commodity in late 19th century Hudson Valley markets, see Bruegel's 'Unrest: Manorial society and the market in the Hudson Valley, 1780-1850' (1996), pp. 1393-1424 in volume 82 of the *Journal of American History*.

38. For a discussion of aspects of this innovation, see Olmstead and Rhodes' *Creating Abundance: Biological Innovation and American Agricultural Development* (2008), which mainly looks at animal and plant breeds

and makes the case for their central role in 19th century agricultural improvement, and McClelland's *Sowing Modernity: America's First Agricultural Revolution* (1997), which focuses on the role of design innovation in farm machinery. Bidwell and Falconer (note 29) also remain a key source.

39. Brian Donahue's book discusses meadow farming in detail (see note 9). Bidwell and Falconer (see note 29) are important sources. The Shaker information comes from journal transcriptions done by Samuel Johnson in collaboration with Jerry Grant of the Shaker Museum (www.shakermuseumandlibrary.org/) and organized and sponsored by the Shaker Swamp Conservancy (shakerswamp.org/).

40. Chapter 3 of Shrubb (see note 33) has a good summary of "high farming."

41. Samuel Deane's *New England Farmer or Georgical Dictionary* (3rd edition, 1822) provides a detailed and thought-inspiring entry under "manure"; aside from the more familiar forms of manure, he includes thatch, leather, brick dust and "night soil."

42. Gypsum's nuanced history and application can be garnered from both Emmon's 1851 account on p. 242 of his *Agriculture in New York*, vol. iii, and works such as Fisher's 2011 article 'Amending soils with gypsum' in the November-December issue of *Crops & Soils* magazine, pp. 4-9.

43. Stoll (note 21), p. 189, cites a similar concept for guano (bird manure that became the fertilizer rage of the mid 1800s): it presaged the use of off-farm nutrient sources that became the mainstay of modern mainstream farming.

44. Olmstead and Rhodes (note 38) use similar logic to claim the importance of 19th century crop and livestock breeding. A variety of innovations were probably part of the puzzle.

45. The standard modern edition of Eliot's work is the 1934 volume edited by Carmen and Tugwell, and including a biographical sketch by True, which supplied some of the details in this paragraph. This edition has been reprinted more recently. An 1811 reprint of the first five essays is available on-line, archive.org/details/papersfor1811com1811elio. Jethro Tull's book, which appeared in various, now expensive, 18th century editions, is also available, archive.org/details/horsehoeinghusba00tull.

46. Charles Varlo came to the United States with an apparently dubious claim to the governship of New Jersey and one third of its land. Foiled in that, he appears to have revamped his somewhat earlier English work, and gone on what may have essentially been a year-long book tour. His *New System of Husbandry* was first published in England in 1770, but it was revised for a 1785 American edition that, apparently, sold widely: it is one of the easiest North American agricultural books of this era to find. See Wikipedia biography, and the on-line version of his American edition, archive.org/details/newsystemofhusba02varl.

47. John Bartram was a prescient scientist and father of respected naturalist William Bartram. His thoughts on soils seem to be preserved primarily in his correspondence. The edited version of Eliot's works (note 45) includes correspondence with Bartram.

48. There is debate about who wrote *American Husbandry* (1775, 2 vols.), based on circumstantial, textual evidence, it has been suggested that American John Mitchell and/or Englishman Arthur Young were the authors; it is, in any case, one of the more extensive summaries we have of late colonial agriculture, although Donahue (see note 9) discounts it as the work of an "imposter" (p. 299) who never visited North America. Recently,

new means of textual analysis, based upon author-specific word use patterns, have helped unravel authorship of mysterious pieces. Liz DeCarlo, a student working with Dr. Patrick Juola at Duquesne University, took up our challenge of applying these techniques to unraveling the authorship of *American Husbandry*. Her results suggest that Arthur Young had a leading role in the creation of this book, although John Mitchell and possibly others may have contributed to it. We much appreciate Dr. Juola's welcoming of our query and Liz's hard work. Even if second hand, some of the book's information is useful.

49. *The Plough Boy* was published from 1819 to 1822. As with many newspapers of that period, aside from editorial and commentary, much of the text was derived from other publications. Davy's book, *Elements Of Agricultural Chemistry* (1813) preceded that of Liebig, *Organic Chemistry in its Application to Agriculture and Physiology* (1840). Cohen, in his discussion of these works, describes Davy as "vitalistic" and tied to the life-as-fertility tenor of his times; Liebig consciously diverged from that with his mechanistic descriptions of and prescriptions for soil fertility.

50. *The Memoirs of the Board of Agriculture of the State of New York* are not yet available on-line. However, Madison's address has been widely reprinted and can be found on-line starting on p. 63 of *The Letters and Other Writings of James Madison*, books.google.com/books?id=CDkMAAAAIAAJ. I would like to thank Bob Fraker of Savoy Books (www.vgernet.net/frakerbook/) for graciously allowing me to read and copy his exemplar of this work.

51. The cited biography is 'G. W. Featherstonhaugh, F.R.S., 1780-1866, Anglo-American scientist' (1955) by Armytage in *Notes and Records of the Royal Society of London*, Vol. 11, pp. 228-235. Wikipedia provides an on-line biography, en.wikipedia.org/wiki/George_William_Featherstonhaugh.

52. Various biographies of Eaton exist, two on-line sources are a summary from RPI (www.lib.rpi.edu/Archives/gallery/Eaton/biography/) and Ballard's 1897 biographical sketch (books.google.com/books?id=2e4WAAAAYAAJ). Although Amos Eaton was born in New Concord, the location of the exact birthplace is uncertain: in 1990 his parents' house was moved from a location near State Route 295 and the Taconic State Parkway to a different part of town. In any case, his mother is said to have walked to her parents' house in order to give birth to Amos, but the current building on that lot may be a later reconstruction after Eaton's actual birthplace burnt down (see thesocietyofnewconcord.org/h_houses.html). Eaton wrote such pioneering work as *Manual of the Botany of the Northern States* (first published in 1817) and *Geological Text-Book* (1830). His students included John Torrey, Ebenezer Emmons and several other prominent 19th century scientists.

53. Spafford's words come from the respective entries in his Gazetteer (see note 8). Spafford apparently lived in or near Columbia County for a while and so had a personal familiarity with its terrain.

54. Both the geological and the agricultural volumes were part of the multi-year, state-sponsored *Natural History of New York* project. After losing a lawsuit against Hall, Emmons moved on to North Carolina, where he played an important role in establishing that state's geological survey.

55. Emmons's *Agriculture of New York* encompasses the following volumes: 1 - Description of the geology and soils of the different agricultural regions (1843); 2 - Description of grain and vegetable production, including substantial analysis of their composition (1849); 3 - Descriptions of the various fruits produced in the State (1851); 4 (also labeled as "3") - Color plates of the fruits (1851); 5 - Description of the injurious insects (1854).

56. Because Emmons previously describes bone dust as 50% phosphate, his calculations translate into about 600 lbs or 4800 gals/cow/yr. For comparison purposes, cows at Hawthorne Valley Farm, which are mainly grass fed but receive grain supplements, produce 8,000-12,000 gals/cow/yr; the average New York dairy cow now produces over 20,000 gals. Those higher yields are largely based on grain feed, grown locally or shipped in from farther west. An unpublished budgeting and soil analysis study by Emily Reiss comparing pastures, hayfields and vegetable fields at Hawthorne Valley Farm, suggested that pastures were the field category with the lowest phosphorus levels.

57. Lewis and Kinsman's *Soil Survey of Columbia County, New York* (1929) is available on-line as one survey in a digitized compilation, books.google.com/books?id=yTUjAQAAIAAJ.

58. The cited textbook is Lyon and Buckmans' *The Nature and Properties of Soils* (1926), p.311.

59. I highly recommend Beeman and Pritchard's (2001) *Green and Permanent Land: Ecology and Agriculture in the Twentieth Century* for an overview of this period; their discussion influenced the structuring of this section. The link to the Reconnaissance Erosion Survey map is www.flickr.com/photos/uconnlibraries-magic/4400932649/. The related report, *Soil Erosion in New York* (1936) by Howe and Adams is Cornell Extension bulletin #347.

60. The *Soil Survey of Columbia County, New York* is available on-line from the USDA at soildatamart.nrcs.usda.gov/manuscripts/NY021/0/Columbia.pdf. At least until recently, these reports were also available free of charge from the USDA office in Ghent. In any case, the data in this report have been computerized and nifty, lot-specific soil reports are now available free on-line from the USDA at websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx . This is a useful tool well worth exploring. Soil survey maps are compiled from soil sampling combined with remote sensing. They should be generally accurate for broad, field-scale patterns, but more precise work may require additional, on-site soil investigation.

61. 'Fertilizer use for horticultural crops in the US during the 20th century' (2005) by Mikkelsen and Bruulsema provides a nice overview of fertilizer use history. It appeared in *Horttechnology*, vol 15, Jan-Mar 2005, pp. 24-30.

62. There are various books on soil life available. Three of the works which I have found most appealing are Bardgett's *The Biology of the Soil* (2005), Nardi's *Life in the Soil* (2007), and Lowenfels and Lewis' *Teaming with Microbes* (2010).

63. Information on the Cornell Soil Health test is available at their web site, soilhealth.cals.cornell.edu/. Their manual (available digitally on-line) is the *Cornell Soil Health Assessment Training Manual* (2009, 2nd edition) by Gugino and colleagues.

64. Four works that have helped our ground beetle research and have been important resources for this section are Lindroth's classic, 6-part *The Ground Beetles of Canada and Alaska* (1963-1969), Bousquet's *Illustrated Identification Guide to Adults and Larvae of Northeastern North American Ground Beetles (Coleoptera: Carabidae)* (2010), Larochelle and Lariviere's *A Natural History of the Ground-Beetles (Coleoptera: Carabidae) of America North of Mexico* (2003), and Ciegler's *Ground Beetles and Wrinkled Bark Beetles of South Carolina* (2000). Bob Davidson of the Carnegie Museum in Pittsburgh has provided much help during our exploration of the ground beetle realm.

65. At least two papers discuss *Loricera pilicornis*' hunting technique, Bauer's (1983) 'Predation by a carabid beetle specialized for catching Collembola' in *Pedobiologia*, vol. 24, pp. 169-179, and Hintzpeter and Bauer's (1986) 'The antennal setal trap of the ground beetle *Loricera pilicornis*: A specialization for feeding on Collembola,' in the *Journal of Zoology*, vol. 208, pp. 615-630.

