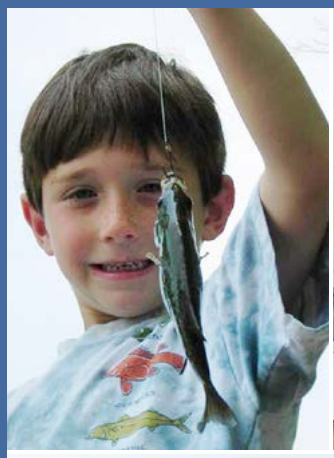
Creating a Natural Resources Inventory

A Guide for Communities in the Hudson River Estuary Watershed



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Hudson River Estuary Program
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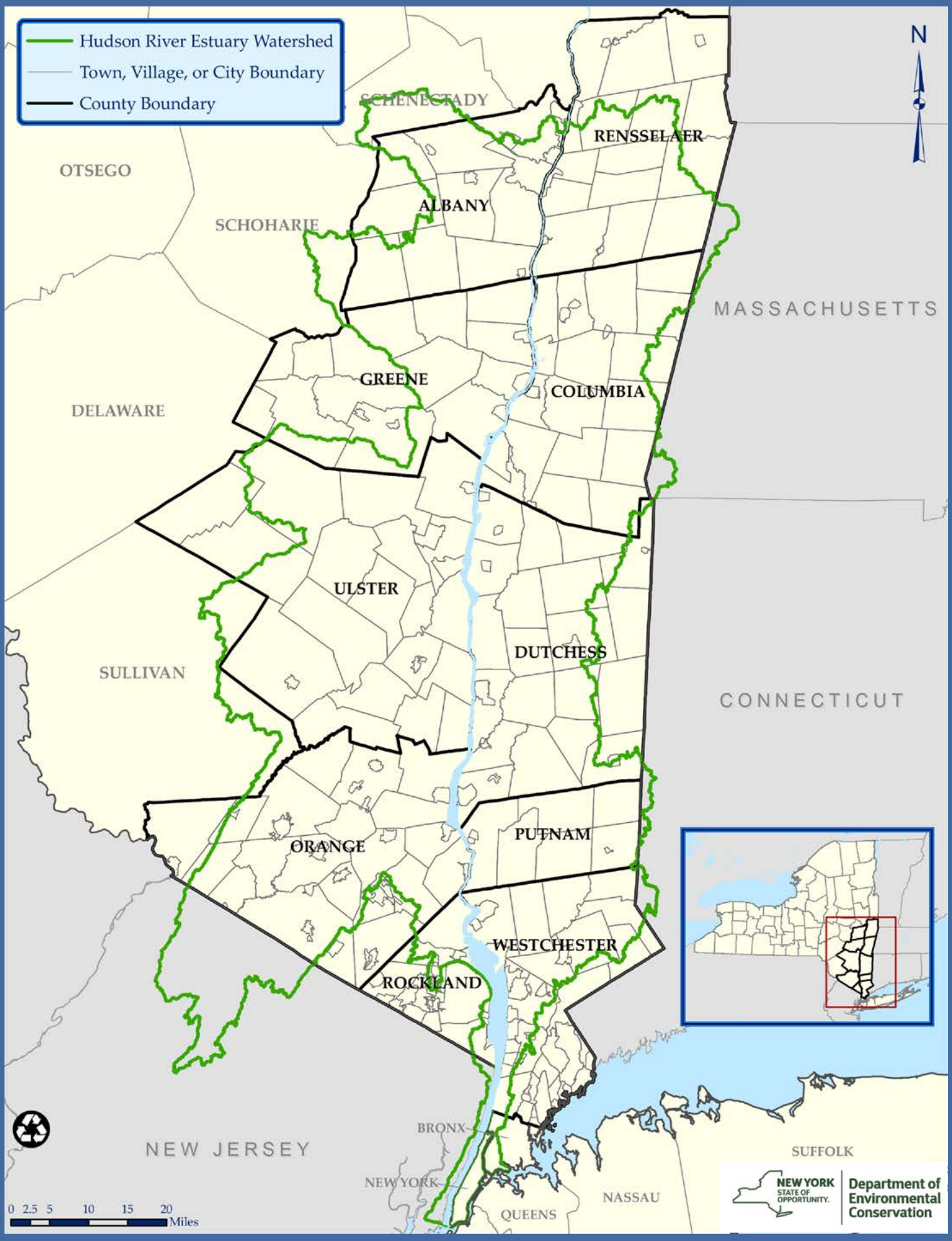
New York State Municipalities in the Hudson River Estuary Watershed



Creating a Natural Resources Inventory

A Guide for Communities in the Hudson River Estuary Watershed

2014

Ingrid Haeckel and Laura Heady
Cornell University Department of Natural Resources
for New York State Department of Environmental Conservation's
Hudson River Estuary Program

Cornell University

NEW YORK STATE OF OPPORTUNITY. Department of Environmental Conservation

Hudson River Estuary Program
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About the Hudson River Estuary Program

The Hudson River Estuary Program uses the science of ecology to help people enjoy, protect, and revitalize the Hudson River estuary. Created in 1987 through the Hudson River Estuary Management Act (ECL 11-0306), the program focuses on the tidal Hudson and its adjacent watershed from the dam at Troy to the Verrazano Narrows in New York City.

The core mission of the Estuary Program is built around six key benefits:

- Clean Water
- Resilient Communities
- Vital Estuary Ecosystem
- Estuary Fish, Wildlife, & Habitats
- Scenic River Landscape
- Education, River Access, Recreation, & Inspiration.

The Estuary Program works in close collaboration with many partners – from nonprofit organizations to businesses, local governments to state and federal agencies, interested residents, and many others. For more information, visit www.dec.ny.gov.

About Cornell University's Department of Natural Resources

The Department of Natural Resources at Cornell University creates knowledge and facilitates learning to improve society's stewardship of the environment and promote a conservation ethos for a sustainable planet. For more information, visit http://dnr.cals.cornell.edu/.

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ISBN: 978-0-692-34875-8

Recommended Citation:
Haeckel, I. and L. Heady. 2014. Creating a Natural Resources Inventory: A Guide for Communities in the Hudson River Estuary Watershed. Department of Natural Resources, Cornell University, and New York State Department of Environmental Conservation, Hudson River Estuary Program. Ithaca, N.Y. 102 pp.

Cover photography by Ingrid Haeckel, Laura Heady, and Steve Stanne
Map by Clare Dunn
Cover page illustration of Karner blue butterfly by Patricia Kernan, preface illustration of pine tree by B. Starcke King

Preface and Acknowledgments

Shoreline cities, quaint villages, expanding suburbs, and pastoral towns—the communities of the Hudson River Valley are as diverse as its natural areas and habitats, but they all share two key characteristics. First, they are all connected to the estuary, either directly on its shorelines or tributaries, or by the living landscape of forests, fields, wetlands, and streams that comprises its watershed. Second, they all rely on local decision-makers—town boards, planning and zoning boards, conservation advisory councils, and open space commissions—to grapple with the many challenges facing Hudson Valley communities, including economic growth, development, aging infrastructure, climate change, historic preservation, and protection of farmland, source water, scenery, and wildlife habitat.

To build community capacity for sound decision-making that balances future growth with protection of the Hudson River estuary and the rich natural resources in its watershed, Cornell University's Department of Natural Resources and the New York State Department of Environmental Conservation's (DEC) Hudson River Estuary Program initiated an outreach and technical assistance program in 2001. The program emphasizes voluntary approaches, offering technical assistance, data sharing, training, and grants to support community planning and conservation initiatives at the local level. With assistance from the Estuary Program, many municipalities have developed plans and practices that address regional habitat priorities and local community values, and will ultimately help to sustain the health and resiliency of the estuary ecosystem.

Despite this progress, many municipalities are still in need of a foundation of natural resource information to guide their planning decisions. This guidebook was developed to address that need by assisting communities with learning how to inventory their natural and cultural resources. By having information about features such as aquifers, floodplains, shoreline habitat, and farmland, communities can begin to identify priorities and local officials can incorporate protection of important resources into land-use planning to ensure they remain available to future generations.

The concept of the guidebook came from *Natural Resources Inventories: A Guide for New Hampshire Communities and Conservation Groups* (2001), originally written by Phil Auger and Jeanie McIntyre and revised and updated by Amanda Lindley Stone of University of New Hampshire Cooperative Extension (UNHCE). It also serves to provide an update to the 1997 document, *Natural Resource Inventory: A Guide to the Process,* which was written by the Dutchess County Environmental Management Council (EMC) in partnership with the Ulster County EMC. In the spirit of conservation, the authors, UNHCE, and the Dutchess EMC graciously gave us permission to use the text of their handbooks, for which we sincerely thank them. Chapters 1, 2, 3, 5, and 6 and Appendix D are based on the New Hampshire document and borrow language from that text; Chapter 4 and other appendices were extensively rewritten.

This guidebook helps to implement the *Hudson River Estuary Action Agenda*, which provides a vision and plan to help people enjoy, protect, and revitalize the Hudson River estuary and its valley. Although the focus of the guidebook is on the Hudson Valley region, it describes a process that can be used by any municipality in New York State and in other states where communities are engaged in local planning and conservation initiatives. The guide also complements the program's *Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River Valley* (Strong 2008), which provides a broad overview of strategies that can be used locally to conserve natural assets.

We greatly appreciate the program leadership, guidance, and support of Ted Kerpez, Region 3 Wildlife Manager for the New York State Department of Environmental Conservation; Frances Dunwell, Coordinator of the Hudson River Estuary Program for DEC; and Patrick Sullivan, Cornell University Professor of Natural Resources.

Special thanks go to Hudson River Estuary Program and New York State Water Resources Institute colleagues Emily Vail, Andrew Meyer, and Elizabeth Murphy, who contributed to the content of the water resources, climate, and scenic resources component sections in Chapter 4 and related appendices; to Ted Fink, AICP of GREENPLAN Inc. for his review of the guidebook and development of Appendices G and H; to the New York State Museum for providing illustrations and to Patricia Kernan for her assistance with selecting and preparing images; and to Peter Karis, RLA of Taconic Site Design & Landscape Architecture for assistance with maps included in Appendix I. We're also grateful to colleagues from the Hudson River Estuary Program, DEC, Cornell University, and other organizations and agencies who reviewed earlier drafts and provided valuable comments and suggestions, including: Nancy Beard, Karl Berger, Mark Castiglione, Neil Curri, Laura DeGaetano, Kelly Dobbins, Halina Duda, Ellen Jouret-Epstein, Amanda LaValle, Jeff Mapes, Jennifer Minner, Maude Salinger, Kate Schmidt, Karen Strong, Nava Tabak, Erin Tobin, Russell Urban-Meade, and Stephanie Wojtowicz. Finally, we thank Jim Pryslak, graphic designer, for his important contribution to the layout and design of this book.

Contents

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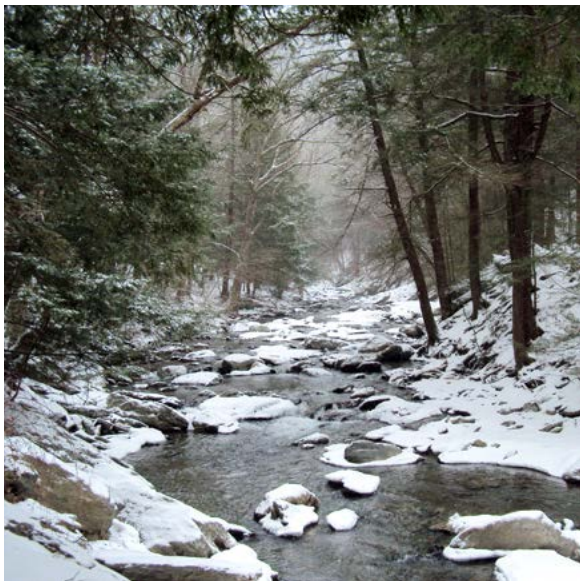

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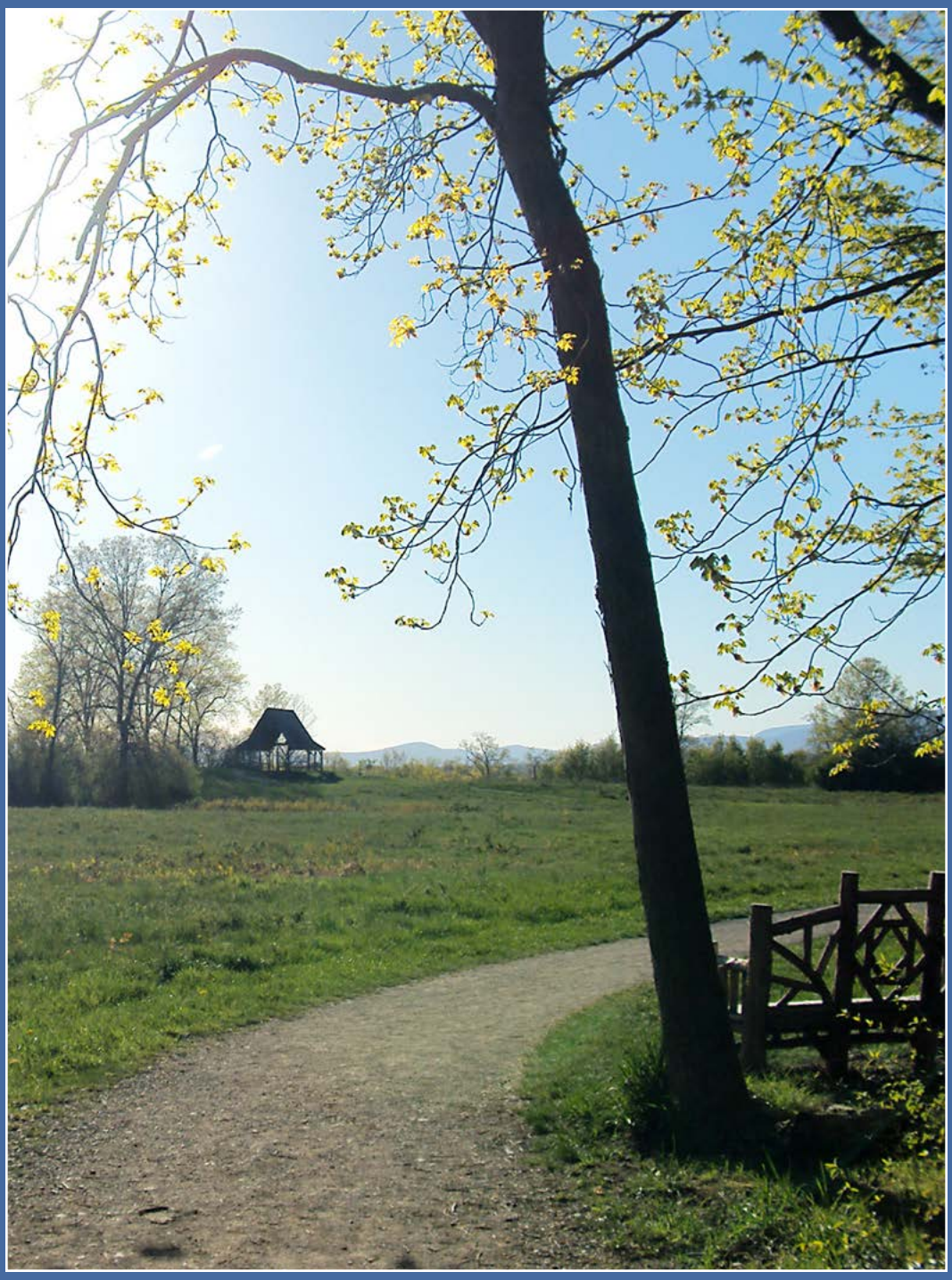


CHAPTER: 1

Introduction

Why inventory natural resources?

The Hudson River Valley's shorelines, wetlands, forests, streams, grasslands, and shrublands are not only habitat for abundant fish and wildlife, but also provide many vital benefits to people. These ecosystems help to keep drinking water and air clean, moderate temperature, filter pollutants, absorb floodwaters, and provide for pollination of agricultural crops. They also present opportunities for outdoor recreation and education, and create the scenery and sense of place that is unique to the region.

The Hudson River estuary watershed, which roughly includes the ten counties bordering the tidal river from Albany and Rensselaer counties to Rockland and Westchester, is home to approximately 2.8 million people. From 2000 to 2010, the population of the watershed grew by 125,639 residents, or 4.7%—twice the rate of the state as a whole. And in the preceding decades, land in the Hudson Valley was converted to suburban development three times faster than the population grew, leading to declining density in existing cities and suburbs and making communities vulnerable to the harmful effects of sprawl (Pendall 2003).

Land-use planning is instrumental in balancing future growth and development with protection of natural resources. Although municipalities frequently need to make decisions affecting these resources, they often don't have adequate data available to inform those decisions. Often they find themselves reacting to proposed development rather than planning for future growth, or making decisions on development projects without considering the larger context. This narrow approach to decision-making loses sight of broader-scale issues and goals, such as climate resilience, walkable communities, connected habitats, or watershed management.

By identifying and describing natural resources at the local scale, a natural resources inventory (NRI) provides communities with a strong foundation for proactive planning and informed decision-making. NRIs have value not only to communities in rural settings, but also those in more urban and suburban areas. The process encourages participation in identifying and prioritizing natural resources important to the community, and provides information that will support careful land-use planning and improved resource protection measures. And by incorporating natural resources into every level of decision-making and planning, municipalities can make a meaningful contribution toward preserving the natural heritage of the region, and can ensure that healthy, resilient ecosystems—and the benefits they provide—are available to their communities for future generations.

Tidal marsh. © L. Heady

What is a natural resources inventory (NRI)?

A natural resources inventory (NRI) compiles and describes important, naturally occurring resources within a given locality (e.g., municipality, watershed, or region). Cultural resources, such as historic, scenic, and recreational resources, are often included in an NRI, as well. The inventory has two basic purposes: 1) to provide the building blocks for comprehensive land-use and conservation planning, and 2) to allow natural resource information to be included in local planning and zoning. The scope of the NRI is determined by the community. At its simplest, an NRI is the compilation and description of existing natural resources data. At its most complex, it includes detailed analysis of resources or new data collected specifically for the inventory. An NRI is not a static document. As new and revised data become available, the inventory should be updated to insure its completeness and accuracy.

Until an inventory has been conducted, many communities don't have a clear picture of where their natural (and cultural) resources are located, which resources are significant to the community, and why. The compilation of maps, data tables, and descriptions in an NRI contribute to a better understanding and appreciation of the community's natural resources and provide the foundation for a wide range of planning and conservation applications.

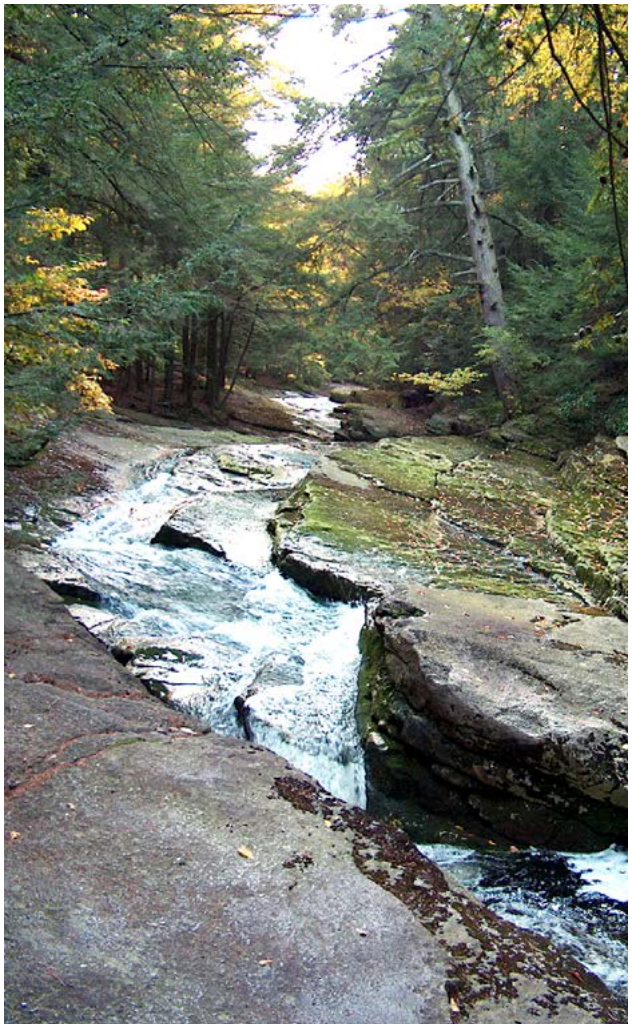
Ideally, an NRI should include the following three components:

Maps: Inventory maps show the location and extent (as known) of existing resources, such as forests, surface and ground waters, and farmland within the chosen study area. They provide a visualization of the patterns of natural and cultural resources and land uses within the study area and its surroundings, and how they relate to each other and to built features such as roads and residential neighborhoods. Inventory maps are useful for a variety of applications, e.g., zoning updates and open space planning (see Chapter 6).