66. The mechanism has been studied by various authors, a classic is Aneshansley and Eisner's (1969) 'Biochemistry at 1000C: Explosive secretory discharge of Bombardier Beetles (*Brachinus*)' in *Science*, vol. 165, pp. 61-63. An amazing video of Bombardiers in action is available at www.youtube.com/watch?v=Pib9qT-pccI.

67. The fascinating world of wing dimorphism in ground beetles has recently been explored in a paper by Bourassa and colleagues (2011), 'Wing-dimorphism and population expansion of *Pterostichus melanarius* (Illiger, 1798) at small and large scales in central Alberta, Canada (Coleoptera, Carabidae, Pterostichini)' in *ZooKeys* 147, pp. 545–558. Building on the earlier work of Lindroth, these authors explore how winged-ness varies as a rapidly expanding population of introduced ground beetle establishes itself.

68. The most detailed account of snail feeding in ground beetles that I have found is in Symondson's chapter, 'Coleoptera (Carabidae, Staphilinydae, Lampyridae, Drilidae and Silphidae) as predators of terrestrial Gastropods' on pp. 37-84 of *Natural Enemies of Terrestrial Mollusks* (2002), edited by Barker.

69. Olson in his 1940, 'Earthworms of New York State,' *American Museum Novitates* (#1090) lists 17 species for the State. *The Biology and Ecology of Earthworms and Earthworm Ecology*, by Clive Edwards and colleagues (available in various editions) is probably the key scientific reference on earthworm biology. A really nice summary and handy field guide (and the source of the natural expansion figure, plus much of the remaining text) is Cindy Hale's *Earthworms of the Great Lakes* (2007). The concerned farmer published his comments in the *Genesee Farmer* sometime around 1836 (I came across its republished version which appeared in *The Maine Farmer and Journal of the Useful Arts* Dec 16, 1836). Finally, Hendrix and Bohlen's article, 'Exotic earthworm invasions in North America: Ecological and policy implications' in *Bioscience* volume 52 (2002), pp. 801-811 is a good, if perhaps somewhat outdated, description of the situation and is available on-line, ic.ucsc.edu/~wxcheng/envs161/Hendrix_Bohlen_2002.pdf.

The United States, at least south of the level of glaciations, does have native earthworms, but it seems they have been relatively poorly studied and their interactions with native species are uncertain. There may even be some evidence of native species from north of the southernmost line of glaciations; however, that evidence is speculative and, in any case, in those northerly sections they are virtually absent as an ecological agent. It may also be that on farms or other disturbed grounds farther south, exotic earthworms also predominate, as they are better adapted to agricultural conditions than native species. However, these patterns are still being explored. I thank Edward Avizinis, Donald Schwert, and Sam James for email discussion during the formulation of this section.

70. The IUCN/Invasive Species Specialist Group paper entitled, 'Exotic earthworms impact information,' provides a nice summary of current research and is available on-line at www.issg.org/database/species/reference_files/earthworm_man.pdf. It provides the basis for much of what is written here.

71. The paper by Callaham and colleagues entitled, 'Policy and management responses to earthworm invasion in North America' (2006) in *Biological Invasions*, vol. 8, pp. 1317-1329 considers the routes of earthworm ar-

rival, and possible policy responses. This and many other interesting earthworm papers are available at Great Lakes Worm Watch's publication page, www.nrri.umn.edu/worms/research/publications.html; it is a web site worth exploring.

NOTES CHAPTER FIVE

1. Numerous resources exist about the Hudson River itself; fewer view the watershed as a whole. Perhaps the most up-to-date is the website of the Hudson River Estuary Program, a state program which looks at all the waters that drain through the River's estuary (www.dec.ny.gov/lands/4920.html). Much could be said and has been said about the Hudson River; while Columbia County encompasses part of the River itself, this chapter will focus more largely, but not exclusively, on our smaller waters.

2. The Greater Stockport Creek Watershed Alliance, www.stockportwatershed.org, is a valuable local resource; Fran Martino, oft seen with kayak and the driving force behind the Alliance and much other environmental work in the County, is a great source of information on things aquatic.

3. The original reference is the 1980 paper by Robin Vannote and colleagues entitled, 'The river continuum concept,' and published on pp. 130-137 of volume 37 of the *Canadian Journal of Fisheries and Aquatic Science*.

4. For more on the Hudson's tidal wetlands, see Chapter 20, 'Tidal wetlands of the Hudson River Estuary,' by Erik Kiviat and colleagues, published on pp. 279-295 of *The Hudson River Estuary*, (2005), edited by Levinton and Waldman. The NYS DEC has conducted a tidal wetland assessment. While relatively little information is available on-line (www.dec.ny.gov/lands/5107.html), a CD containing maps and photographs is available from that web site.

5. Wetland classification is something of a personalized art: different places and people categorize wetlands differently. A nice resource, at least on fens and bogs, is *Bogs of the Northeast* (1985) by Charles Johnson. *The Book of Swamp and Bog* (1995) by John Eastman does not address the classification of wetlands, but does provide a nice introduction to the resident plants. Hudsonia's *Biodiversity Assessment Manual* (2001), written by Erik Kiviat and Gretchen Stevens, gives detailed descriptions of these habitats in our region. Gretchen Stevens provided very helpful insights into fen plant ecology that were incorporated into this section. For more information on the manual, related workshops and Hudsonia's on-going work, see hudsonia.org/.

6. Wilbur Zelinsky considers place names for water bodies in his chapter, 'Some problems in the distribution of generic terms in the place-names of the northeastern United States,' pp. 366-409 in his book *Exploring the Beloved Country* (1994); this is a reprint of a 1955 paper.

7. The late "Doc" Fisher's *Rise and Fall of the Taconic Mountains* (2006) presents nice maps of the various slices and faults.

8. Although it is but one piece of the puzzle, acid rain has highlighted the role of bedrock in neutralizing acidic additions. For a discussion of the effects, geology, and chemistry of acidification in the Adirondacks, see Jerry Jenkins' *Acid Rain in the Adirondacks: An Environmental History* (2007). The National Atlas has a good article on karst geology (www.nationalatlas.gov/articles/geology/a_karst.html).

9. Various archeologists have documented the importance of freshwater resources to Native Americans in our area. Most of the documented fishing or clamming sites have been near the Hudson River itself, although this

might reflect the fact that the fish of the River were large (e.g., sturgeon) and their bones thus most likely to be preserved. Likewise, freshwater mussels were probably available in much larger numbers than from smaller water bodies. The fish, mussels and crustaceans of smaller creeks may have also been important, but their small size and dispersed use may have obscured evidence of this importance.

10. Information on indigenous use of the Hudson River comes from the following: Tom Lake, 'The ancestral lure of the Hudson Estuary: Predictable aquatic resources' on pp. 5-17 in Dunn's (2009) *Mohican Seminar 3*; Chilton's (1992) 'Archeological investigations at the Goat Island Rockshelter: New light from old legacies' in volume 9, pp. 47-75 of the *Hudson Valley Regional Review*; Brumbach and Bender, 'Woodland period settlement and subsistence change in the upper Hudson River Valley' on pp. 227-239 of *Northeast Subsistence-Settlement Change, AD 700-1300* (2002), edited by Hart and Reith.

11. Information on Mahican place names was derived from Ruttenber (1906) *Indian Geographical Names*; this Wikipedia page: en.wikipedia.org/wiki/List_of_place_names_in_New_England_of_aboriginal_origin; Trumbell's (1870) *Composition of Indian Geographical Names: Illustrated from the Algonkin Language*; and Lion Miles' on-line Mohican Dictionary, mohican-nsn.gov/Departments/Historic_Preservation/Mohican%20 Dictionary.pdf. A list of Mahican place names, largely without translation, is provided at debbie_winchell.tripod.com/mohican/geographic.html, it is derived primarily from appendix B of Sally Dunn's *The Mohicans and Their Land: 1609-1730* (1994).

12. See particularly the work of Dorothy Peteet and her student, Sanpisa Sritrairat. They have published on the sediments of various sites along the Hudson; and Dorothy has provided very helpful input relating to various ideas in this book; see, for example, 'Linking uplands to the Hudson River' by Peteet and her colleagues, including Sritrairat; the article is chapter 9, pp. 123-133 in *Environmental History of the Hudson River* (2011), edited by Henshaw.

13. The van der Donck excerpt is from his *A Description of New Netherlands* (2010) translated by Goedhuys, and edited by Gehring and Starna. See *Prehistoric Fishweirs in Eastern North America* (1992) by Allen Lutins, a MS thesis at Suny Binghamton; it is available on-line at www.lutins.org/thesis/. Various of the accounts reprinted by Jameson in *1609-1664 Narratives of New Netherlands* (1909) speak of fish and fishing, although exactly which indigenous group is being referred to is sometimes hard to determine. However, it is unlikely that fishing styles varied dramatically between groups and, while weirs and nets seem to be the most consistently mentioned, these group activities may have simply been more apparent. For a video of a stone fishing weir in use, see this 1967 video of the Netsilik Inuit in northern Canada, www.youtube.com/watch?v=fBokL2FgayU.

14. On fish poisons, see for example, www.primitiveways.com/fish_poison.html. Information seems to be scattered through the secondary literature, but I have not found a well-referenced, published compilation.

15. Norton's *The Fur Trade in Colonial New York 1686-1776* (1974) provides a good background to fur trade economics.

16. Nira Salant provided very helpful data from her work with Doug Bain and Mark Green estimating early beaver populations in the Northeast. Based on the data she provided, estimated precolonial beaver densities in the County are calculated according to the number of colonies observed per length of stream in prime, un-

trapped areas elsewhere; the number of miles of stream in Columbia County; and the mean number of beaver per colony. Estimates of surface area affected come from literature records of beaver pond size and duration, together with guesses at successional rate of post-beaver meadows. For discussion of the ecological implications of the fur trade see Robert Henshaw, 'Historical facts/biological questions'; chapter 1 *Environmental History of the Hudson River* (see note 12). The timing of the beaver's ecological disappearance (perhaps a few individuals remained, but with minimal ecological impact) from the mid-Hudson Valley is somewhat uncertain – Norton (see note 15) states that by the late 1600s, the Iroquois were unable to find beaver in much of their domain; given the power of that tribe, it is likely the Hudson Valley would have lured their interest if it held great stores of beaver. Leach, in the *Northern Colonial Frontier, 1607-1763* (1966), states that by 1640 most beaver along the Hudson River were probably gone, although the basis for his statement is unclear. There is nonetheless ample evidence that, by the second half of the 1600s, if not earlier, tension around access to beaver trapping grounds was high. Burke, 'The New Netherlands fur trade, 1657-1661: Response to crisis,' in *A Beautiful and Fruitful Place*, edited by Zeller (1991), pp. 283-291 (on-line at www.newnetherland-institute.org/files/6613/5067/3661/8.5.pdf) summarizes the apparent decline and provides evidence of beaver shortages. The only direct mention of Mahican beaver harvests is apparently a 1633 account of them having brought some 300 pelts to a trader (quoted in Starna, *From Homeland to New Land* [2012], www.nps.gov/mava/historyculture/upload/From-Homeland-to-New-Land-Final-Report.pdf); all that can be said is that this provides proof, were it needed, of Mahican involvement in the fur trade. Trelease, in *Indian Affairs in Colonial New York* (1960), quotes the records of about 46,000 pelts/yr in the mid 1650s.