Associated Data and Information Sources: An NRI is more than just a collection of maps. The data that serve as the basis for the inventory can provide specific details about information displayed on the maps (e.g., acreage of specific features like forest patches). Documentation of the data sources used for the inventoried resources should also be included to facilitate future updates and provide a clearer basis for appropriate uses of the inventory. Keep in mind that some data (e.g., the detailed results of water quality assessments) don't lend themselves to display on a map, and are best reported in tabular format. Other data may warrant display in both map and table format (e.g., soil map units are best shown on a map with their corresponding properties listed in a table).

Descriptive Report: A written report is an important element of the NRI. The report should describe the project's goals and methods, provide descriptive summaries of each resource inventoried, and summarize its findings and recommendations.

Chapter 4 provides more detailed information on what to include in an NRI.



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How can a natural resources inventory be used?

The results of an NRI should be available for use by municipal officials, county planning agencies, interested community and watershed groups, developers, and residents. Decision-makers and community stakeholders can use the NRI as a foundation for creating strategies that incorporate natural resource-based planning and prevent the unintended loss of their valued assets. Real estate developers benefit by knowing, before they formulate a proposal, which resources are valued and prioritized by the community. Some ways that an NRI can be used include the following (Chapter 6 provides a more detailed discussion of these applications):

- Develop or update the natural resources section of the municipal comprehensive plan
- Provide information for watershed assessment and planning
- Designate critical environmental areas (CEAs)
- Develop and implement a municipal or regional open space plan
- Amend existing zoning and subdivision regulations
- Evaluate the effects of proposed land use and zoning changes
- Inform environmental review of development proposals
- Document current conditions so changes over time can be assessed.

Rather than being an end in itself, a natural resources inventory is intended to be a reference in many aspects of planning and a valuable tool for achieving some of the goals listed above. While an NRI is useful for municipal-scale planning, it is generally not suitable for site-scale issues and the NRI maps should not be substituted for on-site surveys during project review. However, the NRI may be used as a screening tool during environmental reviews to see how projects fit in the larger context and identify areas where more site-specific assessments may be required.

About this guide

This guide is designed for use by municipal and county officials (e.g., conservation advisory councils and planning boards), conservation organizations, watershed associations, and interested citizens. It may also be useful to professional planners, consultants, and developers. It was written to help municipalities pursue a natural resources inventory by suggesting an approach (Chapter 2); and recommending components to include, explaining why they are important, and providing sources of data and assistance (Chapter 4). In addition to recommending basic inventory components, Chapter 4 provides some suggestions for additional detailed inventory studies. Ultimately, the scope of the inventory project is up to the

community, and may be influenced by a number of factors, including emerging priorities, staff or volunteer capacity, and budget. This guide can be used by both communities embarking on an NRI for the first time, and communities that are updating or expanding an existing NRI.

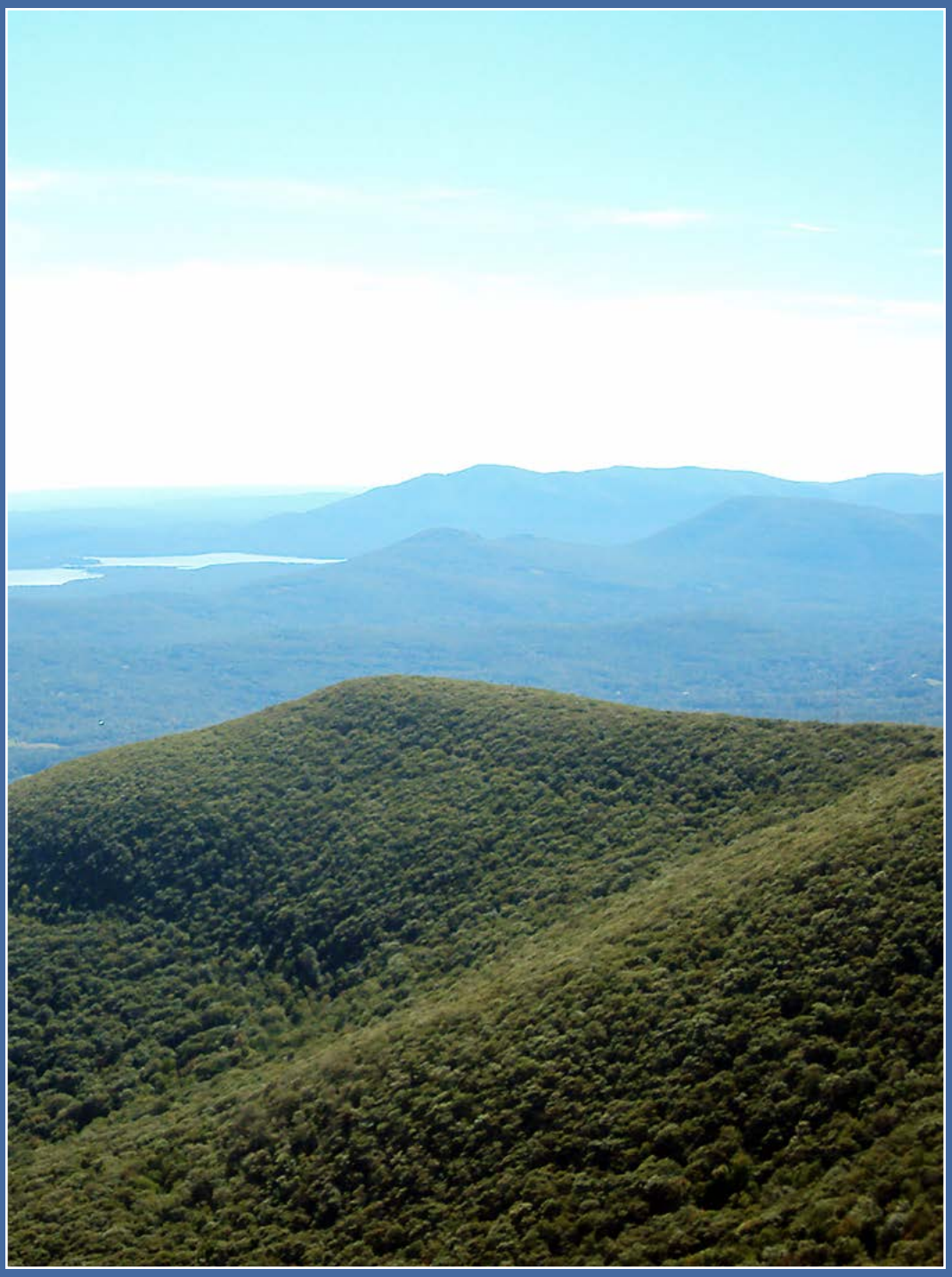
Ultimately, the scope of the inventory project is up to the community, and may be influenced by a number of factors, including emerging priorities, staff or volunteer capacity, and budget.

Although the emphasis of the guide is on municipal NRIs, the inventory process can be applied to larger areas, such as counties and watersheds. For example, many of the components described in Chapter 4 are included in a watershed characterization or assessment phase when developing a watershed plan (see New York State Department of State's *Watershed Plans Guidebook: Protecting and Restoring Water Quality*).

The use of Geographic Information Systems (GIS) has become more commonplace and provides an efficient, computer-based tool for managing, updating, and combining NRI information that lends itself to a mapped format. It is a recommended approach for compiling inventory maps and the guidebook suggests GIS data sources throughout Chapter 4. Depending on municipal capacity, use of GIS for compiling NRI data may require the assistance of a group that has technical capabilities, such as county agencies or consultants. Chapters 3 and 5 and Appendix C contain information about using GIS and web-based mapping tools for the purpose of developing and analyzing an NRI.

The guidebook also includes suggestions for how to put the inventory to work (Chapter 6) and model language for formal adoption of the NRI (Appendix G), and gives an example of a checklist for resource assessment during subdivision review (Appendix H), inventory maps (Appendix I), and NRI and open space planning projects (Appendix J) from Hudson Valley municipalities. Additional appendices provide lists of resources (Appendices A and B); and information on commonly used maps (Appendix D), biodiversity assessment (Appendix E), and climate resilience (Appendix F).

While the guidebook focuses on the Hudson River Valley, it describes an inventory process that can be applied throughout New York State and in other states where local municipalities play a role in land-use and conservation planning. For any community pursuing an NRI, it is recommended that county and municipal agencies are contacted to determine what local data are available to complement the national, state, and regional maps and data sets described in Chapter 4.



CHAPTER: 2

Getting Started

Getting Started: Summary of the Approach

1 **Establish a work group**
Invite local boards, community groups, and area residents to attend an initial planning meeting to brainstorm NRI goals and objectives.

Establish a smaller work group of 7-10 interested people to direct the project.

Elect a project leader/coordinator.

Solicit volunteers.

Determine technical and GIS capacity of the group and identify technical advisors as needed (e.g., county planning department).

2 **Determine goals and scope of project**
Review community needs and prioritize NRI goals.

3 **Define the study area**
Decide on the focal area of the NRI (e.g., the town, a subwatershed within the town, a region involving several towns).

4 **Review existing natural resources documents**
Gather and review existing natural resource documents, e.g., comprehensive plan, watershed management plan, environmental impact statements, etc.

5 **Develop a draft inventory outline**
Develop a draft outline that addresses project goals and proposes what to include (components to be inventoried and described, maps and tables to be compiled, and other narrative sections) and a rough time line.

6 **Develop a budget and scope of work**
Investigate costs, identify potential funding sources, and develop a budget. If hiring a consultant, develop a scope of work that details expectations.

7 **Publicize the inventory and solicit public input**
Keep the community informed about the project. Provide updates and get feedback at community events and meetings, through websites and social media, and with public displays.

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Establish a work group

Once a community has decided to create a natural resources inventory, it should establish a work group and determine who will take the lead on the project. Conservation advisory councils (CACs) (also known as environmental commissions) are an ideal work group to coordinate a municipal inventory. Some municipalities may have staff capacity to lead the NRI. Other communities or organizations may find it's best to establish a steering committee and project leader to oversee the NRI project.

While a CAC is a logical leader in developing a municipal natural resources inventory, not all New York communities have active conservation councils, nor should any one group carry the entire load of an inventory project. An inventory that relies primarily on volunteers will be accomplished most effectively by pooling a variety of local talent into a well-organized work group. By inviting local boards, community groups, and residents to an initial planning meeting, the goals and objectives of the NRI project can be brainstormed and discussed, and potential members of the work group can be identified. This approach provides a diverse range of constituents with an opportunity to contribute to the NRI, facilitates communication between groups, and strengthens support for the NRI. Here are some suggestions:

Members of municipal boards, commissions, and committees: Invite members of the CAC, planning, zoning, and legislative boards, comprehensive plan committee, recreation commission, historical commission, agriculture committee, and other municipal groups to participate in the project. This ensures a variety of interests are represented.

Members of the community: Identify residents of the municipality who have relevant backgrounds, professional experience, or particular knowledge about the community's natural and cultural resources who might be willing to provide some assistance with the project.

Conservation Advisory Councils (CACs)

The State of New York General Municipal Law (Article 12-F Section 239-x) gives any town, city, and village the authority to create a conservation advisory council (CAC) "…to advise in the development, management, and protection of its natural resources." The law also states that CACs are to provide an inventory of open areas and wetlands within the municipality. The open areas inventory is defined in Section 239-y as having each area "identified, described, and listed according to priority of acquisition or preservation." Before priorities can be determined, a basic inventory of natural resources is needed.

Other groups: Local land trusts, watershed associations, historical societies, nature groups (like bird clubs), not-for-profit organizations, and colleges and universities are helpful groups to involve in an NRI project (see Appendix A). If the municipality is within a watershed with an active watershed association, notify them of the project and solicit their input. Find out what work they have done that could be used in the inventory. College interns, high school groups, and educators may be able to assist with technical aspects of the project.

After the initial planning meeting, establish a smaller work group of 7-10 people and elect a project leader/coordinator. The project leader can be tasked with general organization and management of the NRI work group and project. He or she can keep the inventory project on track by scheduling meeting times and places; coordinating members of the work group, including volunteers, local officials, municipal and county staff, and consultants; and arranging for public input and information sessions. Smaller work teams can be formed to focus on specific inventory components and tasks can be delegated based on people's interests and skills, such as mapping, field observation, and researching and compiling local information. A steering committee or select work group members can be assigned with instituting criteria for data collection, reporting and documentation, and overseeing the NRI.

It is recommended that the work group assess its technical capacity at the beginning of the project. This, along with other factors, will help determine the potential scope of the NRI. Does the municipality have GIS staff available to assist with the project? Are there funds to hire a consultant to assist with map creation? Does the work group have knowledge of the local and county data sets that should be included in the NRI? County agencies such as planning departments, environmental management councils, soil and water conservation districts, and extension offices may be able to assist with technical aspects of the project and should be invited to participate as advisors early in the process.

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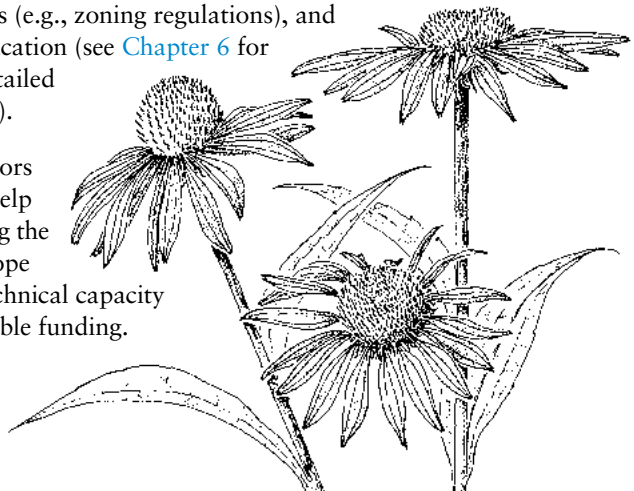
Determine goals and scope of the project

At the outset, establish the goals, objectives, and scope of the project. An NRI isn't an end in itself. The real purpose is to use the inventory as the basis for future planning. Key questions include:

- Why do you want to develop or update a natural resources inventory?
- What do you hope to accomplish? How will the NRI be used?
- What are the community's needs and concerns?
- Are natural resources goals identified in the comprehensive plan? If so, which recommendations have been acted upon? How can the inventory address recommendations that haven't yet been implemented?
- What natural resources information would you like to see included in the inventory?
- Are there specific natural resource priorities in the study area, such as water resources, wetlands, connected habitats, farmland, or scenic views?

The goals will help to determine the scope of the project. Both short- and long-term goals should be identified. Inventory goals can be broken down into more specific objectives and actions, such as water resources evaluation, wetlands inventory and evaluation, wildlife habitat assessment, and identification of outdoor recreation opportunities. Broader goals for using the results of the inventory might include open space planning, land protection, updating the comprehensive plan, updating local regulations (e.g., zoning regulations), and public education (see Chapter 6 for a more detailed discussion).

Other factors that will help in finalizing the project scope include technical capacity and available funding.



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Considerations for Hiring a Consultant

Communities often hire consultants to supplement their own staff and volunteer resources or to gain use of special skills. This is sometimes the case for natural resources inventories, where certain technical skills and expertise may be needed, such as geographic information systems (GIS) and land-use planning. Consultants can provide input on the NRI scope and help with gathering data, creating maps, suggesting implementation ideas, and writing the report. When considering whether to hire a consultant, it is helpful to answer some key questions, including:

- What does the work group want the consultant to do? Is the consultant needed for the whole project, or for specialized work that can't be accomplished by volunteers?
- What skills, expertise, and experience must the consultant have to develop the NRI?
- What is the time frame for the project?
- What is the budget?
- How will the work group oversee and coordinate the work of the consultant?
- Is the consultant familiar with the municipal planning framework and natural and cultural resources of the region, and have they worked on similar projects? Has the consultant worked with volunteer groups before?

If the work group decides to hire a consultant, it will need to prepare a request for proposals (RFP). The RFP must meet all applicable procurement rules and be designed so that responses from consultants will provide all the information that the work group will need to select and hire a consultant. Make sure to fully describe the project needs, deliverables, and the schedule for completion in the RFP. Make sure to request details of the consultant's experience on similar efforts. To ensure a comprehensive response, the RFP itself should be advertised as extensively as possible and mailed to a wide range of consultants.

After receiving responses and reviewing them carefully, set up interviews with potential consultants and talk with references. Prior to setting up interviews, prepare a set of questions to ask each consultant team. Find out more about them and their proposal, and try to determine how well they can achieve the project goals. Fully explore the financial requirements of each consultant's proposal. Interviews are a great opportunity to develop an understanding of everyone's expectations and to set the stage for a strong partnership. Once the work group has selected the project consultant and a contract is executed, the consultant can begin assisting the work group with the NRI project.

Adapted from *Watershed Plans Guidebook: Protecting and Restoring Water Quality* (New York State Department of State 2009).

Define the study area

Setting goals and objectives will help define the study area. Most communities inventory their entire municipality, but there may be reasons to inventory a larger (e.g., intermunicipal) or smaller (e.g., subwatershed in the municipality) area based on project goals and capacity. Below are some examples of potential study areas:

Municipal boundary: If the goal is to inventory a village, city, or town's natural resources, the municipal boundary will define the study area. Recognizing that natural resources cross political boundaries, it is important to include a portion of the area that extends beyond the municipal boundary on the inventory maps; approximately one-mile beyond the study area is recommended. This is especially valuable for considering large, connected habitats, stream corridors, ridgelines, and other features that may require intermunicipal conservation planning. (See examples of municipal inventory maps in Appendix I).

Local watersheds: Since issues like water quality, water quantity, and source water protection also extend beyond municipal boundaries, watersheds provide logical units to study and manage natural resources. Watersheds come in many sizes, and the community's goals can help identify the appropriate watershed scale to inventory; for example, the watershed of a drinking water reservoir may be a top priority, or of a popular trout stream that crosses three towns. Watershed groups may choose to conduct an NRI as part of a watershed management plan. If the municipality is not involved in a current watershed planning effort, look at opportunities for collaborating with adjacent municipalities. Larger watershed boundaries have already been delineated in the United States Geological Survey (USGS) National Hydrography Dataset and some county agencies have mapped subwatershed boundaries. The USGS StreamStats tool can be used to delineate a local subwatershed boundary.

> *A watershed is the area of land where all of the water that is under it, or drains off of it, goes into the same stream, river, lake, or other waterbody.*
>
> — US Environmental Protection Agency

Regional studies involving several towns: Some regional conservation initiatives have inventoried resources based on natural features or watersheds, rather than political boundaries. These inventories encompass multiple municipalities and often involve cooperative efforts (e.g., the *Shawangunk Mountains Regional Open Space Plan* involved representatives from 11 adjacent municipalities and the *Natural Resources Management Plan for the Wappinger Creek Watershed* included 13 municipalities in the watershed; see Appendix J).

Review existing natural resources documents

Many of the maps that form a basic NRI will be compiled from existing, widely-available national and state-wide data sets. The accuracy and value of the NRI will be greatly enhanced by incorporating more local-scale information and data that are available for the study area. Before starting to compile the inventory or planning any new detailed studies, collect and review existing natural resource studies completed in the study area. This may require going through municipal records, searching the library, checking with academic institutions, and checking with other municipal boards (e.g., the planning board) and county agencies like the planning department or environmental management council (EMC) about what studies may have been done. Include the natural resources section of the comprehensive plan in the review. An NRI should be part of, and contribute to, future revisions to the comprehensive plan. Knowing what natural resources information is already available will help avoid duplication and can provide a head start on the inventory.

Develop a draft inventory outline

Work with local officials and other interested citizens to develop a draft outline that addresses project goals. Propose a list of items to include: components to be inventoried and described, maps and tables to be compiled, and other narrative sections to write (introduction, methods, recommendations for using the NRI). Refer to Chapter 4 and Table 2 for a listing of suggested inventory items and recommended data sources. Sketch out a rough project timeline and some idea of costs. Identify tasks and assign responsibilities, and begin to consider options and opportunities for funding the project. Encourage local boards and commissions to endorse the project outline.