17. Most dates are from Stotts' invaluable *Looking for Work: Industrial Ecology in Columbia County, New York* (2007), supplemented by Ellis' *History of Columbia County, New York* (1878). Ruth Piwonka, in her unpublished report on the Town of Kinderhook, comments on the sequence of mill uses, and the initial preponderance of saw mills. The 1643 account is *Novum Belgium* by Jesuit Father Isaac Jogues; it is reprinted in Jameson's *Narratives of New Netherlands*. Accounts of the importance and architecture of early mills can be found in Chapter 14 of Jared van Waganen, Jr's informative, *The Golden Age of Homespun* (1953); pp. 300-324 of John Stilgoe's *Common Landscape of America, 1580-1845*; Chapter 7 of Robinson's *Abandoned New England* (1976); and Lord and Costello's great, illustrated exploration of a set of Rensselaer County mills, *Mills on the Tsatsawassa* (1983).

18. The quote comes from p. 238 of *Report of Cases Argued and Determined in the Supreme Court of Judicature* (for New York; volume 10, 1814) by William Johnson. The early Massachusetts laws can be found, for example, on page 298 and thereabouts in *The Charter Granted by Their Majesties King William and Queen Mary to the Inhabitants of the Province of the Massacusetts Bay in New England* (1759) (archive.org/details/chartergrantedby00mass3). The 1800 New York law is cited on page 88 of *A Treatise on the Law of Watercourses* (1854) by Angell (archive.org/details/atreatiseonlaww00angegoog).

19. Two articles in Levinton and Waldman (see note 4) provide background on fish movements: Waldman's 'The diadromous fish fauna of the Hudson River: Life histories, conservation concerns, and research avenues' on pp. 171-188 and Schmidt and Lake's 'The role of tributaries in the biology of Hudson River fishes,' on pp. 205-216. Alderman and Rosman have published on-line reports assessing the potential for dam removal projects in the Hudson River watershed, these include *River Herring: Assessment of Fish Passage Opportunities in Lower Hudson River Tributaries* (2009-2012), available at www.hudsonriver.org/download/herring12/AldersonRosman.pdf and *Have the "Impediments" to Passage for Migratory Fish on the Lower Hudson River*

Tributaries Changed over a 15 year Period?, available at www.estuaries.org/pdf/2010conference/wednesday17/yatch/session3/alderson.pdf. In 1996, Schmidt and Cooper published an excellent report, *A Catalog of Barriers to Upstream Movement of Migratory Fish in Hudson River Tributaries*, on fish barriers in the lower Hudson, including along the Roeliff Jansen Kill and in the Stockport Creek watershed; it was produced for the Hudson River Foundation and is available on-line at www.harborestuary.org/reports/tributary/USFWS%20Report-NYBightEcosystemTeamFishPassage_1998.pdf.

20. Warden published a series of natural history observations from around Kinderhook; they were collected in 'Observations on the natural history of the Village of Kinderhook at its vicinity' in *The Medical Repository* (1803) volume 6, pp. 4-18, which is available on-line.

21. Dorothy Peteet, together with her colleagues and students, has been central in elucidating the history of the Hudson Valley. The Stockport Creek information comes from the unpublished second chapter in the dissertation of her student Sanpisa Sritrairat, *Multiproxy Analyses of Past Vegetation, Climate, and Sediment Dynamics in Hudson River Wetlands* (2013), on-line at academiccommons.columbia.edu/catalog/ac:155508. Dorothy's work cited here includes her 2007 paper with colleagues, entitled 'Hudson River paleoecology from marshes: Environmental change and its implications for fisheries,' pp. 112-128 of *Hudson River Fishes and Their Environment*, American Fisheries Society Symposium 51, edited by J.R. Waldman, K.E. Limburg, and D. Strayer; 'A history of vegetation, sediment and nutrient dynamics at Tivoli North Bay, Hudson Estuary, New York,' for which Ms. Sritrairat is the lead author, in *Estuarine, Coastal and Shelf Science* volume 102-103 (2012), pp. 24-35; and her article cited in note 12.

22. Our estimates of mill pond number and location in the County come primarily from three sources: the early atlases of Burr and of Beers who pinpointed at least some 19th century mills; the dam maps found in the two volumes by the New York Conservation Department's *A Biological Survey of the Lower Hudson Watershed* (1937) and *A Biological Survey of the Mowhawk-Hudson Watershed* (1934); and the statewide dams database available on-line through the New York State GIS clearinghouse.

23. See note 20 for Warden's account. Malaria, often called the ague or intermittent fever, was widespread in the United States through the early 20th century, although the northern strain, *Plasmodium vivax*, tended to be less lethal than the more southerly varieties. See Simon Litten's *Malaria on the Wallkill*, www.hres.org/joomla/index.php?option=com_content&view=article&id=76:malaria-on-the-wallkill&catid=54:opinion&Itemid=64; Barber's (1929) 'The history of malaria in the United States' in *Public Health Reports* (1896-1970), Vol. 44, No. 43, pp. 2575-2587; and Faust's (1951) 'The history of malaria in the United States' in volume 39 of *American Scientist* pp. 121-130. Thanks to Brian Altonen (brianaltonenmph.com/) for helping clarify terminology.

24. For a concise history of Catskill tanneries and their pollution, see Canham's 'Hemlock and hide: The tanbark industry in old New York' in the summer 2011 issue of *Northern Woodlands*. McMartin's *Hides, Hemlocks and Adirondack History* (1992) tackles tanning's consequences for the Adirondacks.

25. Schram's 2004 *Hudson's Merchants and Whalers: The Rise and Fall of a River Port, 1783-1850* provides some of the history; more recent dates are taken from the great on-line newspaper archives of fultonhistory.com: *Utica Herald Dispatch* Monday Evening June 24, 1907, p. 3 (?, number hard to read); *Chatham Courier* Thursday Sept. 29, 1966, p. 5; *Hudson Evening Register* Friday August 27th, 1943, p. 1. Chapter 15 in Muir's *Reflections on Bullough's Pond: Economy and Ecosystem in New England* (2000) provides the general context, including the account of increased sewage issues with the arrival of indoor plumbing.

26. See the Biological Survey publications listed in note 22.

27. These and other electrical installations are described in Stotts (see note 17).

28. The Mount Lebanon Shaker waterworks were the focus of a recent National Park Service Study. The documents, including a fun video, of that project can be found at: www.youtube.com/watch?v=VDx1rpS2adU. Their report, *Historic American Landscapes Survey, North Family, Mount Lebanon Shaker Village, HALS No. NY-07* can be found at lcweb2.loc.gov/pnp/habshaer/ny/ny2000/ny2059/data/ny2059data.pdf.

29. To get a feel for the general frenzy of ice-cutting season, explore the *Chatham Courier* past issues on fultonhistory.com. George Staats' life and ice cutting business is recounted in an article in the 9 January, 1964 *Chatham Courier*; and an editorial in the 26 March, 1959 edition describes the then-not-so-bygone-as-now days of ice cutting. Quite a bit has been written about the Hudson River ice industry; two works I found particularly helpful were Harris and Pickman's 'The rise and demise of the Hudson River ice harvesting industry,' chapter 14 on pp. 201- 218 in the book edited by Henshaw (see note 12); and Halls' (1888) 'Ice industry of the United States with a brief sketch of its history' in volume 22 of the *Tenth U.S. Census*.

30. The story of New York City's water supply has been the subject of several histories. One of the most useful to me was *Water for a City* (1974) by Charles Weidner, which contains a relatively detailed account of the circumstances of the various east-of-the-Hudson endeavours and from which the direct quote comes. Galusha's *Liquid Assets: A History of New York City's Water System* (1999) also provides a detailed overview. Period pieces include Rafter's *Hydrology of New York* (1905) and *Report of the Commission on Additional Water Supply for the City of New York* (1904). My thanks to an older man, whose name I have lost, who once visited one of our displays and alerted me to this bit of forgotten history.

31. See the works of Weidner and of Galusha (note 30), plus *21st Annual Report of the Board of Water Supply* (January 1927), and 'More Water for New York City' (1927) by Hall in volume 17 of the *Journal of the American Water Works Association*, pp. 243-246.

32. The farm is profiled in 'Robert J. Swan's farm' on pp. 176-179 of volume 18 of the *Transaction of the New York State Agricultural Society* (1858).

33. See note 20 for Warden. In Chapter 6 of *Changes in the Land* (1983), William Cronan summarizes early observations of the effects of deforestation on New England. The association of creek desiccation with cutting was widespread. More recently, the National Research Council has summarized scientific studies of deforestation effects in *Hydrologic Effects of a Changing Forest Landscape* (2008), www.nap.edu/catalog/12223.html.

34. Bioassessment is widely applied, and on-line resources abound. For our region, two particularly relevant resources are DEC's rather technical, *Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State* (2012; www.dec.ny.gov/docs/water_pdf/sbusop12.pdf) and Hudson Basin River Watch's *Guidance Document* (2004; www.hudsonbasin.org/HBRWGD04.pdf). A very useful (for the natural historian) resource is the *New York State Freshwater Macroinvertebrate Atlas* which includes distribution maps for Mayflies, Stoneflies and Caddisflies (www.dec.ny.gov/animals/84568.html). Cruising the internet will reveal numerous resources. One of my favorite print sources is Voshell's *A Guide to Common Freshwater Invertebrates of North America* (2002). Although I have not used it, the 2012 *Field Guide to Freshwater Invertebrates of North America*, edited by Thorpe and Rodgers also looks useful. For Columbia County, the web page of the Greater Stockport Creek Watershed Alliance provides helpful, relatively recent measures of water quality in much of the County (www.stockportwatershed.org/).

35. Driscoll and numerous colleagues studied nitrogen in the Northeast and tried to partition its sources; their paper 'Nitrogen pollution in the Northeastern United States: Sources, effects, and management options' was published on pp. 357-374 of *Bioscience*, volume 53 (2003). The contribution of New York City is taken from Howarth and colleagues' 'Wastewater and watershed influences on primary productivity and oxygen dynamics in the Lower Hudson River Estuary,' pp. 121-139 of Levinton and Waldman (see note 4).

36. The 2011 microbial results are available on-line at the Greater Stockport Creek Watershed Alliance's web site (see note 34).

37. See River Keeper's report *How Is the Water? 2012 Sewage Contamination in the Hudson River Estuary 2006 - 2011* at www.riverkeeper.org/wp-content/uploads/2012/12/RvK_How-Is-the-Water-2012.pdf and DEC's 2008, *Wastewater Infrastructure Needs of New York State*, www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf.

38. Atrazine's potential environmental and health risks are hotly debated. The Wikipedia site on atrazine has links to many of the more recent studies. The Pesticide Action Network (PAN) provides one perspective on atrazine, www.panna.org/current-campaigns/atrazine; a summary of the materials gathered by the EPA can be found on www.epa.gov/oppsrrd1/reregistration/atrazine/. A defense of atrazine use can be found on web sites such as agsense.org/crops/value-of-atrazine/ assembled by some grower groups and Syngenta's www.atrazinefacts.com/about-atrazine/benefits/

39. New York State has a pesticide sales and recording law, but, at the time of writing, by-county, on-line data were only available through 2005. National data have recently been released by the USGS for the period 1992-2009, the results are summarized in the report *Estimation of Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 1992–2009* (2013), which is available on-line. Accompanying the report are yearly summaries at water.usgs.gov/nawqa/pnsp/usage/maps/. The stream study of atrazine and glyphosates is the 2005 paper by Battaglin and colleagues, 'Glyphosate, other herbicides, and transformation products in Midwestern streams, 2002.' It was published in *Journal of the American Water Resources Association* (JAWRA) volume 41, pp. 323-332. The vernal pool study was by the same lead author, entitled 'The occurrence of glyphosate, atrazine, and other pesticides in vernal pools and adjacent streams in Washington, DC, Maryland, Iowa, and Wyoming, 2005–2006' in *Environmental Monitoring Assessment* (2009) volume 155, pp. 281–307. The cited DEC report is the *Draft Long Island Pesticide Pollution Prevention Strategy* (2013, www.dec.ny.gov/docs/materials_minerals_pdf/draftstrategy.pdf). A summary of Midwest drinking water and ground water data can be found in the Natural Resource Defense Council's *Still Poisoning the Well* by Wu and colleagues (2010, www.nrdc.org/health/atrazine/files/atrazine10.pdf). Syngenta, atrazine's parent company with diverse agronomic products, had $14.2 billion in sales in 2012, but does not reveal what proportion of that is linked to atrazine. Information on the 2012 settlement can be found by searching for Syngenta and the names of the plaintiffs, Holiday Shores and the City of Greenville; Syngenta acknowledged no guilt in the case and stated that the settlement was made in order to end business uncertainty. Account of the 2012 settlement can be found at various sites on–line, including Sygenta's own 2012 financial statements.

40. For a summary of nearly two-decade old data on waterborne insecticides and herbicides (and other chemicals) in the Hudson Valley, see *Water Quality in the Hudson River Basin New York and Adjacent States, 1992–95* (1998) produced by USGS scientist Gary Wall and colleagues, ny.water.usgs.gov/projects/hdsn/report/Circular1165.pdf; see also 'Pesticides in the Hudson River Basin, 1994-96' (1998) by Wall and Phillips in *Northeastern Geology and Environmental Sciences*, volume 20, pp. 299-307 and *Pesticides in Surface Waters*

of the Hudson River Basin, New York and Adjacent States (1996) by Wall and Phillips, U. S. Geological Survey Fact Sheet 238-96. ny.water.usgs.gov/projects/hdsn/fctsht/FS238-96.pdf. Tissue concentrations are from Bode and colleagues (2001) *Biological Assessment of Tributaries of the Lower Hudson River*. Gypsy Moth spraying information was abstracted from the annual reports of the NYS Department of Conservation.

41. Ample information is available on-line concerning Hudson River PCBs, one of the most comprehensive is provided by Clearwater at www.clearwater.org/pcbs/index.html. Additional information was gathered from the article by Baker and colleagues, ‘PCBs in the upper and tidal freshwater Hudson River Estuary: The science behind the dredging controversy’ (2006), pp. 349-367 of Levinton and Waldman (see note 4) and in Bopp and colleagues’ ‘Contaminant chronologies from Hudson River sediments,’ on pp. 383-397 of the same book. Information on the Dewey Loffel site can be found on the Town of Nassau web page, townofnassau.org/content/Generic/View/17; and the New Lebanon site is profiled in the DEC site description, www.dec.ny.gov/docs/remediation_hudson_pdf/411014roda.pdf.

42. The results are detailed in our 2006 pond study, *Ponds of Columbia County: Patterns in their Biodiversity, Thoughts on their Management*, available at hvfarmscape.org. Additional information comes from Bopp (cited in note 41) and from Benoit and colleagues’ ‘Sources and history of heavy metal contamination and sediment deposition in Tivoli South Bay, Hudson River, New York’ on pp. 167-178 of volume 22 of *Estuaries*; and Sritrairat and colleagues’ paper cited in note 21.

43. Data sources are *Songbirds as Indicators of Environmental Mercury Loads in New York* (2007), a poster by Melissa Duron and colleagues at 2007 NYSERDA conference, www.nyserda.ny.gov/Energy-and-the-Environment/Environmental-Research/EMEP/Conferences/2007-EMEP-Conference/-/media/Files/Events/Events%20and%20Conferences/EMEP%202007/posters/2007_EMEP_E05_Duron_Melissa_poster.ashx; the DEC report, *Strategic Monitoring of Mercury in New York State Fish* (2008) at www.dec.ny.gov/docs/wildlife_pdf/hgfish.pdf; Driscoll’s 2012 report to the Northeastern States Research Cooperative, *The Production and Transfer of Methylmercury within Terrestrial Foodwebs across the Northeastern Landscape* (2012) at nsrcforest.org/sites/default/files/uploads/driscoll08full.pdf; Osborne and colleagues’ report to the Nature Conservancy (2011) *Mercury Contamination within Terrestrial Ecosystems in New England and Mid-Atlantic States: Profiles of Soil, Invertebrates, Songbirds, and Bats*. (Report BRI 2011-09) at www.briloon.org/uploads/centers/hgcenter/hiddenrisk/BRI_2011-09_Osborne.etal.2011.pdf; Evers’ and colleagues’ (2012) *Hidden Risk: Mercury in Terrestrial Ecosystems of the Northeast*. BRI Report 2012-07 at www.briloon.org/uploads/centers/hgcenter/hiddenrisk/HiddenRisk_lr.pdf; and Scudder and colleagues’ (2009) *Mercury in Fish, Bed Sediment, and Water from Streams across the United States, 1998–2005*: U.S. Geological Survey Scientific Investigations Report 2009–5109, at pubs.usgs.gov/sir/2009/5109/.

44. Various web sites explore hormone mimics and endocrine disrupters; two that seem especially comprehensive are www.wisconsinwatch.org/projects/hormones/ and www.nrdc.org/health/effects/bendrep.asp. A recent review of these chemicals is *State of the Science of Endocrine Disrupting Chemicals – 2012* published by United Nations Environment Programme (UNEP) and the World Helath Organization.

45. The New York wastewater treatment plant data come from Ernst and colleagues’ presentation entitled *Hormones, Pharmaceuticals, and Estrogenicity of Waste-water Treatment Plants* at the 2011 Northeast Water Science Forum, at www.neiwpcc.org/ppcpconference/ppcp-docs/2011presentations/Session%206/nywsf.v3.pdf; national stream data are from Kolpin and colleagues, *Pharmaceuticals, Hormones, and Other Organic Waste-*

water Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance (2002, digitalcommons.unl.edu/usgsstaff pub/68); an accessible summary of that report is *Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams*, by Buxton and Kolpin at toxics.usgs.gov/pubs/FS-027-02/. The Minnesota data are from *Pharmaceuticals and Endocrine Active Chemicals in Minnesota Lakes* (2013) by the Minnesota Pollution Control Agency, at www.pca.state.mn.us/index.php/view-document.html?gid=1942. The New York City reservoir data are from *Occurrence of Pharmaceutical and Personal Care Products (PPCPs) in Source Water of the New York City Water Supply* (2010), NYCDEP (www.nyc.gov/html/dep/pdf/quality/nyc_dep_2009_ppcp_report.pdf).

46. A nice summary of the issue is provided by Frazier's 2005 'Paving paradise: the peril of impervious surfaces' in volume 113 of *Environmental Health Perspectives*, pp. A456–A462.

47. See our pond report (note 42) and the interesting work of Win Fairchild, available at pondsofchestercountypa.net/. Other useful regional resources on ponds are Thorson's (2009) *Beyond Walden: The Hidden History of America's Kettle Lakes and Ponds*. The 2005 *The Biology of Lakes and Ponds* by Brönmark and Hansson looks helpful, although we have not used it.

48. We have two books we regularly use for understanding vernal pools: Colburn's 2004 review of scientific research, *Vernal Pools: Natural History and Conservation* and Kenny and Burnes' handy, dandy *A Field Guide to the Animals of Vernal Pools*, well worth its $12 price tag, available from www.vernalpool.org/fldgide.htm.

49. One of our old favorites, since updated, on the habitats and activities of flowing water is *Stream Ecology: Structure and Function of Running Waters* (2007) by Allan and Castillo.