Develop a budget and scope of work

The direct cost of an inventory depends on the goals and scope of the project, and the extent of the mapping work and collection of new data. Investigate the costs of producing inventory maps, factor in other potential costs (e.g., hiring a consultant, student interns, photocopies, etc.), and develop a budget. If hiring a consultant, give careful thought to the scope of work or contract to ensure all desired deliverables are included; for example, the work group may want large-format maps printed along with the NRI report, and the community may want all GIS files for future use. The next step is to identify potential funding sources, which could include the CAC's budget, municipal general funds, private funding, and grants (e.g., Hudson River Estuary Program Grants and Greenway Community Grants).

Publicize the inventory and solicit public input

Throughout the project, it is important to keep the community informed. Publicize the NRI project from the start. Community members are more likely to be supportive of a project if they feel involved. Some natural resources may be best identified and evaluated based on community input. For instance, a questionnaire asking residents to list the most attractive natural landscapes in the community may provide information about popular scenic areas and destinations for recreation.

There are many opportunities to share updates on the project and solicit feedback from the community. Be creative and strategic about how best to reach a diversity of residents. Display initial inventory maps at community events and board meetings, and have members of the NRI work group on hand to ask for ideas, answer questions, and provide information. Write articles documenting project progress for publication in local newspapers or for posting on the community blog, municipal website, or Facebook page. Create a dedicated project website or page on an existing municipal website. Run an informational video on the local access TV channel. Ask to be a guest on a local talk radio show. Sponsor a potluck dinner at a community hall and invite everyone to attend with an idea and a dish to share.

Where to find help

There are a number of public and private organizations that can help with an inventory project. Communities can benefit from their technical knowledge, experience, and objectivity. Many of these groups are mentioned throughout Chapters 1-4. Appendix A lists these and other organizations that can provide assistance, along with their websites and phone numbers.

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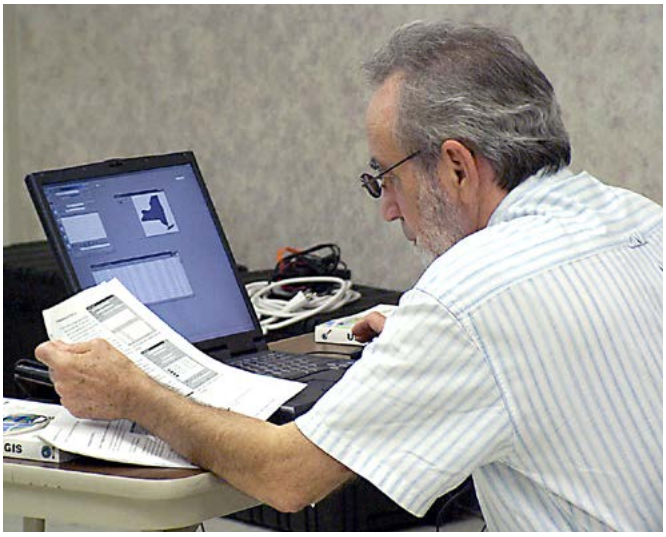
CHAPTER: 3

Mapping Options: Using Online Tools and Geographic Information Systems (GIS)



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Maps are often the most visible and frequently used products of a natural resources inventory. NRI maps can highlight important resources, show potential problems and threats, and illustrate geographic and spatial relationships. Geographic information systems (GIS) technology greatly enhances the mapping process, allowing complex projects that would otherwise be extremely time consuming to be completed more quickly. GIS can be used to rapidly inventory known resources, map new resources identified in the NRI process, and create overlay maps that illustrate the size, extent, and relationship of resources relative to each other and to other features. This in turn may provide insight into the relative ecological importance and conservation value of different resources.

The mapping process described in this guide uses GIS data as the primary source for inventory maps. Guidance is given on how to incorporate natural resources information that isn't available on GIS. For communities without GIS software or technical capacity, an increasing number of online mapping tools allow users to explore publicly available GIS data sets and provide an interactive platform for evaluating local natural resources (see Table 1 and Appendix C).

What is a geographic information system?

GIS is a computer-based tool that allows users to collect, manage, analyze, manipulate, and display geographic information. It can be used for simple tasks like creating a digital map, or for more complex operations like analyzing large quantities of data. GIS data include the location of geographic features and characteristics about those features. Different types of information, such as soils, wetlands, well locations, roads, parcels, and municipal boundaries are organized and stored into their own separate themes, or *data layers*. Using GIS, multiple data layers can be overlaid to generate a composite map. For example, a map of surface waters could include streams, lakes, ponds, wetlands, floodplains, and local or regional watersheds, as well as roads, political boundaries, and topographic contours. By combining information from a variety of sources into a common scale and format, GIS maps help planners consider the interactions of many resources and land uses in their decision-making. It is also easy to produce, update, and correct large-format printable maps using GIS.

A powerful feature of GIS lies in its capacity to combine mapped information with advanced database capabilities. The GIS database can be queried to answer a variety of questions regarding land use and natural resources, and display the answers in the form of maps and/or tables and graphs. GIS can also be used to generate buffers (zones of a particular distance around map features) and perform various calculations related to distance and area. Chapter 5 gives an introduction to how GIS can be used to analyze the completed inventory.

Declining prices of computers and GIS software have made it easier for local governments to develop and maintain GIS for a variety of planning purposes. This guide suggests opportunities for incorporating GIS technology throughout the NRI process. Environmental Systems Research Institute, Inc. (ESRI) is a leading developer of GIS software and offers the widely used ArcGIS Desktop software package for purchase, as well as a variety of desktop and online packages available at no cost to the general public, including ArcGIS Online, ArcGIS Explorer Online, ArcGIS Explorer Desktop, and ArcReader. These free packages provide differing methods for adding, displaying, manipulating, storing, and sharing data. The ESRI website also provides numerous free resources for GIS-related training and help. In addition to ESRI products, various open source GIS software are available online. Many statewide GIS datasets are also available in kmz format for viewing in Google Earth, a free desktop software package (see Appendix C).

Communities without GIS capability can work with county planning departments, regional planning commissions, planning consultants, or others skilled in GIS to develop maps. In addition, paper copies of several commonly used maps can be purchased and an increasing number of web-based mapping tools are now available to view and analyze natural resource data online, such as the DEC Environmental Resource Mapper (Table 1).

Online mapping tools

The rapid expansion of GIS technology has increased public access to spatial data sets, and many of the basic functionalities of GIS software are now available in user-friendly mapping tools. Exploring online mapping tools can be a useful first step for getting to know publicly available data sets that can be incorporated into custom maps for the study area during the NRI process. The interactive capabilities of online mapping tools are especially useful for evaluating overlapping resources and putting resources into context; this is a central advantage of GIS over the use of paper maps. Many web maps also provide some capability to access information associated with spatial features with the click of a mouse and include options for printing maps or exporting the map to a digital file. Some advanced tools allow more complex analysis of GIS data or the creation of reports associated with the features in view. Table 1 provides a list of useful online mapping tools relevant to natural and cultural resources in New York State at the time of publication.

Table 1. A summary of online mapping tools for viewing natural and cultural resource data.

Online Mapping Tool	Web Site Address
NYS Digital Orthoimagery	**gis.ny.gov/index.cfm**
Orthoimagery (1994-present), digital elevation models, 10-m contour lines, DEC streams, DEC freshwater wetlands, historic photos.	
Bing Maps	**www.bing.com/maps**
Bird's eye oblique, high-resolution aerial photography taken during early spring; useful for wetland and stream identification.	
USGS TopoView	**ngmdb.usgs.gov/maps/TopoView**
Current and historic USGS topographic maps since 1880.	
NRCS Web Soil Survey	**websoilsurvey.sc.egov.usda.gov**
Orthoimagery and soil survey units. Includes soil data explorer tool to access numerous soil attributes and options for downloading soils data and reports.	
USGS Hydrography Viewer	**viewer.nationalmap.gov/viewer**
USGS topographic maps, elevation data, watershed boundaries, NHD streams and waterbodies, USGS stream flow and tide stations, FEMA flood hazards zones, NWI wetlands, protected areas, National Land Cover Database (1992-present).	
USGS Stream Stats	**water.usgs.gov/osw/streamstats/new_york.html**
Tool for mapping and analyzing local watersheds and calculating streamflow statistics.	
DEC Environmental Resource Mapper	**www.dec.ny.gov/animals/38801.html**
DEC waterbody classifications, DEC freshwater wetlands, generalized locations for rare plants and animals, significant natural communities, unique geological features. The mapper does not show all natural resources which are regulated by DEC, and for which permits from DEC are required.	
SEQR Environmental Assessment Form Mapper	**www.dec.ny.gov/eafmapper**
Tool to partially complete EAFs using place-based information included in the DEC Environmental Resource Mapper.	
NWI Wetlands Mapper	**www.fws.gov/wetlands/Data/Mapper.html**
Orthoimagery and National Wetlands Inventory wetlands and attribute data.	
New York Nature Explorer	**www.dec.ny.gov/animals/57844.html**
Generalized locations for rare plants and animals, locations of significant natural communities. County-level lists of species from the *NYS Breeding Bird Atlas* (2000-2005) and the *NYS Amphibian and Reptile Atlas* (1990-1999), and threatened and endangered plant and animals species. Municipal-level lists of rare plants, animals, and significant natural communities are available, excluding sensitive species, with protection status and conservation rank.	
Scenic Hudson Sea Level Rise Mapper	**www.scenichudson.org/slr/mapper**
Tool to visualize future scenarios of sea level rise on the tidal Hudson River and changes in flood hazard zones. Includes projections of households and people at risk from future inundation or flooding.	
NYSHPO GIS Public Access	**cris.parks.ny.gov/**
State and National Registers of Historic Places, state parks, generalized areas of archeological sensitivity.	
Landscope Hudson River Valley	**www.landscope.org/new-york/featured_places/hudson_river_valley**
Scenic Byways, Scenic Areas of Statewide Significance, Hudson River Valley Greenway trails, firetowers.	
NOAA C-CAP Land Cover Atlas	**coast.noaa.gov/digitalcoast/tools/lca**
Regional land cover and land cover change information and tool that summarizes general change trends (such as forest loss or new development).	
County web maps	**various**
Usually include tax parcels, orthoimagery, and regulatory features. May also include local natural resource data and cultural resources, e.g. recreation sites.	

Where can you obtain GIS data, maps, and assistance?

New York State's GIS Data Sharing Cooperative, known as the NYS GIS Clearinghouse, offers a large online statewide database including many of the data layers required for a natural resources inventory. GIS users can browse the list of data sets or search for specific keywords to find available data. The NYS GIS Clearinghouse provides certain federal GIS resources, as well, including downloadable data from the US Census Bureau and the US Geological Survey. Cornell University Geospatial Information Repository (CUGIR) is an additional source of GIS data for New York State with an emphasis on features relevant to agriculture, ecology, natural resources, and human-environment interactions. Data are also available from federal agency websites, the DEC Hudson River Estuary Program, county planning departments, regional planning commissions, and nonprofit organizations. Appendix C provides a listing of relevant GIS data layers and aerial photography and links to online data sources at the time of publication. In addition to current data sets, older topographic maps and historical aerial photographs are often available digitally and can be valuable to assess the effects of land-use change over time.

Some municipalities have developed in-house GIS capacity, but many have not. Communities lacking GIS technical capacity have several options for obtaining mapping assistance:

Many county planning departments and regional planning commissions have experienced staff who can help combine natural resource data layers on maps in an easy to read format. There may be a fee to generate these maps. Even if the work group decides to seek mapping assistance elsewhere, county staff and planning commissions can provide valuable guidance on local data sources and mapping considerations.

DEC Hudson River Estuary Program staff develop natural resources summary reports upon request that include townwide maps for a wide range of habitats and water resources. This service is free of cost and intended to support local Hudson Valley planning efforts including NRIs, comprehensive plans, open space plans, watershed plans, and others.

Private organizations including engineering, planning, and environmental consulting firms offer GIS services. Some communities hire a consultant to produce maps and narrative for an inventory project, or a combination of both.

Some nonprofit organizations also offer consulting services, or have funding that enables them to assist communities free of charge.

GIS workshop. © L. Heady

University students learning GIS skills may be able to help develop maps and assist with other aspects of the inventory as part of a class project or internship. Contact nearby geography, planning, or environmental studies programs to explore this possibility.

Before you request GIS maps, it is helpful to have some idea of the combinations of data layers that will appear on each map. Chapter 4 suggests some combinations of data layers and Appendix I gives examples of GIS maps from a municipal NRI. Maps should be tailored according to the nature and extent of of local resources and the goals of the inventory.

In communities with access to GIS software, the NRI work group may consider appointing one or more members to learn GIS skills. Without proper training in GIS and map-making, it is easy to misrepresent geographic information. Introductory GIS courses are often available through community and local colleges and a growing number of educational institutions offer online GIS courses. Low cost introductory trainings are occasionally offered through Cornell Cooperative Extension and many free training opportunities and resources are available on the ESRI website. In addition, the NYS GIS Clearinghouse offers a GIS Help Desk where users can submit questions regarding software issues, data layer specifics, and many other topics. The Help Desk Archive is a useful resource for answers to a broad range of questions. The NYS GIS Clearinghouse website also provides links to GIS education and training opportunities and various regional and statewide GIS email lists that provide current information on GIS opportunities.

Limitations of GIS Data

Much of the publicly available GIS data comes from different sources, produced at different times, at different scales, and for different purposes. It is often collected or developed from remote sensing data (i.e., aerial photographs, satellite imagery) or derived from paper maps. For these reasons, GIS data can contain both inaccuracies that were present in the original data, as well as any errors from converting it from other sources. Therefore, maps created in GIS are approximate and best used for planning purposes. They should not be substituted for site-specific surveys. For legal purposes, such as environmental review, features of concern on NRI maps should be verified.

What map scale should be used?

Since most commonly used GIS data sets for natural resources are produced at a scale of 1:24,000 (1" = 2,000'), it is recommended that this scale be used to generate NRI maps. The 1:24,000 scale is also compatible with several other published maps such as the US Geological Survey topographic maps and the National Wetlands Inventory maps. Remember that GIS data are only as accurate as the scale of the original mapping. Displaying maps at a larger scale than the original source data (i.e., zoomed in) implies a level of accuracy that can't be supported by the data, and can lead to misinterpretation. Recognizing this limitation, small-scale maps can nevertheless help to raise questions about resources present on a particular site that can be verified through site visits and expert surveys.

Map Scale

Map scale is the relationship of map measurement to actual ground distance and can be expressed as:

Ratio: Scale is commonly presented on a map as a ratio, e.g., 1:24,000. This means that one unit (e.g., inches) on the map is equivalent to 24,000 units (inches) on the ground, or 1 map inch equals 2,000 feet on the ground (24,000" divided by 12 [to convert inches to feet] = 2000').

Bar scale: A bar scale shows map scale graphically, usually expressed in miles.

Maps are generally referred to as small, intermediate, or large scale based on the ratio of units. Small scale maps are in the range 1:100,000 or smaller and usually show a large geographic area such as a state.
Intermediate scale maps range between 1:10,000 and 1:100,000. Maps in this range provide the accuracy and detail necessary for natural resource inventories. Large scale maps (more than 1:10,000) are used in specific applications, such as site surveys, where the additional detail and accuracy justify the higher expense.

What do you do if the information you need isn't available digitally?

Communities may wish to include more specific information about local resources, which may not be available in GIS format, or may require new data collection, such as a biodiversity assessment or the inventory of local scenic and recreational resources. In addition, certain public datasets in the NYS GIS Clearinghouse system lack statewide coverage. Several options are available to make information compatible with GIS maps:

Digitizing new data: Spatial features can be digitally traced, or digitized, to create a new GIS data layer for the study area. Digitizing is labor-intensive manual work, and can be costly. However, it can be well worth the effort to get valuable information into GIS. Once in the system, the data can be easily accessed and modified for future updates. Note that digitized data layers are only as accurate as the source data.

Using a Global Positioning System (GPS) instrument: GPS instruments can be used to record the location of newly documented natural resource information. This may be a lower cost option than digitizing, and can have a higher level of accuracy, but it requires field work and a trained GPS operator.

Creating manual overlays: This is the least expensive option for including information not currently in GIS. There are two ways to create manual overlays:

a. Print an outline of the municipal boundary or study area on architectural tracing paper or mylar. These transparent materials can be overlaid with the NRI maps, and new or updated natural resource information can be manually drawn on them. Overlays can also be used to temporarily update existing paper maps between periodic updates of the NRI and GIS database.

b. New or updated information can be added directly to paper copies of the existing maps. Ensure that the information is entered as accurately as possible. These data can subsequently be digitized.

Consult county planning department staff, regional planning commissions, or other GIS experts for mapping guidance prior to developing new GIS data.

How recent are the GIS data?

Some data layers used in an NRI don't change much over time (e.g., topography, soils, aquifers, watersheds, etc.). Others, such as roads, tax parcels, habitats, land use, conservation lands, and rare species information need periodic updating. Check the creation date for each data layer being used and be aware of the limitations of using data that are several years old. Find out how frequently the GIS data sets are updated and when future updates are scheduled, and create a plan for periodic update of the NRI. All data sources should be listed (with dates) on inventory maps and documented in the NRI report. Sample maps in Appendix I show documentation for the data layers.

CHAPTER: 4

What to Include in the NRI

A natural resources inventory includes maps and an accompanying report with narrative descriptions, supporting data tables, and recommendations. In general, NRIs focus on natural resources and can include land uses and cultural resources as well. Ultimately, the scope of the inventory is up to the community and may be influenced by project goals and objectives, emerging priorities, staff or volunteer capacity, availability of data, and budget. Examples of NRI maps are provided in Appendix I, and a wide range of inventory projects are described in Appendix J.

A basic NRI can be completed using general but widely available information about natural and cultural resources and land use. Statewide data sets for natural resources are now easily obtained in GIS format. Some communities may wish to include more specific information about local resources, which may be available from county agencies and other organizations, or may require new data collection. Depending on particular community interests or concerns, detailed inventory studies may be warranted to supplement the existing data and enhance the NRI.

A basic NRI can be completed using general but widely available information about natural and cultural resources and land use. Depending on the needs and goals of the NRI project, additional detailed inventory studies can enhance the depth and value of the NRI.

The first stage in an NRI is to collect and map readily available data to provide a basis for describing and assessing the current status of known natural resources in the study area. Most of the data used in a basic NRI can be acquired from county, state, and federal agencies and other public information sources. This process will help the work group to refine its focus and determine whether additional data are needed to make the inventory more meaningful and valuable in the context of the study's goals and objectives.

Pickerel frog. © L. Heady

© I. Haeckel

Table 2 contains a list of suggested components and recommended data for a basic NRI, including cultural resources and land use. Each of the suggested NRI components and data sources are discussed in more detail starting on page 16. For communities that have already started work on an NRI, or are updating an existing NRI, the data recommendations can be reviewed and gaps identified. Similarly, the need for detailed inventory studies can be evaluated. Information from existing plans in the community can often be easily incorporated into an NRI. For example, municipal comprehensive plans and local watershed management plans, if available, may have relevant information. Environmental impact statements (EISs) from proposed developments in a community are kept on file by the planning board and may be an additional source of local natural resources data.

Where existing data falls short of the community's specific needs and goals for their NRI, the work group may decide to undertake detailed inventory studies either from the outset of the project or in follow-up studies after completion of the basic NRI. Detailed inventory studies collect additional information for particular inventory components to provide greater depth of knowledge and support the primary goals of the NRI. This may involve incorporating information from existing local studies, initiating new studies, analyzing existing GIS-based data, and/or collecting and analyzing new data. The results of the detailed inventory studies should be added to the series of basic NRI maps and incorporated into the narrative report.

Examples of the kinds of detailed inventory studies that can be added to an NRI are suggested for many of the basic components described below. The suggestions aren't exhaustive, but rather give some of the more common studies that can be added to an NRI. Other studies or data sources may be of interest, depending on the community's goals.

Inventory Format

Maps

Inventory maps show the location and extent (as known) of existing resources. Displaying groups of related resources in composite overlay maps helps to visualize the relationship of resources with land use, which can help to inform local planning. NRI components may also be presented in stand-alone maps where appropriate, such as soils. Carefully consider map layouts and avoid crowding maps with too much information. This guide recommends mapping options in some places, but recognizes that a one-size-fits-all approach is unlikely to accommodate the wide variety of conditions and features that occur across the region.