50. We have four books that we use for most of our odonate work: *A Field Guide to the Dragonflies and Damselflies of Massachusetts* (2007) by Nikula and colleagues; *Dragonflies and Damselflies of the East* (2011) by Paulson; *Field Guide to the Dragonflies and Damselflies of Algonquin Provincial Park and the Surrounding Area* (2013) by Jones and others; and *Damselflies of the Northeast* (2003), written and beautifully illustrated by Ed Lam. *The Dragonflies and Damselflies of Ohio* (2002), edited by Glotzhober and McShaffrey has good natural history information and even a guide to exuvia. Aside from that, I know of no published guide to dragonfly exuvia, but there are a couple of web pages to get you started: insects.ummz.lsa.umich.edu/MICHODO/test/HOME.HTM and www.wildlife.state.nh.us/Wildlife/Nongame/dragonflies/NHDS_PDFs/NHDS_Exuviae_Guide.pdf. Finally, THE resource for dragonfly distributions in New York is the New York State Dragonfly and Damselfly Survey, www.dec.ny.gov/animals/31061.html. The detailed report, downloadable from that page, contains range maps for all species. ID and natural history information is, however, not present for most species. Much of the information presented in this section of the book comes from these publications; additional references are listed in the notes below.

51. Michael May's 2013 review of migratory dragonflies, 'A critical overview of progress in studies of migration of dragonflies (Odonata: Anisoptera), with emphasis on North America' in the *Journal of Insect Conservation* volume 17, pp.1-15, is a good starting point. Xerces, the insect conservation society, has a fun project to involve citizen scientists in collecting information on migratory dragonflies, www.xerces.org/dragonfly-migration/. Celeste A. Mazzacano of Xerces kindly provided additional background information.

52. Brackish water dragonflies are discussed in Catling's (2009) 'Dragonflies (Odonata) emerging from brackish pools in saltmarshes of Gaspé, Quebec' in *Canadian Field-Naturalist*, volume 123, pp. 176–177.

53. Some of the information on nymphal ecology comes from 'Habitat distribution, dietary composition and life history characteristics of odonate nymphs in a blackwater coastal plain stream' (2002) by Burcher and Smock in *American Midland Naturalist*, volume 148, pp. 75-89.

54. Food web discussion information is in part from 'Organic matter flow in stream food webs with reduced detrital resource base' (2000) by Hall and colleagues in the journal *Ecology* volume 81, pp. 3445-3463.

55. First and foremost, retired NYS ichthyologist Bob Daniels has been crucial to our fish studies throughout – answering questions, joining us in the field, and generally providing support on all things fishy during the research and writing of this book. Bob Schmidt of Hudsonia and Simon's Rock is another great local fish resource. We have two fish books that we consult with regularity: *The Inland Fish of New York* by C. Lavett Smith (1985) and *Freshwater Fishes of the Northeastern United States: A Field Guide* (2004) by Werner. We also use Becker's *Fishes of Wisconsin* (1983) because of its rich natural history information. The accounts in this section are primarily derived from these works.

56. Biogeography information comes in part from Weigner and von Hippel's 2010 paper, 'Biogeography and ecological succession in freshwater fish assemblages of the Bering Glacier Region, Alaska,' pp. 167-180 of the *Geological Society of America Special Paper #462*. According to the 1934 *Biological Survey of Mowhawk Hudson Watershed*, between 1924 and 1933, over 35,000,000 fish were reportedly stocked in the lakes and streams within the Kinderhook watershed alone (not all of which is in Columbia County); this included nearly 350,000 Brown Trout and more than 750,000 Brook Trout.

NOTES CHAPTER SIX

1. Detailed information on the Harvard Forest's Wildlands & Woodlands project is available on-line at harvardforest.fas.harvard.edu/other-tags/wildlands-woodlands. They are currently working on a similar initiative incorporating farmland. Brian Donahue's *The Great Meadow* provides a detailed account of how one early New England town managed its agricultural resource use.

2. The ideas presented here largely summarize information presented in more detail at various points in this book; I'll not re-cite most of the previously-cited works. However, I would be remiss not to mention, yet again, the two classic histories of the County, Ellis's 1878 *A History of Columbia County, New York* and Stott's 2008 *Looking for Work: Industrial Archeology in Columbia County, New York*. They provide the groundwork.

3. Spafford's quote comes from his *A Gazetteer of the State of New-York* (1813).

This index tracks references to people, places and creatures.

Themes, ethnic groups and habitat types were not indexed.

Page number in *italics* indicates an illustration. Page number followed by m indicates a map.

Page number followed by t indicates a table, chart or graph.

A

Adams, John, 78
Adder's Tongue, 108
Adirondack Mountains, 58, 88, 92, 94, 96, 251, 272
Agawamuck Creek, 246, 253, 254m
Alaska, 149, 292
Albany, New York, 13, 30, 67, 96, 129, 131, 137, 141, 167, 175, 200, 205, 244, 245, 271, 276, 301, 304
Albany County, New York, 170, 202
Albany Pine Bush, 166
Alder, 233
Alewives, 247
Alfalfa, 121, 190
Algae, 249, 288
Allegheny Mountains, 58
Alsike Clover, 137, *137*
American Beech, 36, 37, 41, 68
American Bison, 83, 101
American Chestnut, 36, 41, 42, 49, 50, 52, 76, 243
American Eel, 232, 247
American Hackberry, 37
American Lady butterfly, 143
American Larch, 70. *See also Tamarack*
American Pennyroyal, 119
American Shad, 241, 246
American Turkey, 125
Anadromous fish, 243, 246–247
Ancram, New York, 30, 105, 218, 228, 234, 245, 252, 259, 307
Anderson, Alexander, 173
Ant, 160
Antarctica, 143
Appalachian Brown butterfly, 109
Apple, 28, 130, 204, 268, 304
Apple-Cedar Rust, *71*, 74
Aquatic worms, 260
Argentina, 100
Arrowhead Violet, 118
Asaphidion curtum, 218, *219*
Ash, 54, 55, 231
Asia, 218
Asian Longhorn Beetle, 55
Atlantic Sturgeon, 246–247
Audubon, John James, 88
Aupaumut, Hendrick, 163–164
Austerlitz, New York, 90, 96, 115, 302

B

Bachman, John, 88
Badger, 91
Bailey, Liberty Hyde, 51
Balsam Fir, 75
Baltimore Checkerspot butterfly, 109, 135
Bank Swallow, 280
Barley, 122, 188
Bartlett, W. H., 118
Bartram, John, 138, 195, 197
Bartramian Sandpiper, 111
Bass, 181, 231, 241, 243, 246, 247, 289, 290
Bat, 148, 273
Beans, 162, 164, 169, 189
Bear, 97, 125, 164
Beaver, 95t, 96, 102–104, *103*, 108, 244, 249, 268, 283, 303
Beck, T. Romeyn, 202–205
Becraft Mountains, 160, 304
Bee, 54, 148, 160

Beebe Hill State Forest, 70, *96*
Beech Bark Disease, 53
Beech tree, 36, 37, 41, 49, 50, 68
Beetle, 52–55, 61, 160, 216–224, *218–222*, 294
Bennett, Hugh, 209
Bering Straits, 292
Berkshire County, Massachusetts, 30, 54, 94, 106, 135, 137, 138, 146, 153, 203, 302
Berkshires, 272
Big Bluet, 287, 287
Big-eyed Beach Beetle (*Asaphidion curtum*) 218–219, *219*
Big-shouldered Diggers (*Dyschirius pilosus*) 221–222, *222*
Bingham Mills, New York, 247, 253
Birch, 34, 50
Bison, 83, 101
Bittern, 111
Bitternut Hickory, *78*, 79–80
Bittersweet, 54
Black bean, 177
Black Bear, 97, 125
Blackbird, 125
Blackburnian Warbler, 302
Black Dash butterfly, 109
Blackfly, 260
Black Locust, 34, 51, 74
Blacknose Dace, 230
Black Oak, 75–77
Black Spruce, 235, 236, *236*
Black Swallowtail, 123
Black-tailed Deer, 83. See also Mule Deer
Black-throated Blue Warbler, 302
Black-throated Green Warbler, 302
Black Walnut, 243
Bladder Campion, 139
Bledius, 221
Block, Adrian, 19
Blueberry, 235
Blue-eyed Grass, 108
Bluegill, 290
Blue grass, 187
Blue Heron, 273, *273*, 303
Blue-spotted Salamander, 282, *282*
Blue Stores, New York, 23
Bluet, 287, *287*
Blue Toadflax, 111
Blue Vervain, 109
Bobcat, 61, 92, 94, 98, 125
Bobolink, 109–111, *110*, 114, 130
Bobwhite, 111
Bog Turtle, 108, 307
Bombardier beetle (*Brachinus janthinipennis*) 219–220, *220*
Boston, Massachusetts, 138, 141, 151
Box Elder, 80
Box Turtle, 304
Brachinus, 219–220
Brachinus janthinipennis, *220*
Brassica, 123
Bristly Rover (*Loricera pilicornis*), 218–219, *219*
Bronze Copper butterfly, 109, *153*, 153–154
Brooklyn, New York, 55
Brook Snaketail, 284, 284, 285, *285*
Brook Trout, 230, 292, 302
Broom Sedge, 118
Buckwheat, 28, 122
Buffalo, 101
Bullfrog, 249, 279, 281, 282
Bullhead, 290
Buprestidae, 54
Bur-cucumber, 123
Burne, Matthew, 281
Bur Oak, 77
Bushland, 163
Butter and Eggs, 138, *138*
Buttercup, 163
Butterfly, 53, *53*, 54, 70, 79, 105, 109, 110, 114–115, 123, 132, 135, 141, 143–154, *144*, *145*, *147*, *151–153*, 283
Butternut squash, 163
Buttonbush, 233

C

Cabbage, 122, 123, 152, 153
Cabbage White, 123, 151–153, *152*
Caddisfly, 229, 230, 260, *260*, 292, 293
Canaan, New York, 17, 41, 79, 89, 115, 122, 137,