All inventory maps should include a map window or *frame* that accommodates the study area and its surroundings, preferably extending at least one mile into neighboring municipalities. It is especially valuable to bring attention to particularly large natural areas spanning municipal boundaries, since larger areas often have greater ecological value than smaller, fragmented areas. Taking a broad view will help show the extent of resources that span municipal boundaries, and can also help identify opportunities for intermunicipal cooperation. County planning departments, regional planning commissions, Hudson River Estuary Program staff, consultants, and other groups with GIS capabilities can provide guidance with compiling inventory maps. Appendix I provides some examples of inventory maps.

Inventory report

A written report is an important element of the NRI. It should identify members of the work group and describe the project's goals and methods, include descriptive summaries of each resource inventoried, and summarize findings and recommendations. It is valuable for the report to interpret the results of the inventory, describe how the inventory can be used, and recommend a strategy for regular review and updating of the NRI. Depending on project goals, the report may suggest conservation recommendations that will require action by the community (see examples in Chapter 6). The NRI report provides a record to familiarize local officials and the public with the inventory work, can serve as a reference for decision-making, and can help set the stage for identifying conservation priorities and achieving planning and conservation goals.

At a minimum, the report should include a descriptive summary of each map. The narrative should describe each of the resources shown, discuss relevant aspects of resource distribution throughout the study area, draw attention to significant areas of resource concentration or concern, and discuss any major or emerging threats to the resource. It is valuable to frame conservation recommendations within this context, if the inventory provides them.

Documenting data sources

The descriptive summary of each resource should document the data sources used, including both GIS data layers and non-GIS studies. It is also important to list all data sources (including publication dates) on the maps produced for the inventory. If new GIS data are created for the inventory, associated metadata should be developed to describe the methods and standards used. Data tables or graphs documenting additional attributes about a particular resource can be useful to include in the inventory report. By creating a detailed record of data sources, documentation eases the task of future updates.

Table 2: Suggested Inventory Components and Recommended Data: The following list primarily includes widely-available national and New York State data sets. Additional regional data sets may exist and in many cases, county agencies like planning departments have more localized data and should be consulted at the start of the inventory project. In all cases, local data should be included where available and appropriate.

Inventory Component	Recommended Data to Include	Page
Base Map	• Municipal boundaries, transportation and utility networks, topography, aerial imagery, regional watershed boundaries, streams and waterbodies, landmarks	16
Geology and Soils		
Bedrock and Surficial Geology	• Bedrock and surficial geology features and table with geologic unit attributes	16
Soils	• Soil survey units and table with attributes	18
Slopes	• Percent slope calculated from a digital elevation model	19
Water Resources		
Groundwater and Aquifers	• Unconsolidated aquifers	19
Watersheds	• National Hydrography Dataset 10-digit HUC or other regional watershed boundaries • 12-digit HUC subwatershed boundaries • Smaller watersheds of interest to the NRI effort	21
Streams and Waterbodies	• National Hydrography Dataset streams and waterbodies	22
Floodplains	• FEMA floodway and 100-year and 500-year floodplains	23
Wetlands	• National Wetlands Inventory data • DEC Freshwater Wetlands data • Hydric soils from county soil survey	24
Water Quality: Assessment and Standards	• DEC Water Quality Classifications • DEC Waterbody Inventory/Priority Waterbodies List • Water quality monitoring data	26
Water Quality: Potential and Known Contamination Sites	• SPDES permit sites • Hazardous waste sites	28
Habitats and Wildlife		
Significant Biodiversity Areas	• Hudson Valley Significant Biodiversity Areas	28
Hudson River Coastal and Shoreline Habitat	• Documented submerged aquatic vegetation • Tidal wetlands • Significant Coastal Fish and Wildlife Habitats • Hudson River shoreline habitat type • Significant natural communities	29
Stream and Riparian Habitat	• See Streams and Waterbodies section, above • Significant natural communities • Migratory fish runs • DEC trout and trout spawning streams • Known aquatic barriers to resident and migratory fish movement (e.g., dams, culverts)	30
Wetland Habitat	• See Wetlands section, above • Significant natural communities	32
Forests	• Large forest patches • Matrix forests and linkage zones • Significant natural communities	33
Grasslands and Shrublands	• *NYS Breeding Bird Atlas and NYS Amphibian and Reptile Atlas* data • Significant natural communities	34
Rare Plant and Animal Species and Significant Natural Communities	• Rare plant and animal species and significant natural communities • Areas of known importance for rare species and significant ecosystems • *NYS Breeding Bird Atlas and NYS Amphibian and Reptile Atlas* data	36
Unfragmented Habitat Blocks	• There are currently no region-wide publicly available data sets. See Chapter 4 for existing methodologies.	39
Climate		
Climate Conditions and Projections	• Scenic Hudson's sea level rise projections for the Hudson River estuary • Table with current average climate conditions and projections of future climate conditions	40
Cultural Resources		
Historic Resources	• National Register and NYS historic districts and individually-designated historic sites • National Heritage Corridor/Area and NYS Heritage Areas	41
Scenic Resources	• Scenic Areas of Statewide Significance • Scenic byways	43
Recreation Resources	• Outdoor recreation destinations and amenities • Public trails and fishing sites • Conservation and public lands	44
Land Use		
Zoning and Tax Maps	• Municipal zoning and tax maps • Real property tax records	45
Land Use and Land Cover	• National Land Cover or Coastal Change Analysis Program (C-CAP) data set	46
Farmland	• Prime farmland soils and farm soils of statewide importance • Agricultural districts	47
Conservation and Public Lands	• Conserved or publicly owned lands under federal, state, county, town, or private ownership • Conservation easements	49

Inventory Components

Base Map

Background

A base map depicts background reference information such as roads, landmarks, political boundaries, and landforms, onto which other thematic information is displayed. The base map should be prepared, reviewed, and finalized before proceeding with other NRI maps. With the exception of topography (which may not appear on all maps) the base map data can serve as the basis for other inventory map layouts. Aerial photography can be especially useful to orient map users to the study area and may warrant inclusion in a second base map.

What to include

Municipal boundaries. Neighboring municipalities can be identified for easier map interpretation.

Study area boundary. The study area boundary may include the entire community, a portion of the community (e.g., a local watershed), or several communities (e.g., a regional watershed). It should include at least a one-mile extension beyond the study area to show the resources that extend beyond study area boundaries, or an area sufficiently large to show ecologically significant intermunicipal features.

Transportation networks (roads, railroads, and trails). Key road names can be added to the NRI map.

Utility networks (electric transmission and gas lines).

Regional watershed boundaries.

Surface water features (lakes, ponds, rivers, and streams).

Topography. Topography may be displayed with contour lines, a shaded digital elevation model, or a topographic quadrangle image. It isn't necessary to use the topographic base on all subsequent maps. It can clutter a map that already has several other data layers, making interpretation difficult.

Aerial photography. High resolution (6 inches to 1 foot) orthoimagery is now widely available for many areas of New York State.

Major landmarks (e.g., hamlets, named summits).

Note: With the exception of local landmarks, all of the GIS data above are available statewide through the NYS GIS Clearinghouse.

Where to find help

See Appendix A for organization contact information, Appendix C for sources of GIS data, and Appendix D for more information about available topographic maps and aerial photography.

County planning department or regional planning commission
Mapping assistance

Hudson Valley clay was historically used for brick-making. © L. Heady

Aerial photography

Aerial photography taken in spring before trees leaf out can be used to identify ephemeral streams and small wetlands. Color-infrared imagery can be used to define types of land cover and land use. Oblique imagery from Google Earth and Bing Maps are especially useful for desktop analysis and offer the ability to rotate the image.

GEOLOGY AND SOILS

Bedrock and Surficial Geology

Background

The geology of the Hudson Valley is diverse and has helped to shape the character of its natural communities as well as its human communities; for example, cement industries line the Hudson River as a result of the area's large supply of limestone and gypsum. Geological characteristics have an effect on many factors, such as topography, groundwater resources, migration of pollutants, and mineral resources. The properties of bedrock geology and surficial geology (loose deposits above bedrock) also strongly influence soil properties, as well as groundwater and surface water chemistry, which in turn influence the type of ecological communities that can thrive. For example, alkaline environments and the calcium rich or *calcareous* condition that is often associated with limestone bedrock often support more unique or rare plants and biodiversity than other areas (Anderson and Ferree 2010, Kiviat and Stevens 2001). Significant geological features can also be important economically, by providing destinations for outdoor recreation such as hiking or scenic assets that attract tourists, or opportunity for mining operations.

Knowledge of geological properties is important for making sound planning decisions. For example, if bedrock is close to the surface, foundation and road construction is more expensive and may cause other environmental problems such as erosion. Information about geology is also used for identifying sand and gravel aquifers and sources of sand, gravel, and crushed stone for building and road construction.

What to include

Surficial and bedrock geology data for New York State are available in GIS format and print maps from the New York State Museum (NYSM). The maps are highly generalized (at a scale of 1:250,000) and cannot be relied on to describe the precise geology at any particular area on the ground. The maps are still very useful, however, for describing the general geological character of an area. The map is divided into five sheets; the Lower Hudson and Hudson-Mohawk sheets cover the Hudson Valley region. Corresponding tables and narrative text in the NRI can include bedrock types and characteristics of interest. For example, calcareous bedrock that may be associated with uncommon natural communities can be determined from the NYSM bedrock geology map along with Appendix 6 of the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001), which includes information to help determine the calcareous or acidic nature of mapped bedrock in the Hudson Valley region.

Detailed inventory studies

Geological features of interest can be added to maps of surficial and bedrock geology types. New York State Department of Environmental Conservation's (DEC) Division of Mineral Resources maintains a data management system on mines regulated under the Mined Land Reclamation Law of 1975. Locations of mines and quarries that are not regulated by DEC can be identified from the county soil survey, United States Geological Survey (USGS) topographical maps, and local knowledge. In addition to mapping active or abandoned mines, the work group may want to identify the community's mineral commodities, such as sand and gravel. Some sand and gravel deposits are also important for groundwater recharge (see Groundwater and Aquifers section). Combining data on mineral resources with soils, hydrology, and land-use information collected as part of the NRI will help inform community-based decisions concerning use of these geological resources.

Detailed geology studies have been completed for many places in New York. Check with USGS, New York State Geological Survey, county soil and water conservation district, and local academic institutions to see what is available for the study area. The USGS publication, *Geological and Water Supply Reports and Maps: New York*, contains a list of maps and reports relating to geology and mineral and water resources, completed before 1976. Other sources of information include municipal records and knowledgeable members of the community.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

New York State Museum and *NYS Geological Survey*
Bedrock and surficial geology maps and GIS data

DEC Division of Mineral Resources
New York State Mined Land Reclamation Database

United States Geological Survey
Geology reports for New York

County soil and water conservation district
County soil survey maps

The remains of 19th century bluestone quarries are common in the Catskills. © I. Haeckel

Soils

Background

To understand the natural processes of the land, and to plan land use accordingly, there is no more fundamental place to start than soil. Soil controls decomposition of organic matter and biogeochemical cycles; regulates water flow; influences the vegetation, habitat type, and agricultural potential of particular locations; and supports human habitation and structures (Randolph 2003). Soil acts as a natural filter to help protect the quality of water and air, regulates rates of aquifer recharge versus runoff, and supports food production and growth of forests and biological communities that society depends on.

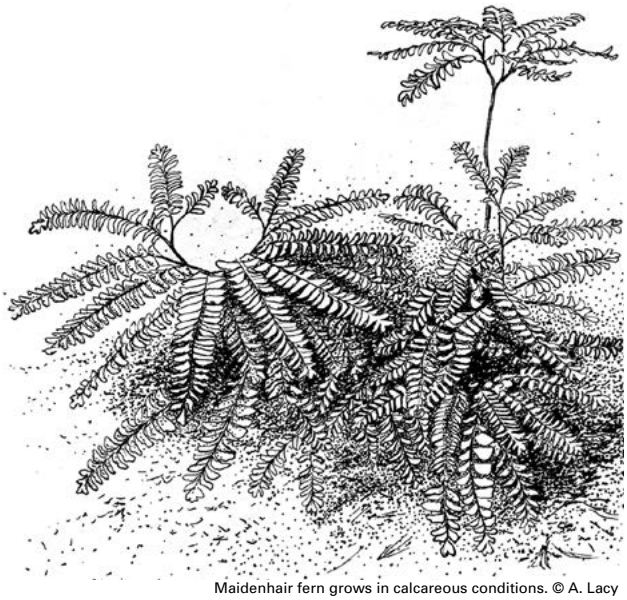
Soil information is critical for land-use planning as it helps to determine where it is appropriate or feasible to build. Each soil type has a certain set of characteristics defined by (but not limited to) properties such as permeability, drainage, available water capacity, pH, depth to bedrock, and risk of corrosion. Consideration of soil properties is important for planning and designing drainage systems; siting of structures; evaluating the potential for septic systems; assessing the need for specially-designed foundations, basements, and roads; determining the feasibility of excavation; and so forth.

Soil properties are important for identifying ecological resources, as well (see Heady and Stevens 2011). Drainage classes provide information on wetlands; *poorly* and *very poorly drained soils* are hydric soils that can be used as wetland indicators and *somewhat poorly drained soils* are indicators of possible wetland locations. Similarly, *muck* or *peat soils* are considered wetland soils. As with bedrock geology, the chemistry of soil influences the kinds of ecological communities that occur in a given place. Calcareous soils are often associated with uncommon habitats and rare species.

Agriculture and forestry practices are also informed by soil data. Soils influence what crops are best to grow, whether irrigation or drainage is needed and how to design irrigation systems, and whether soil amendments are necessary. Soil properties can inform which farms are most valuable for preservation. (See Farmland section.)

What to include

Soil Survey maps and a companion report are available for every county in New York State from the Natural Resources Conservation Service (NRCS). The surveys categorize soil data into series, types, and phases. Soil series delineate soils originating from the same parent materials and having relatively uniform structural engineering properties except for texture. Soil series are the main unit of a county's detailed soil survey. Within a series, differing soils are broken down into soil phase categories according to slope and other properties. The polygons or map units displayed on the soil maps are differentiated at the phase level. Traditional hard copy



Maidenhair fern grows in calcareous conditions. © A. Lacy

soil survey maps are available from county soil and water conservation districts and digital copies of soil survey reports can be downloaded from the NRCS website. The NRCS online Web Soil Survey also allows users to access and download digital soil survey data from the Soil Survey Geographic Database (SSURGO). SSURGO files may also be downloaded for GIS use from the NRCS Geospatial Data Gateway. It is useful to include a map in the NRI displaying soil phases, which can be color-coded to display a particular property of interest to the community, such as depth to bedrock.

The study area's prominent soils and their key characteristics can be described in the inventory report to interpret the soil maps. A table can be used to list soils by their series, phase, and map unit, along with properties that are of particular interest to the community; these could include parent material, drainage classes, depth to high water table, percolation rate, texture, erosion potential, hydrologic soil group, reaction (e.g., calcareous), and depth to bedrock. Consult with the planning board or engineer to determine what would be most useful. Appendix 6 in Kiviat and Stevens (2001) summarizes the soil properties, including drainage class, reaction, and depth to bedrock, which are most useful for identifying places that may be ecologically important in the Hudson River estuary corridor. For an overview of how soils information is used in Biodiversity Assessment, see Appendix E.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data. See Appendix D for more information about available soil maps.

Natural Resources Conservation Service
Soil Survey Geographic Database (SSURGO), Web Soil Survey application, digital soil survey reports

County soil and water conservation district
County soil survey maps

Slopes

Background

Steep topographical features can bring special character to a community, often providing scenic vistas, hiking opportunities, and natural beauty. Steep slopes are environmentally sensitive, however, and require special attention during land-use planning because they are vulnerable to soil erosion, excessive stormwater runoff, and slope instability. Disturbance of steep slopes can introduce sediment and impact the quality of adjacent water resources.

What to include

A slopes map can display steepness in the study area by percent slope class, based on a digital elevation model (DEM). DEMs with 10-meter spacing are available for most of New York through a partnership between USGS and DEC. These DEMs were produced using contour lines compiled for USGS 7.5-minute quadrangle maps, and are hosted by Cornell University Geospatial Information Repository (CUGIR). More recently, higher-resolution DEMS have been created using LIDAR (light detection and ranging) data in some parts of New York State. Check the NYS GIS Clearinghouse to find the finest-scale data available for the study area. Note that creating a map of slopes using a DEM entails an analysis that may require the assistance of a consultant or GIS professional. General data and narrative about slope can also be obtained from county soil surveys. To help with interpretation of the slopes map in the NRI, describe the significant topographical features and steepness characteristics of the study area in the report.

Where to find help

See Appendix A for organization contact information and Appendix C for sources of GIS data.

Cornell University Geographic Information Repository
Digital elevation models for New York State

New York State Orthos Online interactive mapping tool
High-resolution digital elevation models for selected areas of New York State

Forested slopes and streambanks are less vulnerable to erosion. © I. Haeckel

WATER RESOURCES

Groundwater and Aquifers

Background

At least one-quarter of New Yorkers depend on groundwater supplies for drinking water, and many Hudson Valley communities depend entirely on groundwater. Groundwater also supports habitats and species, and is particularly important during dry periods when it is often the dominant source of water flowing in streams and rivers. Groundwater is found between grains of sand, gravel, silt, or clay *(unconsolidated sediments)* or in the cracks and fractures of bedrock (*consolidated sediments*). The saturated geologic zones in sediments and bedrock that receive, store, and transmit significant amounts of water to wells and springs are called *aquifers*. The upper surface of the saturated zone is called the *water table*. Groundwater is recharged when rain and melting snow slowly infiltrate through the soil. The land surface principally contributing to aquifer recharge is called the *aquifer recharge area*. This is generally all watershed land areas aside from streams and their riparian margins, which are *aquifer discharge areas*.

An assumption is often made that groundwater is less vulnerable to spills and pathogens than surface water and less likely to be contaminated. In reality, aquifers can become polluted by a variety of mechanisms, including chemical spills, leaking buried sources such as landfills or underground storage tanks, road salt, common household use of herbicides and other chemicals, and improperly spaced or poorly installed septic systems. *A wellhead protection area*, usually a subset of the larger aquifer recharge area, is the area surrounding and upgradient of a public water supply well or well field of interest. Wellhead protection programs seek to limit contaminants in such areas to limit water quality risks to well water.

Regional aquifer depletion is rare in New York, but local groundwater overuse occurs when water withdrawal exceeds local recharge and can result in nearby wells running

dry along with impacts to waterbodies and habitats that depend on groundwater for base flow. Excessive extraction can harm fish and other aquatic organisms by changing the stream flows and water temperatures they rely on for survival and successful reproduction. Buildings, parking lots, and roads can interfere with groundwater recharge if adjacent areas do not allow compensatory recharge and may reduce recharge volumes considerably, exacerbating the effects of overconsumption.

Golden saxifrage grows in groundwater seepages and springs. © L. Heady

What to include

The location and extent of aquifers should be mapped, as well as a visual representation of areas covered through local aquifer protection ordinances, if any. Unconsolidated aquifers in New York State, consisting typically of valley-fill glacial outwash deposits, were coarsely mapped at a scale of 1:250,000 by USGS in partnership with DEC and are available on the NYS GIS Clearinghouse. Most other lands overlie bedrock formations sufficiently fractured to support modest water uses (domestic wells and occasional high-capacity wells) and should be recognized in NRI assessments as bedrock aquifers. Detailed maps of specific wellhead protection areas may be available from county agencies or from a municipal or private water supplier.

Detailed inventory studies

Additional groundwater information may be obtained from well reports, published groundwater studies, unpublished consultant reports, well constructors, source water assessment reports, county soil surveys, and county health departments. Examples of information that can be gleaned from these existing sources include:

- consolidated (bedrock) and unconsolidated (sand and gravel) aquifer locations and yield
- aquifer discharge areas, typically consisting of all perennial streams and non-isolated ponds/lakes and their associated riparian wetlands, as well as all other non-isolated wetlands; all other areas should be considered as recharge areas
- any wellhead protection areas of interest

Local groundwater overuse occurs when water withdrawal exceeds local recharge and can result in nearby wells running dry along with impacts to waterbodies and habitats that depend on groundwater for base flow.