203, 253, 302
Canada, 100, 149, 286, 288
Canada Anemone, 108
Canada Goldenrod, 142
Canada Lily, 91, 108, *141*, 141–142
Canada Lynx, 92, 94, 98
Canada Warbler, 302
Canadian Maritimes, 217
Canis lycaon, 95
Can-of-Worms Lichen (*Conotrema urceolatum*) 81–82
Capital District, 301
Carabidae, 216
Cardinal, 62
Caribou, 160
Carpinus, 67
Carrot, 123
Catadromous fish, 247
Catamount, 92
Catbird, 117
Caterpillar, 223
Catskill Mountains, 13–14, *14*, 30, 58, 88, 92, 228, 251, 272–274
Cattle, 26t, 28, 101, 119, 124, 132, 136, 169, 177, 180, 185, 188–189, 205, 302
Cecropia Moth, 78
Cedar, 69, 73–75, 119, 304
Celandine, 136
Central Park, New York City, 250
Chandler, Samuel, 71
Chatham, New York, 29, 30, 48, *48*, 49, 115, 163, 206, 257, 280, 300, 302
Chester County, Pennsylvania, 138
Chestnut, 36, 41, 42, 49–52, 76, 243
Chestnut Blight, 52
Chestnut Oak, 73, 75, 76, 82, 102, *102*
Cheviot, New York, 89
Chicory, 136, *136*
Chironomid, 293
Chittenden Falls, New York, 30
Chlaenius, 223, 223–224
Cholera, 250, 265
Clammy Cuphea, 119
Claverack, New York, 83, 106, 124, 136, 163, 180, 203, 300
Claverack Creek, 163, 228, 231, 247, 256, 267–268, 301, 303
Claverack Landing, New York, 303
Claverack Rock Shelter, 241
Clermont, New York, 106–107, 122, 171, 302, 304, 305
Clermont Historical Site, 287
Clouded Sulfur butterfly, 151
Clover, 110, 134–137, *137*, 140, 187, 189, 192
Cobweb Skipper, 105
Cogbill, Charlie, 41
Coke, Thomas, 172
Coles, Christopher, 17
Colliurus pensylvanica, 220–221, 221
Columbiaville, New York, 30
Comma butterfly, 143
Common Green Darner, *285*, 285–287
Common Juniper, 74
Common Lousewort, 111
Common Monkeyflower, 108
Common Plantain, 134–136, *135*
Common Ragweed, 123
Common Reed, 164
Common Ringlet, *149*, 149–150
Common St. Johnswort, 136, 138
Common Shiner, 291, *291*
Common Vervain, 108
Common Winter Cress, 153
Concord, Massachusetts, 186, 248
Coneflower, 108
Conifers (generally), 68–74
See also specific conifers.
Connecticut, 49, 138, 140
Connecticut River, 18, 151, 287
Connecticut River Valley, 112
Conotrema urceolatum, 81–82
Cooper, H. P., 142
Cooper, James Fenimore, 81
Copake, New York, 49, 307, 308
Copake Lake, 236
Copper grass, 187
Corn, 28, 51, 100, 123, 162–164, 169, 187–189, 191, 222, 257, 268, 305

Cosmopolite (Cosmopolitan) butterfly, 143–145
Cotton, 25
Cottonwood, 44
Cougar, 83, 92–94
Coventry, Alexander, 22–23, 46, 49, 71, 106, 113, 124, 136, 160, 169, 171–175, 177, 179, 181, 183–186, 188–192, 247
Coventry, Betsy, 184–185
Cow Vetch, 139
Coyote, 95, 125
Craine, Joe, 101
Cranberry, 235
Crow, 125
Ctenuchids, 145
Cuff, 184
Curly Dock, 136
Currants (*Ribes*), 53
Cyclops, 285
Cynthia of the Thistle butterfly, 143–145

D

Dace, 290
Damselfly, 231, 283–290
Dandelion, 53, 138
Daniels, Bob, 293
Dark-eyed Junco, 302
Darlington, William, 123, 138
Darter, 290
Darwin, Charles, 62
Davidson, Bob, 218
Davy, Sir Humphrey, 195, 198–199, 204
Day Lily, 141
Deane, Samuel, 46
Deciduous trees (generally), 75–82
See also specific trees
Deer, 42, 55, 82, 83, 88–91, 93, 95, 97, 111, 125, 141, 142, 160, 163, 164, 181
Deer Mice, 54
DeKay, James Ellsworth, 88
Delaware River, 256–257
Detroit, Michigan, 54
Devil's Beggartick, 123
Devoe, Alan, 90, 94, 239
Dewan, Amielle, 57, 127
Dewberry, 118
Dewey, Chester, 135, 138
Dicksissels, 109
Dogwood, 37, 119, 120, 304
Donahue, Brian, 186
Dorson's Rock, Old Chatham, 239
Downing, Alexander, 126
Downy Trailing Lespedeza, 119
Dragonfly, 229, 272, 278, 283–290, *285*, *288*, 292, 297
Drowned Land Swamp, 234
Duanesburg, New York, 200
Dutch Elm Disease, 52–53
Dutchess County, New York, 13, 18, 27, 30, 54, 58, 94, 138, 191, 232, 256, 300, 306, 308
Dutch Flatlands, 300–303, 303m, 305
Dwight, Timothy, 71
Dyschirius, 221–222

E

Early Goldenrod, 142
Earthworm (*Lombricus*), 55, 224–226, *225*
Eastern Blacknose Dace, 292
Eastern Cottontail, 97
Eastern Cottonwood, 44
Eastern Cougar, 83, 92–94
Eastern Coyote, 95, 125
Eastern Hemlock, 36, 37, 41, 44, 50, 54, 68, 73, 76, 82
Eastern Kingbird, 117
Eastern Meadowlark, 109, *110*, 114, 130
Eastern Ribbon Snake, 108–109
Eastern Sycamore, 44
Eastern Timber Wolf (*Canis lycaon*), 83, 95
Eaton, Amos, 111, 117, 139, 199–200, 202–205, 207, 214
Ebony Jewelwing, 230, *287*, 287–288
Eel, 232, 247
Elder, 164
Elderberry, 163
Eliot, Jared, 195–198, 201, 205, 206
Elk, 83, 101, 160, 190
Ellis, Franklin, 113, 118, 253, 270
Elm, 44, 55

Elm Bark Beetle, 52–53
Elmore, Andrew, 101
Emerald Ash Borer, 54
Emerson, George, 72, 76, 79
Emmons, Ebenezer, 88, 113, 193, 203–208, 214, 215
England, 110, 125, 172, 178, 184, 189, 198
Erie Canal, 26, 194
Esopus Creek, 241
Essex County, New York, 83
European Hare, 97
European Starling, 62
Evening Primrose, 110–111

F

Fairy Shrimp, 282–283, *283*
Featherstonhaugh, G. W., 197, 199–206, 214
Field Sparrow, 117
Fingernail clam, 282
Fir, 34, 75
Fish, 164, 181, 241, 280, 290–294
Fisher, 58, 91, 92, *92*, 97, 98
Fitch, Asa, 152
Flathead Mayfly, 231
Fleabane, 110
Florida Panther, 94
Flowering Dogwood, 37, 304
Fly, 77, 288, 292
Flycatcher, 111
Fort Edward, New York, 269, 271
Fox, 95, 97, 181
Fox-tail, 187
Franklin, Benjamin, 195
Franklin, Devin, 97
Fringed Gentian, 235, *235*
Frog, 148, 249, 281, 282, *282*, 304
Fungi, 156
Fur-backed Wanderers (*Chlaenius tricolor*) *223*, 223–224
Fuzzy Tillage Beetle (*Harpalus rufipes*) 217–218, *218*

G

Gallatin, New York, 58, 306
Garlic Mustard, 53, 54, 153
Garter snake, 278
Germantown, New York, 72, 89, 106–107, 304–306
Ghent, New York, 46, 115, 120, 300
Gibson, W. Hamilton, 140
Gill-Over-the-Ground, 138
Glacial Lake Albany, 15, 16, 16m, 69, 156, 158, 159, 303
Glassberg, Jeffery, 130
Golden Club, 232
Golden Ragwort, 108
Goldenrod, 118, 142–143, *143*
Goldkrest, 163, 241
Gooseberry, 53, 70
Grape, 163, 304
Grasses, 102, *105*, 106, 108, 110, 112, *112*, 118, 148, 187, 190
Grasshopper Sparrows, 109
Grass-leaved Goldenrod, 142, 143, 143
Grass of Parnassus, 235, *235*
Gray, Asa, 136
Greason, Mike, 91
Great Blue Heron, 273, 273
Great Plains, 100
Great Spangled Fritillary, 147
Green algae, 278
Green Ash, 231
Greendale, New York, 90
Greene County, New York, 13, 50, 54, 232, 300
Green Frog, 249, 281, 282
Green-headed Coneflower, 108
Green Heron, 278
Green Mountains, 36, 58
Greenport, New York, 301, 303
Green River, 228, 238
Green River Valley, 90
Grey Comma butterfly, 53, 53, 70
Grey Dogwood, 119
Grey Fox, 95, 97
Grey Goldenrod, 118, 142, 143, *143*
Grey Petaltail dragonfly, 229
Grey Squirrel, 98
Grey Wolf, 95
Ground beetle, 61, 216–224
Grouse, 111
Gypsy Moth, 78, 148, 268, 271

H
Hackberry, 37, 304, 305
Hair Grass, 102
Hairy Woodpecker, 111
Hall, Brian, 106
Hall, James, 203
Hancock, Massachusetts, 96
Hare, 97, 98
Harlem Valley, 51, 74, 122, 160, 294, 306, 307
Harlemville, New York, 90, 269
Harpalus rufipes, 217–218, *218*
Harrison, Arthur, 140
Harvard Forest, 106
Hawk, 111
Hawkweed, 139
Hawthorn, 119
Hawthorne Valley Farm, 113, 120, 293
Hay, 27–28, 106–115, 131, 180, 189, 191, 257, 305, 306
Heal-All, 136
Heart-leafed Plantain, 232
Hellebore, 164
Hemlock, 36, 37, 41, 44, 50, 54–55, 68, 73, 76, 82
Hemlock Wooly Adelgid, 54–55
Heron, 273, *273*, 278, 280, 303
Hickory, 36, 37, 41, 51, 67, 75, *78*, 78–80, 98, 163,
174, 301, 304
High-bush Blueberry, 235
High Falls, 246, 253
Hill Country, 77, 302–303
Hillsdale, New York, *27*, 30, 52, 65–66, 90, 92, 94, 302
Hobblebush, 37, 68, 302
Homespun, Henry Jr., 198–199
Honeysuckle, 54
Hoosic Mountains, 88, 92
Hornaday, William T., 88
Hornbeam (*Ostraya, Carpinus*), 67
Horned Lark, 123
Horse, 131, 132, 177, 180, 191
Housatonic River, 18, 228
House Sparrow, 62
Hoysradt, Lyman, 138
Hudson, Henry, 18, 244
Hudson, New York, 30, 43, 46, 67, 184, 252, 266, 297, 301, 303, 304
Hudson River, 19, 24, 25, 36, 39–40, 45, 46, 54, 75, 100, 104, 107, 110, 113, 122, 134, 136, 158, 160, 163, 165, 175, 210, 218, 219, 228, 232, 238–239, 241, 246–247, 249, 251, 252, 255, 263, 264, 266, 269, 287, 291, 294, 300–304
Hudson Valley, 13, 16–18, 24, 51, 96, 106, 108, 138, 141, 149, 158, 161, 162, 167, 173, 175, 178, 182, 189, 198, 208, 238, 243, 244, 253, 257, 267, 271, 274, 275
Hummingbird, 141, 285
Huxley, Thomas Henry, 62