- "groundwater watersheds" that illustrate the direction that groundwater is moving, from high points to low points, and where it converges or diverges
- specific mapping related to any confined aquifers
- aquifer recharge rates (The Dutchess County aquifer recharge rate study is a useful reference for the Hudson Valley region; see Chazen 2006.)
- well locations and yields
- groundwater quality data
- depth to groundwater, water table, artesian (naturally flowing at grade) groundwater supplies
- geologic sensitivity to pollution.

A comprehensive groundwater resources study can help communities to interpret and understand their groundwater resources. By analyzing the existing groundwater information and providing any additional necessary documentation, the comprehensive study can identify areas where groundwater protection is appropriate, look for potential conflicts between land use and groundwater resources, address wellhead or groundwater protection plans, and assess wastewater treatment systems. Comprehensive groundwater studies require professional expertise and are typically prepared by consultants. The New York Rural Water Association is a nonprofit organization that has experience preparing wellhead protection plans and has completed groundwater assessments as well.

Groundwater assessments and reports may be available from the DEC's Ambient Groundwater Monitoring Program, which seeks to document the quality of New York State's groundwater, identify long-term groundwater quality trends, characterize naturally occurring conditions, and establish an initial statewide comprehensive groundwater quality baseline.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Division of Water
Unconsolidated aquifers, Ambient Groundwater Monitoring Program reports and data

NYS Department of Health Source Water Assessment Program
Source water assessments, maps

County health department
Water assessments

County planning department or regional planning commission
Well locations and yields, maps

Local water supplier
Well locations and yields

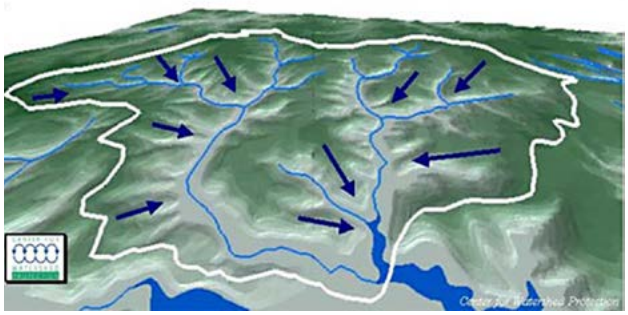
New York Rural Water Association
Local source water assessments, aquifer locations, ground water quality, maps

Watersheds

Background

A *watershed* is the area of land from which water drains into a stream, river, lake, or other waterbody. Watersheds are divided by high points on the land, such as ridges, mountains, and hills and may be made up of many smaller drainage areas, or *subwatersheds*. A subwatershed that drains a small creek can be encompassed by a single parcel. At the regional scale, watersheds are more complex. For example, the Wappinger Creek watershed in Dutchess County spans thirteen towns and includes a number of tributaries, each with its own subwatershed. Similarly, the Wappinger Creek watershed itself is a subwatershed of the larger Hudson River watershed, which drains about 13,500 square miles of land into the Atlantic Ocean at New York Harbor. Healthy watersheds, including both land and water resources, can recharge groundwater, reduce erosion and flooding impacts, minimize public infrastructure and water treatment costs, and be more resilient to climate change. All of these benefits contribute to the health and safety of human communities.

A watershed is the area of land that drains into a stream, river, lake, or other waterbody.



© Center for Watershed Protection

Watersheds provide logical units to study and manage water resources because issues such as water quality and water quantity commonly extend beyond both property and political boundaries. Mapped watershed boundaries also provide a quick visual reference of how surface waters relate to each other and other features, such as adjacent steep slopes or floodplains. The particular land-use questions under consideration will determine the appropriate watershed scale to evaluate. An NRI can be conducted on a watershed scale involving several towns within a single watershed, or a municipality can choose to focus inventory efforts on local subwatersheds occurring within and adjacent to its borders. This approach may help focus an inventory on a priority area and be more easily accomplished.

Watersheds provide logical units to study and manage water resources because issues such as water quality and water quantity commonly extend beyond both property and political boundaries.

© L. Heady

What to include

Regional watersheds and subwatersheds should be mapped at a regional scale showing the study area's context, and the narrative can make reference to any ongoing watershed management efforts or groups, such as local watershed associations or intermunicipal agreements. A regional map can include other major features such as significant biodiversity areas and major forest blocks and linkage zones, described later in this guide. Standard watershed boundaries for the entire US have been created through the USGS National Hydrography Dataset in a nested hierarchy by size. Each watershed is assigned a Hydrologic Unit Code (HUC). Size 10-digit HUC watershed boundaries correspond approximately to the regional-scale tributary watershed boundaries of the Hudson River. Size 12-digit HUC subwatershed boundaries encompass about 60 square miles each and are the finest-scale USGS data available for New York State. 12-digit HUC data can be the most useful watershed units for municipalities because they often fall within jurisdictional boundaries and match the scale of potential local impacts, thus making it easier for towns to address issues. The National Hydrography Dataset can be viewed online using the USGS Hydrography Viewer and GIS data can be obtained from the USGS website. In the Hudson Valley, the Hudson River Watershed Alliance's *Watershed Atlas* provides online maps of major and subwatershed boundaries and surface water resources.

Finer-scale subwatershed boundaries can be mapped with the USGS StreamStats Program or GIS. Note that some local watersheds may have already been delineated and digitized by watershed associations or county agencies.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

United States Geological Survey
HUC watershed delineations, StreamStats tool for local watershed delineation

DEC Hudson River Estuary Program
Technical and mapping assistance

Hudson River Watershed Alliance
Watershed Atlas maps, information on local watershed groups, watershed plans, and intermunicipal agreements

Local watershed association
Maps, watershed assessments and plans

County agencies (such as planning department, soil & water conservation district, or Cornell Cooperative Extension)
Maps, watershed plans

Streams and Waterbodies

Background

Streams, reservoirs, lakes, and ponds and their adjacent riparian (streamside) habitats provide critical benefits to communities, including clean water, flood management, and recreational opportunities like fishing and kayaking. The health of the Hudson River estuary is closely linked to the health of its tributaries and their watersheds.

There are various classification systems for surface water systems based on a range of physical conditions, habitat values, and human uses, including hydrology, flow, average depth, surface area, temperature, habitat structure, water quality, sensitivity to pollutants, and recreational uses, among other attributes. A basic NRI may simply document known streams and waterbodies, while detailed inventory studies can research characteristics relevant to local water resource concerns and interest.

Perennial streams flow continuously throughout years with normal precipitation, but some may dry up during droughts. *Intermittent streams* only flow seasonally or after rain. They can easily be overlooked when dry, but have great impact on the water quality and quantity of larger downstream waters and warrant attention. Stream barriers, such as dams and poorly designed and installed culverts, can have serious effects on stream habitat, local flooding, and water quality. Bridges, open-bottom culverts and similar structures that completely span a waterway and associated riparian area and floodplain usually have the least impact on streams. Stream habitat values are discussed further in the Stream and Riparian Habitat section.

Poorly planned development in a watershed can dramatically increase the amount of stormwater runoff, chemicals, sediment, and other contaminants entering streams and waterbodies, threatening water quality, degrading habitat value, and increasing flood risk. Precipitation has become more variable and extreme with climate change in the Northeast, exacerbating these threats. Annual rainfall occurring in heavy downpour events increased 74% between the periods of 1950-1979 and 1980-2009, and most areas of the Hudson Valley have been impacted by serious flooding in recent years (Rosenzweig et al. 2011). Thorough documentation of streams and waterbodies in an NRI can help communities to plan for and mitigate future flood risk as precipitation trends continue. See the Floodplains section for more information on flooding considerations and Appendix F for information on precipitation projections in the Hudson Valley. See the Water Quality and Land Use sections for further discussion of watershed connections to surface water pollution, water quality assessment, and monitoring studies.

Poorly planned development in a watershed can dramatically increase the amount of stormwater runoff, chemicals, sediment, and other contaminants entering streams and waterbodies, threatening water quality, degrading habitat value, and increasing flood risk.

What to include

Streams and waterbodies can be mapped and described using the USGS National Hydrography Dataset or more detailed local data sources, where available. (Some municipal and county agencies have developed finer-scale stream maps, for example.) This information may be displayed together with watershed boundaries, which provide logical units for evaluating surface water resources (see Watersheds section). The National Hydrography Dataset can be viewed online using the USGS Hydrography Viewer and GIS data can be obtained from the USGS website. It may be helpful to combine features such as floodplains, riparian wetlands and forests, waterbodies, and subwatersheds in a single map in the NRI.

Hanging culverts prevent fish from travelling upstream. © M. Adamovic

© L. Heady

Detailed inventory studies

Intermittent streams and small waterbodies are not captured on USGS and statewide stream maps. These important resources can be identified and delineated through airphoto interpretation, map analysis, local knowledge, and site visits to create more accurate maps. See Appendix E, Biodiversity Assessment, for details.

The New York State Inventory of Dams and the USGS National Hydrography Dataset document a small fraction of dam locations. Many dams, especially small ones, are missing from these data sets. Culvert data sets do not exist on any standard, county, or statewide scale in New York. The DEC Hudson River Estuary Program is collecting information on dams and culverts in the Hudson Valley. Field surveys can fill in missing dam and culvert information.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

United States Geological Survey
National Hydrography Dataset, Hydrography Viewer

DEC Hudson River Estuary Program
Technical and mapping assistance, aquatic barrier information

Hudson River Watershed Alliance
Watershed Atlas maps

Local watershed association
Maps, watershed plans

County agencies (such as planning department or soil & water conservation district)
Maps

Floodplains

Background

Floodplains are low-lying areas adjacent to streams and other waterbodies that become inundated during heavy precipitation or snowmelt. By slowing and storing floodwaters, floodplains reduce downstream flood damage and serve as a safety zone between human settlement and the damaging impacts of floods. Naturally vegetated floodplains help prevent erosion, recharge groundwater, and can serve as travel corridors for wildlife. These highly productive ecosystems are home to a unique suite of plants and animals that tolerate occasional flooding and support the in-stream food web. When left in their natural state, they provide space for the fluctuations in flow that cause streams to expand, contract, and sometimes change course. Floodplains and other streamside areas are also where land-use change will most easily influence stream quality.

Floodplains have traditionally been delineated by the Federal Emergency Management Agency (FEMA) and the US Department of Housing and Urban Development based on flood frequency according to the extent of land expected to have a 1% or greater chance of being inundated in any given year (often referred to as the "100-year flood"). It is important to note that floodplains and their statistical flooding intervals are estimations based on the best data and technology available at the time of mapping. Due to many variables, such as the often unpredictable nature of floods, local drainage problems, and the variable intensity of land development in watersheds, some flood-prone areas may not appear on designated floodplain maps, and floodplain designations may change over time as more information becomes available.

Naturally vegetated floodplains help to slow down and store flood waters. © I. Haeckel

Jewelweed. © P. Kernan

As development occurs in a watershed, pavement and other *impervious surfaces* (e.g., roofs of buildings) increase runoff volume and velocity, leading to more frequent and damaging floods. Preserving floodplains and minimizing the extent of impervious surfaces are ever more important as uplands are developed and as the frequency and magnitude of flood events increases with climate change (see Climate section). Floodplain maps provide a starting point for proactive conservation planning.

Preserving floodplains and minimizing the extent of impervious surfaces are ever more important as uplands are developed and as the frequency and magnitude of flood events increases with climate change

What to include

The 100-year floodway and 100-year and 500-year floodplains mapped by FEMA should be mapped together with streams and waterbodies. The *floodway* is defined as the stream channel and adjoining floodplain areas that are reasonably required to carry the 100-year flood without increasing the flood surface elevation by more than a foot. It is the area where flood hazard is generally highest in the floodplain, i.e.,where water depths and velocities are the greatest. The *500-year floodplain* refers to the area that has a 0.2% chance of being inundated in any given year.

Future projected floodplains accounting for sea level rise have been calculated for communities along the Hudson and can be accessed using the online Scenic Hudson Sea Level Rise Mapper tool.

Wetlands, watershed boundaries, and infrastructure such as dams and culverts can also be useful for better understanding floodplains.

Where to find help

See Appendix A for organization contact information and Appendix C for sources of GIS data.

Federal Emergency Management Agency
Flood hazard maps

DEC Hudson River Estuary Program
Technical and mapping assistance

County agencies (such as planning department, soil and water conservation district, emergency management office)
Flood hazard maps, technical assistance

Scenic Hudson
Sea Level Rise Mapper

Wetlands

Background

Wetlands are areas saturated by surface water or groundwater sufficient to support distinctive vegetation adapted for life in saturated soil conditions. In addition to providing critical habitat for many plants and animals, wetlands provide important benefits to human communities. They help to control flooding and reduce damage from storm surge, act as filters to cleanse water of impurities, and provide recreation opportunities for many people.

Knowing about local wetlands enables municipalities to proactively plan to conserve this critical resource. Although several existing maps provide approximate locations and extent of wetlands, they are inherently inaccurate and not a substitute for site visits and on-the-ground delineation. Small wetlands in particular are often missed. Nonetheless, towns can use wetland maps as a starting point for inventorying local wetlands and supplement with more refined data as they become available. To understand how land-use decisions can impact wetlands, it's important to also consider adjacent upland areas and connected hydrologic features such as streams; the NRI maps will help illustrate the relationships between these different resources.

For discussion of wetland habitats such as vernal pools, see the Habitats and Wildlife section. For discussion of tidal wetlands, see the Hudson River Coastal and Shoreline Habitat section.

Wetlands help to control flooding and reduce damage from storm surge, act as filters to cleanse water of impurities, and provide recreation opportunities for many people.

An acre of wetland can store approximately 1-1.5 million gallons of water. © L. Heady

What to include

There are several GIS data sets that can be assembled to create a composite wetland map for the study area:

National Wetland Inventory (NWI) maps from the US Fish and Wildlife Service (USFWS) have been completed for most of the Hudson Valley region, or are available in draft form. NWI maps are created using aerial photo interpretation and some field checking, and include wetlands of all sizes with some information on habitat. They are not intended for regulatory purposes. NWI maps often underestimate wetland area and omit smaller and drier wetlands. In particular, vernal pools, wet meadows, and swamps are often under-represented on maps. NWI data are available from the USFWS website. See Appendix D for more information about NWI maps.

NYS Freshwater Wetland Maps depict mainly large wetlands (12.4 acres or larger) and a few smaller ones with special attributes. The maps were created by aerial photo interpretation and minimal field checking, and are not intended to be accurate depictions of the limits of state wetland jurisdiction on any site. Many of DEC's regulatory maps are outdated and have similar inaccuracies to the NWI maps (Huffman and Associates 2000). Digital data are available from CUGIR.

County soil survey data provide information about poorly drained and very poorly drained soils, which are commonly used indicators of probable wetlands. Somewhat poorly drained soils can be used to predict locations of possible wetlands. In general, the soils maps tend to somewhat overestimate the acreage of wetland soils, due in part to the scale of the soils mapping (the smallest mapping unit is two acres). The Soil Survey Geographic Database (SSURGO) contains digital soil data from NRCS and is available on the NRCS Geospatial Data Gateway and the NYS GIS Clearinghouse. See Soils section and Appendix D for more information on soils.

Green frog. © L. Heady

In addition, there may be county data, local studies or wetland mapping efforts, or wetland delineations from development reviews that can be added to the wetland map and narrative text. Communities may also want to include wetlands that are created, such as mitigation wetlands for road projects or large developments. County planning departments, New York State Department of Transportation, and departments of public works may have this information.

Detailed inventory studies

Wetland evaluation is the process of determining the values of a wetland based on an assessment of the functions that it performs, such as scenic quality, erosion control and sediment trapping, floodwater storage, or groundwater discharge or recharge. Evaluation of wetlands for different functions allows a municipality to tailor wetland protection for those values it views as most

important. For example, a community may wish to protect wetlands with high value for flood storage, or large wetland complexes that provide important wildlife habitat. While the help of a consultant may be necessary, there are numerous approaches to "rapid assessment" of wetland values that may be used by municipal officials and volunteers; e.g., *Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire*. Note that methods developed for other states or regions may need some adjustment to ensure relevance in New York.

Wetland Buffers. The topography, land uses, and natural areas surrounding a wetland, along with the habitat needs of resident and migrating wildlife, warrant consideration when developing a wetland conservation strategy. By showing wetland buffers (adjacent areas) on the NRI map, these features can be considered along with the functional value of each wetland, if available, and appropriate conservation buffers can be recommended for protection through a wetland law or other formal or voluntary land conservation efforts. The Environmental Law Institute's *Planner's Guide to Wetland Buffers for Local Governments* discusses a range of practices for conserving wetland buffers.

Blue vervain. © L. Heady

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data. See Appendix D for more information on soil and wetland maps.

DEC Division of Fish, Wildlife, and Marine Resources
New York State freshwater wetlands information, Environmental Resource Mapper

US Fish and Wildlife Service
National Wetlands Inventory, Wetlands Mapper

Natural Resources Conservation Service
Soil Survey Geographic Database (SSURGO), Web Soil Survey tool, digital soil survey reports

DEC Hudson River Estuary Program
Technical and mapping assistance

County soil and water conservation district
County soil survey maps

Water Quality: Standards and Assessments

Background

In addition to documenting the location of water resources, an NRI should address water quality in the community. The federal government and New York State have developed water quality standards to monitor and protect waterbodies. The Clean Water Act imposes strict standards on water quality and pollutant levels and New York State's Environmental Conservation Law outlines water quality and priority classifications and standards for waterbodies. DEC Water Quality Standards and Classifications designate the "best uses" that waterbodies should support and are the basis for programs to protect New York State waters. Freshwater stream segments and open waterbodies are classified by the letters AA, A, B, C, or D, which is the lowest classification. Additional designations of "T" or "TS" can be added to Class A, B, or C streams if a waterbody has sufficient amounts of dissolved oxygen to support trout (T) and/or trout spawning (TS). Waterbodies that are designated as "C (T)" or higher (e.g., "C (TS)," "B," "A," or "AA") are collectively referred to as *protected streams*, and are subject to additional regulations and require a State permit for disturbance of the bed or banks. Waterbodies can receive more comprehensive protection at the municipal level. It is important to note that the DEC waterbody classification does not relate directly to water quality; rather, it reflects the quality expected of a waterbody. The DEC Waterbody Inventory/ Priority Waterbodies List tracks the degree to which waterbodies are meeting their "best uses" based on their DEC classification, provides a summary of general water quality conditions, and monitors progress toward the identification and resolution of water quality problems, pollutants, and sources.

Biomonitoring helps to detect changes in water quality. © A. Onion

To assess actual water quality and track human-induced impacts, many parameters are measured and monitored. Monitoring programs sample the chemical condition of water, sediments, and fish tissue to determine levels of constituents such as dissolved oxygen, nutrients, metals, oils, and pesticides. They also monitor physical conditions such as temperature, flow, sediments, and the erosion potential of stream banks and lakeshores. Biological monitoring *or biomonitoring* uses the abundance and variety of aquatic plant and animal life to provide information on the quality of streams and waterbodies. The results of these programs can be used to describe water quality in the study area, identify potential threats, and develop recommendations in the NRI. Careful quality monitoring can help specify targeted mitigation, for example, where nutrient management is needed, where shading and stormwater controls are needed for thermal management, or where streambed/bank restoration is needed to stabilize sources of sediment.

What to include

DEC Water Quality Standards and Classifications and their status from the Waterbody Inventory/Priority Waterbody List should be mapped to indicate state-protected waters and identify waterbodies that are not meeting their "best uses." The former data set is available for viewing on DEC's online Environmental Resource Mapper and both data sets may be obtained on the NYS GIS Clearinghouse.

Biomonitoring data for streams and waterbodies are available through the DEC Rotating Integrated Basin Studies (RIBS) program and the Lake Classification and Inventory Program. The *30 Year Trends in Water Quality of Rivers and Streams in New York State* report summarizes the findings of DEC's biomonitoring from 1972-2002 by watershed. See the DEC website to learn about these programs and find information regarding local water resources.

Detailed inventory studies

Citizen-based water quality assessment data for streams and waterbodies are available through the DEC Citizens Statewide Lake Assessment Program (CSLAP) and Water Assessment by Volunteer Evaluators (WAVE) program. Consider participating in these programs to augment the existing record, raise awareness among residents, and track changes in water quality over time. Citizen monitors can also help identify specific water quality threats, such as observed illicit outfalls or evidence of failing septic systems resulting in overland wastewater flows into streams.

Local watershed groups or county agencies (soil and water conservation districts) may also have information on water quality, including biological, physical, or chemical data. If local data are limited or unavailable, water quality assessment studies can be undertaken to document baseline conditions.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

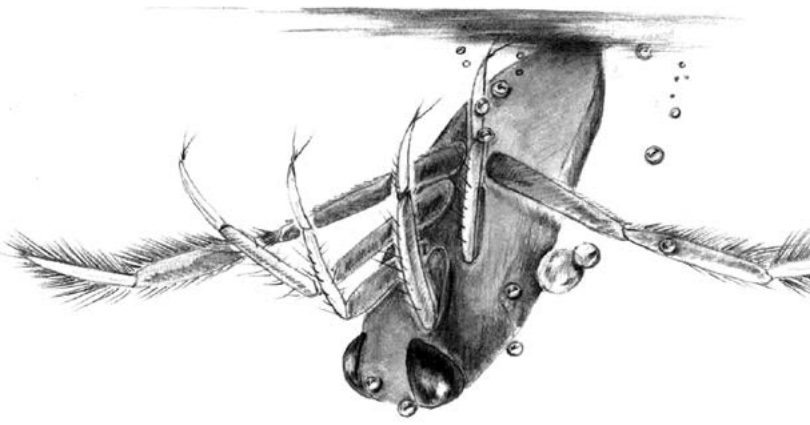
DEC Division of Water
- Water Quality Standards and Classifications
- Waterbody Inventory/Priority Waterbodies List
- DEC Lake Classification and Inventory Program
- DEC water quality monitoring data and reports
- Citizen science monitoring programs (CSLAP and WAVE)

DEC Hudson River Estuary Program
- Technical assistance

Local watershed association/watershed management plan

County agencies (such as planning department, soil & water conservation district, or county water quality committee)
- Water quality information

Backswimmer. © P. Kernan



Water Quality: Potential and Known Sources of Contamination

Background

Stormwater and wastewater problems can impact a community's water resources. By including the locations of stormwater and wastewater infrastructure in the NRI, planners have access to additional information on potential threats to water quality. New York State uses the State Pollutant Discharge Elimination System (SPDES) to control wastewater and stormwater discharges to groundwater and surface water in accordance with the Clean Water Act. The SPDES program requires that a permit be obtained prior to initiation of construction or discharge of wastewater to surface or ground waters. The program also regulates construction or operation of sewage treatment plants and other disposal systems. A Municipal Separated Storm Sewer System (MS4) is a stormwater collection and conveyance system owned by a state, city, town, village, or other public entity that is not part of a sewage treatment plant or combined sewer system. As a permit condition, designated MS4 municipalities are required to map their stormwater outfalls where polluted runoff can enter waterbodies. An inventory of SPDES permit locations for both wastewater and stormwater infrastructure is useful for analyzing cumulative effects of discharges on water resources.

Hazardous waste sites, landfills, junkyards, and salt storage facilities may also pose threats to water resources. In the past, many waste disposal sites were located without regard to human health or environmental impacts. Similarly, the use of uncovered salt storage piles resulted in many cases of groundwater contamination and high concentrations of salt in runoff and surface waters in the past and many contaminated areas remain. It is important to locate and assess the impact of these sites to direct future land uses and protect human health.

What to include

SPDES permit sites and known wastewater infrastructure can be mapped to identify potential point-source pollution locations. Wastewater monitoring data from permit sites can be requested from DEC or the treatment facility and evaluated to identify areas that are stressed or threatened due to increased effluent levels or cumulative land-use impacts.

Stormwater outfalls can be obtained from the municipality's MS4 coordinator.

Hazardous waste sites, landfills, junkyards, and salt storage facilities can be mapped to provide information on potential threats to water quality. DEC maintains an inventory of known hazardous waste sites in New York State that are under remediation or review.

Detailed inventory studies

An outfall inventory is also useful for non-MS4 communities to undertake, if they have not yet mapped stormwater infrastructure.

SPDES outfall site. © E. Vail

Where to find help

See Appendix A for organization contact information and Appendix B for publications and web resources.

DEC Division of Environmental Remediation
Hazardous Waste Management Program, hazardous waste sites

DEC Hudson River Estuary Program
Technical assistance

County agencies (such as Planning Department, Soil & Water Conservation District, and County Water Quality Committee)
Water quality information, stormwater outfall locations

Municipal MS4 coordinator
SPDES permit sites

HABITATS AND WILDLIFE

Significant Biodiversity Areas of the Hudson River Estuary Corridor

Background

Biodiversity encompasses the variety of life in all its forms, from genes to species, and communities to ecosystems, and the interactions between living organisms and their environment. Significant Biodiversity Areas (SBAs) are landscape areas in the Hudson River estuary watershed that contain high concentrations of biological diversity or unusual ecological features that contribute to and serve as a framework for conservation partnerships and voluntary protection efforts. Altogether, 22 SBAs have been identified in the watershed, accounting for much of the range in regional biodiversity (Penhollow et al. 2006). SBAs should not be interpreted as the only important areas for biodiversity.

What to include

The DEC Hudson River Estuary Program worked with the New York Cooperative Fish and Wildlife Research Unit at Cornell University and the New York Natural Heritage Program to identify SBAs in the estuary corridor. SBAs are available on the NYS GIS Clearinghouse

Documenting Invasive Species

An *invasive species* is any kind of living organism that is not native to an ecosystem, and whose introduction causes harm to the environment, economy, or human health. International trade has increased the rate of invasive species introductions, which are one of the greatest threats to New York State's biodiversity. New York State has established eight Partnerships for Regional Invasive Species Management (PRISMs) to coordinate invasive species management functions, including education and outreach, early detection monitoring, and direct eradication and control efforts. By documenting known invasive species infestations in the Habitats and Wildlife section, the NRI can help to raise awareness among the public about the threats invasive species pose to ecosystems, the importance of early detection, and strategies to reduce their spread. New York iMapInvasives is an online database and mapping tool for the collection, distribution, and analysis of invasive species data that can be queried for local records and updated with new observations. More information can be obtained from the New York Invasive Species Clearinghouse, PRISMs, and Cornell Cooperative Extension offices.

and may be shown on a map of regional context (which might include regional watersheds, forest linkage zones, or other significant intermunicipal features), a map of important areas for rare species and significant natural communities, or a combined map of major ecological features. More information about SBAs is available in *The Hudson River Estuary Wildlife and Habitat Conservation Framework*.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Hudson River Estuary Program
Technical and mapping assistance

Hudson River Coastal and Shoreline Habitat

Background

The 153-mile stretch of the Hudson River from the Federal Lock and Dam in Troy to New York Harbor is tidal and thus defined as an estuary. The state of Hudson River shorelines varies from natural to engineered, from tidal habitat to industrial waterfront. Knowing the status of tidal shoreline habitat can help guide restoration and management of a more natural shoreline and identify natural shorelines that might be priorities for conservation. Furthermore, global sea level rise will fundamentally affect the shoreline of the Hudson River estuary in the coming decades. Natural shorelines will potentially allow for the migration of tidal and shoreline habitats as sea level rises. See Appendix E for more information about sea level rise projections.

Tidal marshes, submerged aquatic vegetation (SAV), mudflats, and other significant habitats in and along the estuary support a great diversity of life and contribute to the economic significance of the estuary. More than 200 species of fish are found in the Hudson, including key commercial and recreational species like striped bass, and species of conservation concern like Atlantic and shortnose sturgeon. SAV beds consist of under-water plants that improve water quality in the Hudson and provide essential habitat for invertebrate animals, which feed fish and waterfowl that use the estuary. Tidal wetland habitats play a critical role as nursery grounds for fish and shellfish species, as well as providing nesting sites and migration stops for birds and sources of nutrients for the estuary food web. These wetland systems also help filter pollutants, buffer shoreline properties, and help stabilize the river's shoreline.

Global sea level rise will fundamentally affect the shoreline of the Hudson River estuary in the coming decades.

What to include

Significant coastal habitat. The DEC has identified and evaluated coastal habitats throughout the state's coastal regions, providing recommendations to the New York State Department of State so that the most important or "significant" habitats may be designated for protection in accordance with the New York Waterfront Revitalization and Coastal Resources Act (Executive Law, Article 42). The Significant Coastal Fish and Wildlife Habitats are useful for planning at the local level because they describe the highest quality habitats on the Hudson, outlining fish and wildlife values and activities that may have large impacts on the habitats.

Alewife. © E. Edmonson

Hudson River tidal wetlands are critical nursery grounds for fish and shellfish and provide nesting sites and migration stops for birds. © I. Haeckel

Maps of submerged aquatic vegetation (SAV) beds from Hastings-on-Hudson to Troy in 1997, 2002, and 2007 are available. To show areas that have the potential to support SAV growth, all three inventories have been combined into one "Hudson River Estuary Documented Submerged Aquatic Vegetation" map. The areas mapped indicate locations where SAV growth has been documented and distinguish between the native, beneficial water celery *(Vallisneria)* and non-native, invasive water chestnut. Documented areas of *Vallisneria* warrant special protection, even though in any given year the SAV may not be present.

Tidal wetlands occur in slightly salty or *brackish* conditions in the southern and middle reaches of the estuary, and freshwater conditions in the northern reach. The distribution of Hudson River estuary tidal wetlands from Hastings- on-Hudson to Troy was mapped in 2007. Each mapped wetland was assigned a classification; for example, lower intertidal mix or wooded swamp.

Shoreline type. The Hudson River National Estuarine Research Reserve inventoried the shoreline in 2005 and assigned types such as woody graminoid or revetment to shoreline segments. These data can be used as a starting point but warrant updating to ensure the information is current.

Significant natural communities. The New York Natural Heritage Program's database includes significant, rare, or high-quality ecological communities that occur in the estuary, such as brackish intertidal mudflats and freshwater tidal swamp. These tidal communities are of regional and global significance and often support rare occurrences of plants and animals.

© L. Heady

All of the GIS data sets listed above are available on the NYS GIS Clearinghouse.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Hudson River Estuary Program
Technical and mapping assistance

New York Natural Heritage Program
Significant natural communities, online conservation guides

Hudson River National Estuarine Research Reserve
Guidance on shoreline ecology and engineering

New York State Department of State
Maps and narrative for designated Significant Coastal Fish and Wildlife Habitat areas

Stream and Riparian Habitat

Background

Streams and streamside or *riparian* areas are important transitional zones where land and water are linked. Riparian zones support the aquatic stream environment and are important ecosystems themselves, providing a suite of conditions that are optimal for many plants and animals. Streams and riparian areas often support high biological diversity and can provide potential routes for wildlife movement, seed dispersal, and gene flow across landscapes.

Streams include channel habitat and riparian areas on the tops of the banks, the floodplain, and non-floodplain areas adjoining the stream. A typical stream channel contains microhabitats such as pools, riffles, and runs. Pools and slow runs may support submerged vegetation while

Brook trout. © E. Edmonson

channel bars and portions of lower banks are often vegetated by shrubs and plants that are tolerant of flooding and ice damage. Similarly, floodplains support habitats that can withstand occasional flooding, such as wet meadow, swamp, marsh, and lowland forest, as well as drier habitats like upland meadow. Riparian vegetation helps to stabilize banks and is a source of woody debris that helps to create microhabitat in the stream channel (Penhollow et al. 2006).

Well-shaded, cool to coldwater streams with clean gravel substrate are able to support native coldwater fish such as brook trout that are sensitive to warmer temperatures and sedimentation. Some streams support migratory routes for diadromous fish, such as American eel and herring species. Many other species rely on streams for foraging, breeding, migration, hibernation, and refuge, including mink, muskrat, river otter, bats, woodcock, belted kingfisher, herons, wood turtle, stream salamanders, and many invertebrates, such as dragonflies.

The suitability of stream and riparian habitat for supporting this biological diversity can be altered by agricultural and timber harvesting activities, the creation of physical structures such as buildings, roads, culverts, and dams, and other disturbances that cause clearing of vegetation, sedimentation, or pollution (see Streams and Waterbodies and Water Quality sections). Dams and poorly designed and installed culverts can isolate and severely limit the range of aquatic species and other organisms that use stream corridors, and can also have serious effects on local flooding and water quality. Such aquatic disconnections are significant barriers for resident species such as brook trout, as well as migratory fish species that rely on aquatic connectivity along tributary streams to complete their life cycles. With proper planning and use of best management practices, stream corridors can continue to support natural and human communities.

See the Water Resources sections for more information about watersheds, streams, and waterbodies.

What to include

Fish habitat. If present in the study area, habitat for stream species can be discussed and if GIS data are available, shown on a stream or habitat map in the NRI. Approximate coldwater habitats may be derived from the trout (T) and trout spawning (TS) designations in DEC's water quality classification data. Note that these data do not reflect site-specific habitat quality (see the Water Quality section for more information). DEC's water quality classification data are available on the NYS GIS Clearinghouse. The New York Natural Heritage Program (NYNHP) has additionally identified streams that support migratory fish habitat.

Significant stream-associated natural communities from the New York Natural Heritage Program's database, which often support rare occurrences of plants and animals can be added to the map.

Other sources of information may include local knowledge and studies. Site-specific studies may have been conducted for development reviews and stream assessments may have been completed by watershed groups. In Columbia and Dutchess counties, floodplain habitats were studied and mapped by the Farmscape Ecology Program (FEP) at Hawthorne Valley Farm.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

New York State Department of Environmental Conservation
Water Quality Standards and Classifications: (T) and (TS) designations

DEC Hudson River Estuary Program
Technical and mapping assistance

New York Natural Heritage Program
Significant natural communities, online conservation guides

Trout require well-shaded, cool to coldwater streams. © I. Haeckel

Wetland Habitat

Background

The Environmental Protection Agency estimates that more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half use wetlands at some point in their lives. Many species depend on wetlands for survival; some, like wood ducks, muskrat, cattails, and swamp rose can only live in wetlands. The Hudson Valley has a great diversity of wetlands, from wet clay meadows and hardwood swamps, to emergent marshes and vernal pools. This diversity is shaped by many factors, including hydrology, chemistry, elevation, and drainage. For example, fens, the primary habitat for Federally-endangered bog turtles and many species of rare plants, butterflies, and dragonflies, rely on calcareous groundwater seepage associated with carbonate bedrock like marble. This complexity gives different wetlands different characteristics and is a significant reason why re-creation of lost wetlands often fails to replace the original conditions, and why proactive preservation is a key strategy to maintaining biological diversity.

The Wetlands section has information on basic wetland map components. Discussion of tidal wetlands is included in the Hudson River Coastal and Shoreline Habitat section.

The Environmental Protection Agency estimates that more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half use wetlands at some point in their lives.

What to include

Wetland types are coarsely represented on the National Wetland Inventory (NWI) maps. These designations, which include classifications such as freshwater emergent wetland, freshwater forested and shrub wetland, and riverine, can be used as a starting point for adding wetland habitat information to the NRI. Note that NWI maps have inaccuracies, often underestimate wetland area, and omit smaller and drier wetlands.

Spotted salamanders migrate to vernal pools to breed in early spring. © M. Adamovic

Vernal pools are small, isolated, seasonally-flooded wetlands. © L. Heady

Significant wetland communities. The New York Natural Heritage Program's (NYNHP) database includes high quality examples of bogs, fens, kettle shrub pools, vernal pools, spruce-fir swamp, and other wetland communities, which often support rare occurrences of plants and animals. These data can be included on a wetlands map.

Detailed inventory studies

Biodiversity assessment can produce more accurate and detailed information about wetland locations, type, and habitat quality. See Appendix E for details.

Vernal pool mapping. Many communities are interested in mapping vernal pools, which, due to their small size, are often not documented. These seasonal woodland pools don't always support wetland vegetation, but they are critical breeding habitat for several species of forest salamanders and frogs. *Best Development Practices: Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States* offers some guidance on identifying vernal pools using air photos. Records of vernal pool species in the NYNHP database and the *NYS Amphibian and Reptile Atlas* can be used to infer the presence of vernal pool habitat (see Rare Plant and Animal Species and Significant Natural Communities section).

Other sources of information may include local knowledge and studies, including environmental impact statements.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Hudson River Estuary Program
Technical and mapping assistance, information on woodland pools

New York Natural Heritage Program
Significant natural communities and rare species, online conservation guides

US Fish and Wildlife Service
National Wetlands Inventory, Wetlands Mapper

New York State Department of Environmental Conservation
Woodland pool conservation website
NYS Amphibian and Reptile Atlas

Forests

Background

Conserving and managing large forested areas is necessary to provide wildlife habitat, clean water, climate moderation, and economically viable forest products. In general, larger forests provide greater ecological value than smaller, fragmented patches. However, the value of each forest is relative to the values of other forests in the community, watershed, or natural landscape. Even small patches of forest can be extremely valuable depending on different factors. For example, a network of forest patches along a stream can create a riparian corridor that helps maintain water quality and wildlife habitat, and that serves as a travel route for forest animals. Similarly, wooded hedgerows in an agricultural landscape often provide a refuge for animals that do not typically use agricultural fields.

A great diversity of forest types occur across the Hudson Valley, including a range of upland hardwood and conifer forest communities and more unusual occurrences such as pitch pine-oak-heath barrens, mountain spruce-fir forest, and patches of old growth. Mature lowland forests with uncompacted soils and diverse herbaceous plant communities are rare remnants of ecosystems that were once widespread in the region (Penhollow et al. 2006). Many wildlife species depend on intact forests isolated from human development, including migratory songbirds, red-shouldered hawk, bobcat, black bear, and timber rattlesnake.

Matrix forests represent the largest, most intact forests, whose size and natural condition allow for the maintenance of ecological processes, natural communities, and populations of forest-interior species (Anderson and Bernstein 2003). These characteristics will likely contribute to resiliency in a changing climate. Conserving large, high quality natural areas such as these and natural connections (linkage zones) between them will also allow plants and animals to move northward and higher in elevation as temperatures increase with climate change.

Despite their wide extent, experts are concerned with the future of New York's forests. New York's forest land is largely privately owned and unprotected from development. The fragmentation of large blocks of uninterrupted forests into smaller areas is a problem of statewide concern, and the number of large forest tracts is rapidly declining in many areas. Smaller forest blocks generally have reduced habitat value, are more vulnerable to the spread of invasive species, and are less viable for timber production. Limited forest regeneration is also a concern, particularly in southeastern New York State; sustained overbrowse by deer is one of the contributing factors (Shirer and Zimmerman 2010).

The fragmentation of large blocks of forest into smaller areas is a problem of statewide concern.

What to include

Large forests (>200 acres) in the Hudson Valley were identified by the DEC Hudson River Estuary Program based on the 2010 C-CAP Land Cover Analysis dataset. Classifying forest areas by size and identifying potential connections between them can help to demonstrate relative ecological significance and value for wildlife.

Matrix Forest Blocks were identified in partnership between the New York Natural Heritage Program (NYNHP) and the Nature Conservancy, and linkages and linkage zones between them were identified by NYNHP.

Significant forest communities. NYNHP's database includes high quality examples of forest communities, which often support rare occurrences of plants and animals. These data can be included on a forest map.

All forest GIS data sets listed above are available on the NYS GIS Clearinghouse.

Large interior forest areas provide habitat for wide-ranging wildlife and numerous species that avoid forest edges. © L. Heady

Detailed inventory studies

Biodiversity assessment can produce more accurate and detailed information about forest cover, type, and habitat quality. See Appendix E for details.

Managed forest land. Landowners with at least 50 contiguous acres of forest are eligible to participate in the New York State 480-A tax law program, which encourages the long-term management of woodlands to produce forest crops and offers landowners property tax reductions. Landowners must follow a DEC-approved forest management plan for 10 consecutive years upon entering the program. Information on parcels enrolled in the 480-A program can be obtained from the local tax assessor's office or from the DEC Forest Stewardship Program.