I
Indian Corn, 124, 164, 188
Indian Skipper, 105

J
Jack-in-the-Pulpit, 243
Jack Rabbit, 97
Jamaica Bay, 249
Japanese Barberry, 54
Japanese Knotweed, 54, 139
Japanese Longhorn Beetle, 54
Jay, 111
Jefferson, Thomas, 126
Jefferson Salamander, 282, *282*
Jeliffe, Helena, 140
Jewelweed, 230
Joe Pye Weed, 108
Junco, 302
Juniper, 69, 73

K
Kale, 152
Kalm, Peter, 123, 136–137
Kenney, Leo, 281
Kent, Edwin, 110
Kentucky Bluegrass, 148
Kern, Nancy, 92
Killdeer, 111, 117, 122

Kinderhook, New York, 16, 21, 22, 39, 49, 71, 72, 102, 122, 123, *123*, 131, 218, 245, 300
Kinderhook Creek, 15, 107, 160, 163, 218, 228, 229m, 231, 238, 247, 248, 252, 256, 258–259, 267, 271, 279m, 280, 284, 290, 301
Kinderhook Lake, 236, 248–250, 269
Kinderhook Pine Plains, 159
Kinderhook Village, New York, 210
Kinsman, D. F., 207–208
Kline Kill, 256
Knickerbocker Lake, 236
Knotweed, 154, 162

L

Lagomorphs, 97
Lake Champlain, 15, 246
Lake Erie, 246
Lake Huron, 14
Lake Ontario, 246
Lake Taghkanic State Park, 307
Lambsquarter, 162, 163
Larch, 70, 235
Large Mouth Bass, 289, 290
Lark, 123
Latin America, 243
Lebanon Valley, 122
Leech, 260
Legumes, 192
Lemon Balm, 139
Lentil, 177
Leopard Frog, 304
Lespedeza, 119
Lesser fritillary, 150
Lewis, H. G., 207–208
Lichen, 16, 81–82
Liebig, Justin, 195, 201, 204, 206
Lily, 91, 108, *141*, 141–142
Lindenwald, New York, 279
Little Bluestem, 102, 105, *105*, 118, *120*, 142, 148
Little Sundrop, 119
Livingston, New York, 30, 41, 245, 304, 305
Livingston, Peter R., 23
Livingston, Robert, 22, 26, 171–172, 175–177, 186, 188, 189, 190, 192, 198, 304, 305
Livingston Manor, 22–24, 46, 179, 182, 300, 304, 306–307
Locust, 34, 51, 74
Lombricus, 225
London, England, 250
Long Island, New York, 192, 198, 249, 267
Long-jawed Snail Eater (*Sphaeroderus stenostomus*), 222–223, *223*
Long-necked Field Beetle (*Colliurus pensylvanica*) 220–221, *221*
Longnose Sucker, *293*, 293–294
Long-tailed Weasel, 91, 125
Loricera pilicornis, 218–219, *219*
Lowdermilk, William, 209
Lower Manor (Rensselaer, New York), 302, 303
Lucerne, 190
Luna Moth, 78
Lupine, 72, 102
Lynx, 61, 92, 94, 98

M

Macauley, James, 44, 110
Mack, Richard, 138
Madison, James, 200
Maine, 146, 238
Malaria, 250
Mammals (generally), 83–98. *See also specific mammals*
Manorial Meadows, 304–306
Maple, 34, 36, 37, 41, 44, 49–51, 55, 68, 80–82, *82*, 231, 233, 233
Maple-Beech forests, 67
Marbled Salamander, 306
Marjoram, 137
Marks, Peter, 142
Marsh wren, 111
Marten, 91, 92, 98
Martes, 92
Massachusetts, 13, 22, 55, 62, 92, 95, 96, 106, 140, 151, 152, 184, 203, 238, 246, 272, 287, 298, 307
Mastodon, 83
Mayapple, 108

Mayfly, 231, 260, 261, 261, 272, 288, 292, 293
McVaugh, Rogers, 68, 72, 90, 91, 114, 119–121, 137–141
Meadow Fritillary, 150–151, *151*
Meadowlark, 109, *110*, 111, 114, 130
Meadowsweet, 108
Mealworm, 222
Merino sheep, 26
Mexico, 144, 286
Mice, 125
Midge, 272, 293
Miles, W. A., 50
Milk Purslane, 123
Milkweed, 119
Milkwort, 108
Mill Creek, 245
Mink, 91
Minnesota, 104, 273
Minnow, 290, 291
Mitchell, Samuel, 175
Mite, 218
Mohawk River, 162, 228, 252
Monarch Butterfly, 79, 144
Moneywort, 138
Moose, 58, 83, 97, 164, 190
Moosewood, 81. *See also Striped Maple*
Morgan, Tara, 134, 136
Mosquito, 250, 272
Moth, 77, 78, 145, 148, 268, 271
Mountain Lion, 92
Mountain Maple, 80
Mountain-mint, 118
Mount Lebanon, 137, 187, 254–255
Mount Washington, Massachusetts, 49
Mouse, 54
Mulberry, 68
Mulberry Wing, 109, *145*, 145–146, 154
Mule Deer, 83
Multiflora Rose, 54, 119–121
Munch, Fred, 253
Mussel, 241
Mustards, 152
Mustard White butterfly, 152–153
Mustelids (generally), 91–93
See also specific mustelids
Mycorrhizal fungi, 141, 215

N

Narrowleaf Plantain, 135–136
Nassau, New York, 269
New Amsterdam, 167
New Concord, New York, 202
New England, 25, 42–43, 51, 70, 74, 97, 118, 137, 145, 146, 149, 163–165, 172, 173, 178, 205, 215, 238
New England Cottontail, 97, 98, 307
New Forge State Park, New York, 233
New Jersey, 151, 172, 173
New Lebanon, New York, 30, 50, 73, 97, 107, 109, 112, 113, *118*, 118, 121, 122, 135–137, 140, 218, 231, 233, 259, 269, 288, 294, 302
New Lebanon Valley, 160
New Netherlands, 19m, 22, 167, 168, 170, 244
Newt, 249, 281, 282
New York City, 13, 24, 25, 27, 29, 88, 107, 109, 151, 169, 175, 205, 250, 255, 256, 264, 276, 297, 304, 307, 308
Night crawler, 225
Nightingale, Florence, 250
No Bottom Pond, 239
Nodding Lady's Tresses, 108, 140, *140*, 235, 235
North Bay, 304
North Carolina, 146
Northern Blue Flag, 108
Northern Bobwhite, 117
Northern Cardinal, 62
Northern Harrier, 109
Northern Leopard Frog, 109
Northern Pike, 290
Northern Pygmy Clubtail, *288*, 288–289, 292
Northern River Otter, 91–92
Northern Shrike, *110*
Northern White Cedar, 75, 304
North River, 258
Norway Maple, 81
Norway Pine, 72. *See also Red Pine*
Nuts, 162
Nutten Hook, 241, 255

O

Oak, 34, 36, 37, 42, 44–45, 45t, 49, 50, 68, 73, 75–78, 77, 80, 82, 101, 102, *102*, 174, 233, *233*, 301, 304
Oak-Hickory forests, 67, 75, 80, 98
Oats, 27–28, 122, 188
Odonates, 283–290
Oklahoma, 210
Olana, New York, 303
Omophron americanum, 222, *222*
Ontario, Canada, 74
Orange Sulfur butterfly, 151
Orchard grass, 190
Orchid, 108, 114, *140*, 140–141, 235
Oriental Bittersweet, 54
Ostraya, 67
Otter, 91–92
Oval Pignut, 80
Owl, 111
Oxbow lakes, 280
Oxen, 119, 177, 189

P

Packard, Alpheus, 77
Painted Lady butterfly, 143–145, *144*
Palatine Swales, 305–306
Panther, 92, 94
Parsley, 123
Passenger Pigeon, 124–125, *125*, 181
Pasture Rose, 118
Pea, 169, 177
Peaceful Valley, 17
Pearl Crescent butterfly, 150
Peck's Skipper, *148*, 148–151
Pennsylvania, 138, 146
Pennsylvania Smartweed, 123
Pennyroyal, 119
Peppermint, 137
Philadelphia, Pennsylvania, 197
Philmont, New York, 29, 30, *48*, 48, 245, 246, 253–254, 254m
Piermont Marsh, 249
Pig, 177, 180, 259
Pigeon, 124–125, *125*, 181
Pignut Hickory, 78, 80
Pike, 290
Pileated Woodpecker, 111
Pine, 34, 37, 38, 40, 41, 49, 68–73, *69*, *71*, 76, 201
Pine Marten, 92, 98
Pine Plains, New York, 138
Pink Lady's Slipper, 140
Pin Oak, 77
Pitch Pine, 49, 70–72, *71*
Pittsfield, Massachusetts, 129, 153
Piwonka, Ruth, 22
Plover, 109
Poison Sumac, 233
Pokeweed, 243
Polygonum, 154
Polyphemus Moth, 78
Porcupine, 97
Post Oak, 68
Potato, 28, 122, 187
Poughkeepsie, New York, 129
Poverty Oatgrass, 118
Powys, John Cowper, 90, 113
Prickly Pear Cactus, 304
Primar (Priming) Hook, 181, 247
Primrose, 110–111
Puma, 92
Pumpkins, 164, 188
Purple-fringed Orchid, 108
Purple Loosestrife, 139
Purple Milkwort, 108
Purslane, 123
Pussytoe, 118
Putnam County, New York, 15, 88, 232

Q

Quebec, Canada, 152
Queechy Lake, 236, 248, 255

R

Rabbit, 62, 97, 98, 125, 181, 307
Raccoon, 125, 278
Ragged-fringed Orchid, 108, 114, 140, *140*
Ragged Robin, 139, *139*
Ragweed, 123