Potential lands for sustainable forestry (silvicultural potential). Identifying and encouraging an increase in the acreage of sustainably managed forest can help maintain land in a forested use and benefit wildlife, water quality, and other natural resources. The analysis should exclude lands with steep slopes, which are more vulnerable to negative impacts from soil disturbance. A full methodology for identifying potential silvicultural lands is provided in the Green Infrastructure Center's publication *Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide.*

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Division of Lands and Forests, Forest Stewardship Program
Technical assistance on forest stewardship and 480-A program, 480-A parcel information

Black bear. © W. Trimm

Wood thrush is a migratory songbird of interior deciduous forests. © E. T. Seton

DEC Hudson River Estuary Program
Technical and mapping assistance

New York Natural Heritage Program
Significant natural communities, online conservation guides

Local tax assessor and county real property departments
480-A parcel information

Grasslands and Shrublands

Background

Numerous wildlife species depend on open grassland and shrubland habitats, especially grassland breeding birds that require large meadows for successful nesting. The quantity and quality of grasslands and shrublands have rapidly decreased in the northeastern US during the last century due to increased human population, changes in agricultural technology, and abandonment of family farms. Furthermore, these open lands are generally prime targets for new residential and commercial development. Old farm fields or forest clearings are by nature transitional and relatively short-lived habitats, usually quickly colonized by shrubs and requiring periodic management to maintain openness. Shrublands in turn revert rapidly to forest without continued maintenance or disturbance, such as fire, that triggers young forest growth. Where they still occur, conserving and managing large grasslands and shrublands benefits wildlife and can also support agricultural land uses and scenic values.

Large meadows are an increasingly rare and threatened habitat for grassland-nesting birds and butterflies. © I. Haeckel

What to include

There are currently no region-wide publicly available data for grassland and shrubland habitat in the Hudson Valley. Land use and land cover data help to provide some information about the general extent of large grassland and shrubland areas (see Land Use section below), and aerial photography can help to verify locations. Wildlife records can be used to infer the presence of valuable grasslands and shrublands. Refer to the New York Natural Heritage Program database, the *NYS Breeding Bird Atlas,* and the *NYS Amphibian and Reptile Atlas* for records of grassland and shrubland species found in or near the study area (see Rare Plant and Animal Species and Significant Natural Communities section). Audubon New York's *Hudson River Valley Priority Birds* website provides a listing of grassland and shrubland bird species of conservation concern, and associated online fact sheets provide more information.

Detailed inventory studies

Biodiversity assessment can produce more accurate and detailed information about grassland and shrubland cover, type, and habitat quality. See Appendix E for details.

Where to find help

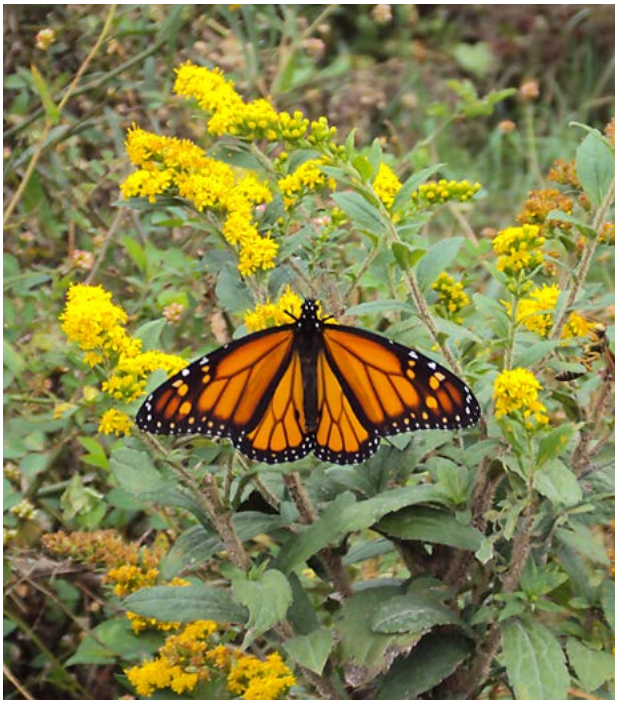
See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

New York State Department of Environmental Conservation
NYS Amphibian and Reptile Atlas and NYS Breeding Bird Atlas

DEC Hudson River Estuary Program
Technical assistance

New York Natural Heritage Program
Significant natural communities, online conservation guides

Audubon New York
Hudson River Valley Priority Birds website and online fact sheets



Monarch butterfly on goldenrod plant. © I. Haeckel

Understanding State and Global Rarity Ranks

The New York Natural Heritage Program (NYNHP) tracks rarity of species and ecological communities at both state and global levels. It is important to note that these ranks carry no legal weight. Following a scale from 1 to 5, 1 indicates "critically imperiled," 3 denotes "uncommon," and 5 indicates "common." For example, the northern cricket frog is quite rare in New York and listed as Endangered (and therefore has a state ranking of "S1") but is common elsewhere (and therefore has a global ranking of "G5"). NYNHP also keeps information on the relative quality of rare species populations and natural community occurrences, which can help inform conservation and land-use planning decisions.

Rare Plant and Animal Species and Significant Natural Communities

Background

The New York Natural Heritage Program (NYNHP) has been finding, tracking, and providing information about New York's biodiversity since 1985. NYNHP maintains the most comprehensive statewide database of known rare plant and wildlife populations and rare or high-quality natural community occurrences (different types of forests, wetlands, grasslands, etc.).

In addition to the NYNHP database, the *NYS Amphibian and Reptile Atlas* and *NYS Breeding Bird Atlas* contain records for species of conservation concern documented in New York. Records of rare species and ecological communities may also be available from organizations like Hudsonia Ltd. or the Farmscape Ecology Program at Hawthorne Valley Farm; their biologists have conducted field surveys in many parts of the Hudson Valley. Local nature-based groups such as Audubon Society or Trout Unlimited may have additional knowledge about wildlife in the study area.

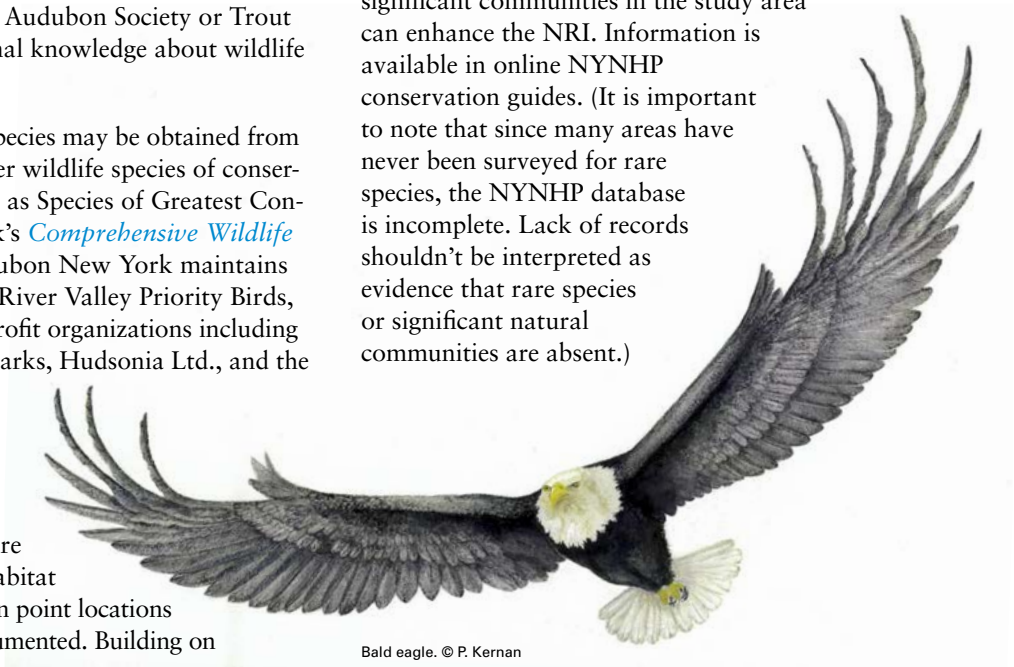
Current legal status of rare species may be obtained from the DEC website. Many other wildlife species of conservation concern are identified as Species of Greatest Conservation Need in New York's *Comprehensive Wildlife Conservation Strategy*. Audubon New York maintains an online listing of Hudson River Valley Priority Birds, and some counties and nonprofit organizations including Westchester Department of Parks, Hudsonia Ltd., and the Farmscape Ecology Program at Hawthorne Valley Farm maintain local and regional rare species lists.

Successful conservation of rare species requires protecting habitat rather than simply focusing on point locations where a species has been documented. Building on species occurrence records, NYNHP has identified areas of importance for sustaining populations of rare plants and animals based on their habitat requirements or the surrounding area required to maintain a natural community. *Important Areas* encompass the specific locations where rare species have been observed, habitat areas which may be used at different times of the year, and the associated areas critical to maintaining those habitats. Proactive planning that considers how species move across the landscape, with careful attention to maintaining connected habitat complexes, will contribute to the long-term survival of rare animals and to the persistence and dispersal of rare plants.

What to include

A summary table of rare plant, animal, and significant natural community occurrences can be compiled from NYNHP database records, including common name, scientific name, habitats, NYS legal status, and NYS rank. Incorporate additional records for species of conservation concern from the *NYS Amphibian and Reptile Atlas* and *NYS Breeding Bird Atlas* and other local sources. Table 3 lists where to find information about local plant and animal species and natural communities. Summaries of rare species and significant natural community occurrences for a specified location (e.g., municipality) are available upon request from NYNHP and the Hudson River Estuary Program. Table 4 provides an example of summary information available from NYNHP. Contact NYNHP for periodic updates to the database. Describing the primary threats, conservation strategies, and management practices for rare species and significant communities in the study area can enhance the NRI. Information is available in online NYNHP conservation guides. (It is important to note that since many areas have never been surveyed for rare species, the NYNHP database is incomplete. Lack of records shouldn't be interpreted as evidence that rare species or significant natural communities are absent.)

Successful conservation of rare species requires protecting habitat rather than simply focusing on point locations where a species has been documented.



Bald eagle. © P. Kernan

Areas of known importance for rare plants, animals, and natural communities can be mapped and presented alongside other major ecological features, such as significant biodiversity areas, matrix forest blocks, regional forest linkage zones, migratory fish runs, or other information identifying the most important areas for biodiversity. Important Area data for the Hudson Valley are available on the NYS GIS Clearinghouse.

Detailed inventory studies

Biodiversity assessment can help to document examples of rare or significant natural communities in the study area and also provide opportunities to document rare plants and animals in the field. See Appendix E for details.

A Note on Sensitive Species

Information regarding specific locations of rare plants and animals is considered sensitive, as its dissemination may lead to collection or disturbance of the plants or animals. Any information on the locations of rare plants and animals, however generalized, must be considered and presented carefully in public documents or presentations, especially information dealing with reptiles (such as bog turtles and timber rattlesnakes), amphibians, bats, and wildflowers. The New York Natural Heritage Program can offer guidance on presenting rare species location information in such a way as to minimize the risks to the plants and animals.

Northern cricket frog. © L. Heady

Volunteers learn to identify vernal pool species. © H. Bock

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Hudson River Estuary Program
Technical and mapping assistance, rare species and significant natural community summary tables

New York Natural Heritage Program
Rare species and significant natural community summary tables, online conservation guides

Audubon New York
Hudson River Valley Priority Birds website and online fact sheets

New York State Department of Environmental Conservation
NYS Amphibian and Reptile Atlas and *NYS Breeding Bird Atlas*
List of Endangered, Threatened and Special Concern Fish & Wildlife Species
List of Species of Greatest Conservation Need

Table 3: Where to find information about plant and animal species in your community.

Resource	Species information	Where to find
New York Natural Heritage Program Database	documented state rare plants, animals, and significant natural communities	Natural communities data are available at gis.ny.gov (except for sensitive features) and a list of rare plants and animals can be obtained from the DEC Nature Explorer (see Table 1). For a complete list of records, submit an inquiry to NaturalHeritage@dec.ny.gov.
New York State Breeding Bird Atlas	breeding bird presence by atlas block, 1980-1985 and 2000-2005	www.dec.ny.gov/animals/7312.html
New York State Amphibian and Reptile Atlas	amphibian and reptile presence by atlas block, 1990-1998	www.dec.ny.gov/animals/7140.html
New York Flora Atlas	county plant lists, search for plant species' habitat and rarity	atlas.nyflora.org
Important Bird Areas	sites identified by Audubon New York that are significant to breeding and migrating birds	ny.audubon.org
Native trout streams	streams where trout naturally reproduce (not stocked)	DEC Regional Office (see Appendix A)
Invasive species	county records of invasive plants, insects, and animals	imapinvasives.org/nyimi/map

Table 4: Sample summary information on known rare plant, rare animal, and significant natural community occurrences in a hypothetical study area; a similar table can be included in the NRI.

Common Name	Scientific Name	Habitat	NYS and Federal Listing	NYS Rank
Mammals				
New England Cottontail	*Sylvilagus transitionalis*	Shrubland	Special Concern, Candidate for federal listing	S1S2*
Eastern Small-footed Myotis	*Myotis leibii*	Cave	Special Concern	S2*
Birds				
Kentucky Warbler nesting	*Geothlypis formosa*	Forest	Protected Bird	S2B*
Least Bittern	*Ixobrychus exilis*	Wetland	Threatened	S3B, S1N*
Butterflies				
Appalachian Azure	*Celastrina neglectamajor*	Forest	Unlisted	S1S3
Reptiles				
Eastern Wormsnake	*Carphophis amoenus*	Forest	Special Concern	S2*
Timber Rattlesnake	*Crotalus horridus*	Forest	Threatened	S3*
Plants				
Narrow-leaved Sedge	*Carex amphibola*	Forest	Endangered	S1
Communities				
Chestnut Oak Forest		Forest		S4
Oak-Tulip Tree Forest		Forest		S2S3
Red Cedar Rocky Summit		Forest		S3

Conservation status in NYS as ranked by NY Natural Heritage Program on a 1 to 5 scale:
S1 = Critically imperiled
S2 = Imperiled
S3 = Rare or uncommon
S4 = Abundant and apparently secure
S5 = Demonstrably abundant and secure
SH = Historical records only; no recent observations known; may or may not still be present in New York.
SU = Conservation status not assigned
B after one of the above ranks indicates the status rank is for breeding populations only.
N after one of the above ranks indicates the status rank is for nonbreeding wintering populations only.
*NYS Species of Greatest Conservation Need

Unfragmented Habitat Blocks

Background

Unfragmented habitat blocks are natural areas of the landscape that are undivided by roads or development. These intact natural areas can include forest, wetlands, meadows, open water, and farmland, often encompassing many habitat types and supporting a diverse array of plants and animals. Large habitat blocks allow for the maintenance of ecological processes and disturbances that help sustain natural communities, such as blowdowns or wildfires, and provide habitat for far-ranging species and those that are sensitive to human disturbance. For example, certain migratory songbirds will not nest in forests of less than 500 acres, requiring deep interior forest habitat to find essential microhabitats. The effects of development at habitat edges can be detected up to hundreds of feet into the interior of a habitat block, measurably altering light and temperature and creating favorable conditions for the establishment of invasive species and pests. Siting new development near existing roads and developed areas can help to avoid or minimize fragmentation of natural areas at the landscape scale and its associated consequences.

Large habitat blocks allow for the maintenance of ecological processes and disturbances that help sustain natural communities, such as blowdowns or wildfires, and provide habitat for far-ranging species and those that are sensitive to human disturbance.

Unfragmented habitat blocks help to create the landscape connections necessary for plant and animal movement, facilitating travel between different habitats to find food and shelter, and allowing genetic exchange between populations. Roads can be a barrier to wildlife movement and collisions with vehicles often cause injury or death to animals. As climate and weather patterns change, it will become increasingly important to preserve habitat connections to assure that plant and animal species are able to move across the landscape, possibly making range shifts northward and to higher elevations to adapt to changing conditions.

What to include

There are currently no region-wide publicly available data for unfragmented habitat blocks in the Hudson Valley. Forest patch data help to provide some information and will most approximate unfragmented habitat blocks in heavily forested areas. See the Forests section.

Detailed inventory studies

Two methodologies for identifying unfragmented habitat blocks have been applied at the county scale in the Hudson Valley and many other variations are possible. In Ulster County, a green infrastructure model was used to prioritize intact natural areas based on the size and shape of habitat "cores" as well as information on water quantity and quality and rare species occurrences. Natural habitats were identified based on national land cover data and supplemented with more detailed wetland mapping. The methodology, described in *Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide*, is based on publicly available datasets and intended for replication by technical staff at other county or regional planning agencies in New York, but could likewise be implemented at the municipal scale with professional assistance.

The Dutchess County Department of Planning and Development undertook a similar effort to identify contiguous natural and agricultural landscapes for the

Natural resource-based planning and land protection can help to prevent fragmentation of large forested areas. © L. Heady

county's *Centers and Greenspaces Plan*. Recognizing that many ecologically significant areas occur beyond the areas traditionally considered unsuitable for building, the county developed a methodology for identifying agricultural lands or soils, scenic views, historic sites, forests, and wetlands, and then buffered these areas to account for zones of human disturbance from development and roadways. The width of buffers varies depending on development type and traffic volume data. The resulting *biodiversity blocks* measuring over 1,000 acres are a starting point for municipal planning efforts and can be supplemented with more detailed biological information from local sources.

Note that communities can also derive unfragmented habitat blocks from GIS data for habitats mapped during a biodiversity assessment study, such as those completed by Hudsonia Ltd. and many volunteer training groups. See Appendix E, Biodiversity Assessment, for more information about habitat mapping methods.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

Green Infrastructure Center, Inc.
Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide. New York Guide.
Outlines methodology for Ulster County intact habitat cores.

Ulster County Department of the Environment
Green infrastructure intact habitat cores data

Dutchess County Department of Planning and Development
Biodiversity block data

Slow-moving wildlife are especially vulnerable when crossing roads. © L. Heady

CLIMATE CONDITIONS AND PROJECTIONS

Background

Climate in the Hudson Valley region is temperate and variable, from warm summers bringing occasional heat waves and droughts to cold, snowy winters. Climate change has already affected the normal variability in weather patterns, and is projected to continue to significantly alter climate conditions in the future. It is important for municipalities to understand the risks posed by changing climate conditions, and how they relate to local natural resources and human health, as well as to the built environment. Increasing temperature, sea level rise, and variability in precipitation are the primary climate change-related hazards in the Northeast region. These hazards may pose significant risks to natural resources and human communities, namely through heat waves, drought, flooding, and poor air quality. Recognizing the value of natural resources as "green infrastructure" in devising climate adaptation strategies is essential.

Air temperature, sea level, and the frequency and intensity of extreme precipitation events are projected to increase through 2100 in the Hudson Valley region. For example, New York's annual average temperature has risen nearly two degrees Fahrenheit and winter temperature almost 5 degrees since 1970 (Rosenzweig et al. 2011). Sea level, which influences the Hudson River, has risen 15 inches in New York Harbor over the last 150 years. The Northeast has also experienced a 74% increase in the amount of precipitation occurring in heavy rainfall events between the periods of 1950-1979 and 1980-2009. These factors combine to create more frequent and severe heat waves, short-term drought, and flooding.

Appendix F provides projections for climate hazards and risks and an overview of how the NRI can contribute to strategies for building climate resilience at the local level.

What to include

Current and future climate conditions, including:

Air temperature: annual average and increase in annual average.

Sea level rise (if a Hudson riverfront community): inches of sea level rise and a map of sea level rise.

Precipitation: total annual precipitation, days with precipitation exceeding 1 inch, and days with precipitation exceeding 2 inches.

Extreme temperatures: days per year above 90 degrees F, days per year above 95 degrees F, number of heat waves per year, average length of heat waves, and days below 32 degrees F.

Sea level rise and storm surge threaten to increase flood risk along the tidal Hudson River and its tributaries. © C. Bowser

Air pollution sources can be mapped where relevant. There are three types of air pollution sources to include:

> ***Stationary sources:*** incinerators, power plants, and many types of industrial and commercial facilities.
>
> ***Mobile sources:*** cars, trucks, buses and planes.
>
> ***Indirect sources:*** airlines or major highways that cause air pollution by bringing multiple mobile sources into a limited area.

Climate risks of specific importance to the municipality can be explained in the NRI report. For example, heat waves and short-term drought could be of particular concern for communities with significant agricultural activities or vulnerable populations such as elderly citizens. The NRI can include a section on strategies to manage natural resources in a way that mitigates these risks.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

DEC Office of Climate Change
Climate Smart Communities Program

DEC Hudson River Estuary Program
Technical assistance

DEC Regional Office
Information on current air quality and standards

Scenic Hudson
Sea Level Rise Mapper

CULTURAL RESOURCES

Historical Resources

Background

Local history is intimately linked with natural heritage. Historic districts and individual sites often reflect the availability of natural resources that supported economic activities and a way of life that may or may not continue to exist. Many times, they are associated with significant natural areas or open spaces. Documentation of historic resources in an NRI can broaden understanding of how a community developed, what makes it interesting from a historical perspective, and illuminate how land-use patterns today reflect patterns of growth in the past.