Ragwort, 108
Rails, 111
Raspberry, 163
Rattlebox, 119
Read, Charles, 172
Recknagel, A. B., 51
Red Cedar, 69, 73–74, 119
Red Clover, 135, 137, *137*
Red Fox, 95
Red Hickory, 80
Red Maple, 80–82, *82*, 233, *233*
Red Mulberry, 68
Red Oak, 75–76, *77*, 80
Red Pine, 70, 72, 73
Red–spotted Newt, 249, 281, *282*
Red Spruce, 37, 75, 302
Red Squirrel, 98
Red-winged Blackbird, 110
Regal Fritillary, 146–148, *147*, 150
Reindeer, 83
Rensselaer, Kiliaen van, 19, 39, 163, 167, 170, 179
Rensselaer, New York, 302
Rensselaer, Stephen van, III, 24
Rensselaer County, New York, 13, 18, 30, 49, 92, 163, 170, 256, 269, 275, 301
Rensselaer Manor, 167
Rensselaer Plateau, 13, 75
Rensselaerwyck, 19–20, 22, 170, 179, 245
Rhinebeck, New York, 94
Rhode Island, 190
Ribes (currants), 53
Rice Cutgrass, 148
River Keeper, 266
River Otter, 91–92, 269
Robin, 224, 294
Robinson Pond, 236
Rock Bass, 290
Roeliff Jansen Kill, 18, 162, 163, 228, 229m, 231, 243, 247, 253, 256, 266, 268
Rome, New York, 81
Rose Rosette Virus, 121
Rossman, New York, 247, 252
Rove beetle, 221
Ruffed Grouse, 111
Rumex, 154
Rush, 278
Rye, 27–28, 122, 123, 188
Rye Brome, 134

S

Salamander, 225, 278, 282, *282*, 306
Salmon, 246
Salt Lick, 181
Sandpiper, 111, *111*
Savannah Sparrow, 117
Scarlet Oak, 77
Schenectady, New York, 18
Schodack, New York, 71, 206
Scotch Pine, 72–73
Scotland, 187
Scrub Oak, 77
Scudder, Samuel, 144
Sea monkey, 282
Sedge, 102, 108, *109*, 118, 140, 146, 149, 150, 233
Seneca Lake, 258
Seton, Ernest Thompson, 88
Shad, 181, 241, 243, 246, 247
Shagbark Hickory, 78, 79, 80
Shaker Swamp, New Lebanon, 160, 186, 233, 234, 288
Shammonon, 164
Sheep, 26–27, 101, 109, 116–118, 135, 177, 180, 302, 305, 306, 308
Shiner, 290, 291, *291*
Shortgrass Prairie, 105
Shorto, Russell, 167
Short-tailed Weasel, 91, 125
Showy Goldenrod, 142
Showy Lady's Slipper, 140
Shrew, 97
Shrike, *110*
Shrubby Chinquefoil, 235
Siberia, 292
Silver-bordered Fritillary butterfly, 150
Silver Maple, 44, 80, 231
Silvernails, New York, 256
Silverrod, 142

Silvery Blue butterfly, 149
Skipper butterfly, 145–146
Slender Lady's Tresses, 111, 140
Slimy Sculpin, 230, 292, *292*, 294, 302
Small-flowered Crowfoot, 111
Smallmouth Bass, 247, 290
Smooth Alder, 233
Smooth Goldenrod, 142
Snake, 108–109, 280
Snaketail, 231, 284, *284*, 285, 285
Snapdragon, 138
Snapping Turtle, 280
Snipe, 111
Snow Bunting, 123
Snowshoe Hare, 97, 98
Solidago, 142
Songbirds, 273
Song Sparrow, 117
Sorrel, 134
South Bay, 304
Southwick, Solomon, 198–199
Soybeans, 100
Spaeroderus stenostomus, 222–223, *223*
Spafford, Horatio, 71, 107, 182, 203, 306
Sparrow, 62, 109, 111, 111, 117, 122
Spearmint, 137
Speckled Adler, 233
Speckled Beach Pill (*Omophron americanum*) 222, *222*
Spencertown Valley, 96
Sphagnum, 235
Spiked Lobelia, 110
Spotted Salamander, 282, *282*
Spotted Turtle, 108
Springtail, 218–219
Spruce, 34, 37, 75, 235, 236, *236*, 302
Squampamock Flats, 163
Squash, 162–164
Squirrel, 62, 97, 98, 125, 181
Staats, Abraham, 244
Staats, George, 255
Starling, 62
State Line, New York, 17, 206
Steer, 119
Stein Kill, 238
Stichter, Sharon, 151, 154
Stockbridge, Massachusetts, 21, 73
Stockbridge–Munsee Indian Reservation, Wisconsin, 21
Stockport, New York, 245, 303
Stockport Bridge, New York, 252
Stockport Conservation Area, 287
Stockport Creek, 166, 171, 228, 243, 247, 248
Stonefly, 230, 260, 272, 289, 293
Stony Kill, 231, 253, 256
Stotts, Peter, 49
Stottvile, New York, 30, 247
Strawberry, 218
Striped Bass, 181, 231, 241, 243, 246
Striped Maple, 80, 81
Sturgeon, 241
Stuyvesant, New York, 21, 72, 300
Stuyvesant Falls, New York, 29, 30, 31, 245, 246, 253, 254
Stuyvesant Landing, New York, 245
Sucker, 181
Sugar Maple, 37, 44, 50–51, 68, 80–82
Sundew, 235, 236, *236*
Sunflower, 162
Surrey, England, 238
Susquehanna River, 162
Susquehanna Valley, 238
Sutherland Pond, 255
Svinin, Pavel, 247
Swallowtail Butterfly, 141
Swamp Saxifrage, 108
Swamp White Oak, 233, *233*
Swan, Robert J., 258
Sweet Fern, 118
Sweet Flag, 289, *289*
Sweetflag Spreadwing, *289*, 289–290
Sycamore, 44

T

Taconic Hills, 14, 238, 302
Taconic Ridge, *102*
Taconics, 13–17, 13m, 36, 39, 203–206, 228, 238, *239*, 300, 302, 306, 307
Tadpole, 278, 285
Taghkanic, New York, 58, 233, 306
Taghkanic Creek, 163, 256

Taghkanic Lake, 236
Tallgrass Prairie, 105, 109
Tamarack, 70, 235
Tanager, 111
Teale, Chelsea, 39, 106
Tenmile River, 228
Tessellated Darter, 294, *294*
Thistle, 145
Thistle Butterfly, 143–145
Thompson, Zaddock, 110
Thoreau, Henry David, 88
Thrush, 111
Thyme, 137
Tiger Beetle, 160, 294
Tilden, George, 255
Timber Wolf, 83
Timothy Grass, 106, 110, 112, *112*, 187
Tivoli Bay, 241
Tivoli Marsh, 249
Toadflax, 138
Toothwort, 152
Torrey, John, 108, 110, 120, 123, 135, 136, 138, 140
Tortoiseshell butterfly, 143
Trout, 230, 292, 302
Troy, New York, 138, 269, 301
Tufted Loosestrife, *108*
Tulip Tree, 37, 68, 304
Tull, Jethro, 195–196, 201
Turkey, 111, 125
Turk's Cap Lily, 142
Turnip, 122, 152, 153, 188–189
Turtle, 108, 124, 279, 280, 304, 307
Turtlehead, 135
Tussock Sedge, 146

U

Ulster County, New York, 241
Upland Boneset, 119
Upland Plover, 109
Upland Sandpiper, 111, *111*
Urban-Industrial Landing, 303–304, 303m

V

Valatie, New York, 29, 30, 123, 157, 160, 245
Valatie Kill, New York, 253, 269
Van der Donk, Adrian, 39, 40, 164–165, 167–170
Vannote, Robin, 229
Van Rensselaer. *See under Rensselaer*
Varlo, Charles, 197, 201
Varying Hare, 97. *See also Snowshoe Hare*
Venezuela, 243
Venus Flytrap, 219
Venus Looking-glass, 119, 120, *120*
Vermont, 49, 72, 89, 154
Vesper Sparrow, 109, 111, *111*, 122
Vetch, 139, 177, 190, 192
Violet, 118, 140, 150–151
Virginia Yellow Flax, 119

W

Wagner, David, 154
Walnut, 243
Warbler, 111, 117, 302, 306
Warden, Rev. David, 248–250, 258–259
Washington, George, 171
Washington County, New York, 15, 18
Wasp, 77
Water penny, 231
Water Snake, 280
Weasel, 91, 125
Westchester County, New York, 128–133
Western Coyote, 95
West Indies, 25, 184
Wet meadows, 108
Wheat, 25–26, 106, 122, 123, 172–174, 182–183, 185, 188, 192
White, James, 175
White, John, 242
White-bearded wheat, 188
White butterfly, 123
White Clover, 134, 136–137, *137*
White Oak, 42, 45, 45t, 49, 68, 75, 76, 77
White Pine, 37, 38, 68–70, *69*, 72, 73, 76
White Pine Blister Rust, 53, 70, 72, 74
White Pine Weevil, 70, 72
White Sucker, 247, 293

White-tailed Deer, 42, 55, 82, 83, 88–90, 93, 95, 97, 125, 163
White wheat, 190
Whiting's Pond, 236
Whitney, Gordon, 109, 117
Whorled Milkweed, 119
Wild Blue Lupine, 72
Wild Marjoram, 137
Wild Oats, 134
Wild Rice, 162
Wild Sensitive Plant, 119
Wild Turkey, 111
Williamstown, Massachusetts, 88
Willow, 55
Wilson Powell Bird Sanctuary, 239
Winged Monkeyflower, 108
Wisconsin, 21, 100
Witch-grass, 123
Wolf, 83, 95, 181
Wolverine, 83, 91, 92
Woodchuck, 123
Wood Frog, 282, *282*
Wood Lily, *141*, 141–142
Woodpecker, 111
Wood Turtle, 124
Wood-warbler, 111
Woodworth, W. V. S., 71–72
Wooly Mammoth, 83
Worcester, Massachusetts, 109
World War II, 28, 29, 259
Worm, 156, 223
Worm-eating Warbler, 306
Wrinkle-leaved Goldenrod, 142, 143, *143*
Wyomanoc Creek, 107, 269

Y

Yankee Hill Country, 302–302
Yellow Aven, 108
Yellow Pine, 70. *See also Pitch Pine*
Yellow Warbler, 117
Yellow Wild Indigo, 119

Z

Zebra Mussel, 134
Zelinksky, Wilbur, 236–237