The rural Hudson Valley landscape has many examples of historic features: prehistoric Native American settlements, colonial estates, Revolutionary War battlefields, bluestone quarries, parks and gardens designed by noted landscape architects, and vernacular barns, stonewalls, and other reminders of rural livelihoods in the past. Historic districts and sites establish a link with the past and help to provide a community's sense of identity and stability.

Documentation of historic resources in an NRI can broaden understanding of how a community developed, what makes it interesting from a historical perspective, and illuminate how land-use patterns today reflect patterns of growth in the past.

Hudson River lighthouse. © L. Heady

Guidance on conducting a historic resources survey is available from the New York State Historic Preservation Office (SHPO). Town libraries and historians are often excellent sources of historic resource information. Communities may have a municipal historical commission, historical society, or local preservation organization that maintains archives. Historical tax records and old maps can give clues to features of potential significance. The National Register of Historic Places and SHPO document historic districts and individual sites of local, state, and national importance.

What to include

Historic districts and individual sites listed on the New York State and National Registers of Historic Places, New York State Heritage Areas, National Heritage Corridors/Areas, and New York State Archaeological Sensitivity Zones are available in GIS format on the SHPO website and can be viewed using the interactive web map. Significant historic sites can be listed and briefly described in the inventory report.

Historical maps can complement a current map of historic resources in the community. Historical USGS maps are available for download from the Dimond Library at the University of New Hampshire or can be viewed using USGS TopoView. Panoramic historical maps are available for download from the Library of Congress Panoramic Map Collection.

Detailed inventory studies

Historical features that relate to human use of natural resources, such as industrial sites and farms, can be identified and included in the NRI along with more traditional historical sites. Involve the local historical society in this aspect of the inventory. The results can be digitized or manually added to the inventory maps and described in the inventory. The Preservation League of New York State has funding for cultural resource surveys.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

New York State Historic Preservation Office
- State and National Registers of Historic Places
- Archaeological information

NYS Archives and Museum

Preservation League of New York State
- Technical assistance, grants

US Geological Survey
- Historical topographic maps

Library of Congress
- Online Panoramic Map Collection

Local sources
- Historical societies, local preservation organizations, libraries, landowners

Kilns in Ulster County provide a reminder of the area's historical natural cement industry. © L. Heady

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Scenic Resources

Background

A community's landscape defines its cultural, natural, and historic heritage. Scenic roads, waterfronts, prominent high points, river trails, special landscape features, and vistas of all kinds contribute to a community's sense of place and aesthetic quality. They can also provide tourism-related economic opportunities for communities. Poorly-planned development can impact and undermine these values.

Preserving the integrity of scenic vistas requires consideration of both scenic views and the areas visible from them, which together comprise "the viewshed." Identifying the full suite of scenic resources is the first step toward assessing potential impacts from development and determining strategies for protection.

What to include

Scenic Areas of Statewide Significance were developed by the NYS Department of State using a rigorous process to identify scenic resources in several Hudson Valley counties. The data are available on the NYS GIS Clearinghouse.

The ***New York State and National Registers of Historic Places*** lists some scenic resources in the region. These often include unpaved roads and byways (e.g., Old Albany Post Road in Putnam County).

The ***Scenic Byway Program*** led by the New York State Department of Transportation recognizes significant scenic roadways, such as the Shawangunk Mountains Scenic Byway.

Information on regional and local scenic resources is available from a number of sources. Landscope Hudson Valley is an online mapping tool that includes selected scenic resources, developed by Hudson River Valley Greenway, Hudson River Valley National Heritage Area, and the DEC Hudson River Estuary Program.

Critical scenic resources often overlap with conserved areas such as state, county, and municipal parks, other publicly owned land, and areas conserved by private groups such as land trusts. See the Conservation and Public Lands section.

At the local scale, municipal comprehensive plans sometimes describe specific scenic resources, such as agricultural fields, villages and their approaches, scenic roads, forests, etc. Locally-identified scenic resources will likely need to be digitized or manually added to maps.

Some municipalities have defined scenic resources by elevation, designating such areas for closer examination during SEQR reviews, based upon the assumption that ridgelines and other high spots are generally more visible and more vulnerable to potential erosion and other impacts from development.

Detailed inventory studies

A comprehensive inventory of local scenic resources can begin the process of prioritizing and protecting areas with scenic value or serve to update previous scenic resource identification efforts. Many methods exist to inventory and evaluate scenic resources according to a wide range of attributes, including physical features (e.g., farm structures), as well as measures of the diversity, pattern, disturbance, contrast, access, and other important aspects of scenic views. Community-led scenic resources inventories can be challenging because views are complex and their values are subjective and often elicit emotional reactions. However, priorities usually emerge as the community begins the process of identifying important scenic attributes.

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The work group should determine the most appropriate criteria for assessing local scenic values and fully document methods. A survey of community residents can

help identify important scenic viewpoints and their vistas or viewsheds. Consultants can help to carry out surveys, conduct viewshed analyses in GIS, or undertake the entire scenic resources inventory.

Scenic information can be added manually to an existing map or digitized for use in GIS. Scenic vistas can be marked as numbered point locations and listed in an accompanying descriptive table. Designated scenic roads can be shown by highlighting the appropriate section of road on the map. Photographs are useful components of scenic resources inventories, and can be included in the report that accompanies the inventory maps. Using GIS data layers, GIS providers can conduct a viewshed analysis from key vistas or multiple vantage points to determine the most visible areas.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

NYS Department of State
Scenic Areas of Statewide Significance data and website

NYS Department of Transportation
Scenic Byway Program

NYS Office of Parks, Recreation, and Historic Preservation
NYS and National Registers of Historic Places

Hudson River Valley Greenway, Hudson River Valley National Heritage Area, DEC Hudson River Estuary Program
Landscope Hudson Valley (online map application)

County planning departments and local land trusts
Scenic resource identification

Municipal comprehensive plans
Scenic resource identification

Recreation Resources

Background

The Hudson Valley is well-known for the quality and variety of its recreational resources, which include hiking trails, camping areas, trout streams, mountains, whitewater, rock-climbing, ski areas, lakes, ponds, wetlands, and the Hudson River estuary. Public lands such as the Catskill Park, state parks, county parks, and municipal parks, as well as private nonprofit conservation areas provide important recreational opportunities. In addition, some private landowners allow public access to their land for recreational purposes, e.g., snowmobile and hiking trails. Land-use changes, ownership changes, and misuse of recreational areas can threaten the availability of privately owned land for recreational use. Conversely, the expansion or creation of new parks and conservation areas and the rails-to-trails movement can expand access to public and private lands, provide new recreational opportunities, and help generate local tourism and economic growth.

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What to include

A base map showing publicly accessible conservation lands, municipal parks, and other recreation areas. See the Conservation and Public Lands section for mapping information.

New York State recreation amenities, including facilities, trails, and recommended public fishing access sites are available on the NYS GIS Clearinghouse. Contact the DEC Bureau of Fisheries, Public Use Section for up-to-date information on DEC boat launches and the NYS Office of Parks, Recreation, and Historic Preservation for snowmobile trail data. These data can be supplemented with local information that can be digitized or manually added to the inventory maps.

Bicycle trails and routes are available from the New York State Department of Transportation website.

A tabulated list of recreation areas can be included in the written NRI report. Communities may have a local recreation commission that has documented information and county planning departments may have local recreation resources data.

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Detailed inventory studies

Local information. Recreation groups can be a valuable source of knowledge about the location of popular cycling routes, swimming holes, fishing spots, and other recreation resources. Trails for hiking, skiing, snowmobiling, and horseback riding may be maintained by local or regional groups that can supply maps and other information (e.g., snowmobile clubs). This information can be digitized or manually added to maps.

Unmapped local trails. Using a geographic positioning system (GPS), volunteers can walk, hike, or bike local trail networks to document their geographic coordinates and add the information to inventory maps.

Old and abandoned roads are often used for recreation, such as Class VI and discontinued roads. Topographic maps and aerial photographs can be used to map their locations. Some roads and railroad corridors are listed on the NYS and National Registers of Historic Places. It may be useful to record whether these roads are closed by gates, abandoned, or of unknown status.

Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

NYS Office of Parks, Recreation, and Historic Preservation
: State Parks, trails, snowmobile trails, and other amenities; roads and railroad corridors listed on the NYS and National Registers of Historic Places

NYS Department of Environmental Conservation
: Trails in State Forests, Wildlife Management Areas, Unique Areas, Forest Preserve land, boat launches, and public fishing access sites

NYS Department of Transportation
: Bicycling in New York website

Hudson River Valley Greenway
: Technical assistance, grants

NY/NJ Trails Conference, *Rails-to-Trails Conservancy*
: Trail information and assistance with planning trails

New York Snowmobile Association
: Trail networks, list of local clubs

County planning department
: Local data

Local recreation organizations and recreation commissions

LAND USE

Zoning and Tax Maps

Background

Local governments have the authority to enact zoning regulations to promote the public health, safety, and general welfare of their communities, among other purposes. Zoning is primarily enacted to control the use of land and the density of those uses, as deemed appropriate for the community. Zoning can encourage a variety of uses that are desirable, strictly regulate those that may

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be potentially inharmonious, or prohibit those uses that are unwanted in the community. Zoning laws can protect important natural areas and cultural resources such as historic landmarks or districts, wetlands, floodplains, groundwater, wildlife habitats, and scenic areas. Various statutes define the use of zoning to encourage "the most appropriate use of land."

An overlay map of current zoning at the scale of the NRI will give a general indication of land use as it relates to the natural resource base. This map may reveal areas that are zoned for uses that can threaten a critical resource or for which the resource base cannot reasonably or economically support. For example, an overlay map of zoning might point out that portions of the community's groundwater supply are zoned to allow for conflicting land uses, such as allowing gas stations, petroleum bulk storage, or salt storage over important aquifers. Or the overlay may reveal that an area designated for high-density residential homes is situated in a large, unfragmented forest where the headwaters of a recreational creek are located.

Parcel-based tax map information is also helpful when reviewed together with the other NRI maps. A tax map overlay can help in the implementation phase of the NRI project, and can provide helpful information for a voluntary land protection program.

What to include

Digital zoning maps may be available from the county planning department for use in GIS. If the zoning maps aren't digitized, find out if the municipality plans to do so. It is relatively inexpensive and easy to digitize zoning boundaries. If the NRI is being used in paper form, a mylar overlay with zoning information is helpful to use with the other resource maps. Zoning information can also be combined with a composite tax map base.

Digital tax parcel data are maintained by county tax assessor offices for use in GIS or other computer applications. Check with the county to obtain up-to-date parcel data. Keep in mind that tax parcel information frequently changes and current maps aren't always accurate.

Where to find help

See Appendix A for organization contact information.

County planning department
Mapping assistance, digital tax parcel data

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Land Use and Land Cover

Background

Patterns of human land uses and natural land cover in a watershed strongly influence water resources and biological communities through the interactions of water, soil, organisms, and chemical components. Changes in natural land cover (especially forests, floodplains, and wetlands) accompanying conventional development patterns often result in substantial increases in impervious surfaces (e.g., roofs, parking lots, and roads) and can drastically alter stream health and hydrology by adding pollutants and sediment. Research has found that increases in impervious cover are linked to degradation in water quality and aquatic habitat value and an increase in flooding problems (Walsh et al. 2005). Without the use of best management practices, extensive agricultural land use in a watershed can likewise impair water quality through delivery of excess nutrients, sediment, and potentially pathogens to waterways. Furthermore, the fragmentation of natural areas by roads and development impedes wildlife movement, facilitates the spread of invasive species, and reduces overall habitat value.

Knowing the general distribution of land use and land cover in a municipality and its larger watershed context can help a community better understand past and present development patterns and plan for future growth. Directing new development to existing centers uses land more efficiently and saves money by taking advantage of existing infrastructure and allowing for greater density in already settled areas. Concentrating greater density in existing centers is often the best option to protect water resources, biological communities, and farmland because it takes pressure off development of the community's remaining green spaces.

Concentrating greater density in existing centers is often the best option to protect water resources, biological communities, and farmland because it takes pressure off development of the community's remaining green spaces.

What to include

The USGS National Land Cover Database (NLCD) has nationwide land use and land cover information at a 30-square meter resolution based on satellite imagery. Each 30x30m square represents a land use or land cover class, along with an estimate of the proportion of urban impervious surface for that cell. Accuracy assessments are underway for the most recently available 2011 data set. The 2001 NLCD was found to have a nationwide accuracy of about 80%, with variations by geography and by identified class.

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The Coastal Change Analysis Program (C-CAP) of the National Oceanic and Atmospheric Administration (NOAA) produces a nationally standardized database of land cover and land change information for coastal regions of the United States. Similarly to NLCD, C-CAP relies on 30x30m pixel satellite imagery, but is limited to coastal areas and adjacent uplands. C-CAP coverage spans New York State and may provide more accurate land cover assessment than NLCD for some communities. The C-CAP land cover atlas is a useful online mapping tool that allows users to explore changes in general land cover, or look more specifically at forests, wetlands, and development since 1996.

Where to find help

See Appendix A for organization contact information and Appendix C for sources of GIS data.

United States Geological Survey
National Land Cover Database, impervious surface area

National Oceanic and Atmospheric Administration
Coastal Change Analysis Program, Land Cover Atlas

DEC Hudson River Estuary Program
Technical and mapping assistance

An Important Note on Land Cover Data Sets

It is critical to note that land cover data sets are most reliable at regional scales and have important limitations at the municipal scale. They should not be used for site planning and are not a viable substitute for on-the-ground knowledge and site visits—the data are not necessarily accurate at particular locations, and do not present information on many important habitat types. Used in an appropriate manner, satellite-derived data can be a useful tool to understand patterns of land use and land cover in municipalities and to identify areas of concern where land use could be impacting natural resources.

Farmland

Background

Farmland includes cropland, hayfields, pastures, orchards, and nurseries. Millions of acres of crop and pasture land in New York State have been converted to non-farm uses or allowed to revert to forest cover in the last century. In many cases, marginal farmland has been abandoned and prime farmland preserved. In other cases, prime farmland is rapidly being converted to residential development. According to the American Farmland Trust, over the last 25 years, New York has lost almost half a million acres of farmland to subdivisions, strip malls, and scattered development, threatening food security and local economies. An inventory of valuable farmland is important to understand the extent of local resources and prioritize the most important areas to conserve.

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Farmlands provide much more than a place to produce crops and livestock. In New York's primarily forested landscape, fields and other agricultural lands provide habitat for a variety of wildlife species and are important elements of rural community character and scenic views. Farmlands also provide an important historic link with the past. Conserved farm properties safeguard wildlife habitat and environmentally sensitive areas such as meadows, woodlands, wetlands, and streams. In fact, as much as 50% of the current acreage of Hudson Valley farm properties is forested or wetland habitat.

Over the last 25 years, New York has lost almost half a million acres of farmland to subdivisions, strip malls, and scattered development, threatening food security and local economies.

Prime farmland, as defined by the USDA Natural Resource Conservation Service (NRCS), is land best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land potentially available for growing crops, but does not include developed land or surface water areas. Prime farmland soils produce the highest yields with minimal expenditure of energy and economic resources. Prime farmland soils with current agricultural use are the most valuable farmland assets. *Soils of Statewide Importance* are lands, in addition to prime farmlands, that are of statewide importance for crop production. Both prime farmland soils and soils of statewide importance are derived from county soil surveys based on soil unit attributes supplied by NRCS.

What to include

The inventory of farmland in a community is probably more extensive than most residents realize. Farms may include pastures that support beef, sheep and horse farms, hayfields, microfarms and Community Supported Agriculture (CSA) farms, and "pick-your-own" operations, as well as dairy farms. In addition to active farmlands, potential farmland could also be identified based on soil conditions.

Prime and statewide important farmland soils are identified in county soil surveys. Soil survey reports contain useful narrative describing suitability for agricultural crops. Digital soil survey data for use in GIS are available online from the NRCS SSURGO database. Note that soil group valuations are for cropland only and may not reflect accurate valuations for other agricultural activities.

County and local information. County or local agriculture and farmland protection plans are a good source of information about farmland and local laws affecting soil resources and may have maps of priority farmland for preservation. Check with the county soil and water conservation district and local land trusts to see what information they have available on active farms.

Detailed inventory studies

There is no comprehensive data source for ***active or potential agricultural land use*** in New York, and available datasets have varying levels of completeness and accuracy. Scenic Hudson's 2013 foodshed conservation plan for the Hudson Valley region presents a methodology for identifying possible farms based on three different data sources:

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Community supported agriculture builds support for local farms. © L. Heady

Agricultural district data may be obtained from New York State Department of Agriculture and Markets and county planning departments.

Agricultural land use data may be obtained from New York State Office of Real Property. Farmland may be defined as agricultural use (codes 100-190), residential agricultural (code 241), and abandoned agriculture (code 321).

Agricultural tax exemption data may be obtained from NYS Office of Real Property and joined to tax parcels provided by local tax agencies. Exemptions include 4172 (Agricultural District formed by county or New York State) and 173 (Agricultural Land outside of agriculture districts) only.

Possible farm parcels identified in any of the above data sets can be verified using aerial photography and windshield surveys.

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Where to find help

See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

USDA Natural Resources Conservation Service
Prime and statewide important agricultural soils

USDA Farm Service Agency, county soil and water conservation districts, and Cornell Cooperative Extension
Active farms

NYS Department of Agriculture and Markets
Agricultural district maps

NYS Department of Taxation and Finance, Office of Real Property Tax Services
Tax exemption data

County planning departments
Technical assistance, land use maps, agricultural district maps

American Farmland Trust, New York Office
Municipal agriculture planning assistance

County agricultural and farmland protection boards
Priority farmland for conservation efforts

Local land trusts

Conservation and Public Lands

Background

By definition, conservation lands are properties that are generally undeveloped and protected from future development. Mapping the study area's conservation lands will help identify potential needs and opportunities for expanding these areas to provide links between protected areas, or to add buffers to sensitive areas. The conservation lands map can also be used to identify priority resource areas currently limited or lacking in protection.

Mapping the study area's conservation lands will help identify potential needs and opportunities for expanding these areas to provide links between protected areas, or to add buffers to sensitive areas.

Protected lands can include a variety of public and privately-owned lands. Public lands may include federal, state, county, and municipally-owned lands. Note that public land ownership doesn't necessarily ensure that land is protected in perpetuity. Land trusts are private, nonprofit organizations that protect land through a variety of voluntary methods, including outright purchase and *conservation easements*, a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. In addition to private lands under protection from development, lands held by religious or educational institutions might be considered to function as conservation lands.

Established in 1885, Catskill Park contains major unfragmented forests, alpine communities, pristine headwater streams, and reservoirs. © S. Stanne

The municipality's list of publicly-owned properties can be examined to determine what, if any, deed restrictions apply to the properties. Lists of municipally-owned lands can be found in annual reports or in the list of properties, by owner, that accompanies the local tax maps.

What to include

Protected and public lands. On maps, it is helpful to display conservation lands by category, e.g., federal, state, county, town, or private ownership. The New York Protected Areas Database (NYPAD) is the most comprehensive database available of protected lands in New York State. NYPAD defines protected lands as those lands that are protected, designated, or functioning as conservation lands, open space, natural areas, or recreational areas through fee ownership, easement, management agreement, current land use, or other mechanism. It is possible to query the database according to ownership category or other parcel attributes. NYPAD is updated on a regular basis, depending on funding availability. Check the NYPAD website for updates.

Volunteer raptor monitoring has helped to inform recent grassland conservation. © L. Heady

Conservation easements are most thoroughly documented in the National Conservation Easement Database (NCED), which compiles easement records from land trusts and public agencies throughout the United States. Check the NCED website for updates.

Local land trusts can provide up-to-date listings of their protected parcels. Hudson Valley land trusts are listed in Appendix A.

Where to find help

See Appendix A for organization contact information and Appendix C for sources of GIS data.

New York Natural Heritage Program
NY Protected Area Database

National Conservation Easement Database

Local and regional land trusts
Current fee- and conservation easement parcel information

Northern harrier © J. Coe

CHAPTER: 5

Analyze the Information

Collecting data is just one piece of the NRI process. Analyzing the information can give greater meaning to the inventory and help to determine if additional detailed inventory studies are necessary. Analysis may also help to set resource protection priorities and identify recommended land-use planning strategies (see Chapter 6). As the work group presents and discusses the inventory, consider these questions:

Which areas in the community have the most important resource values, and where do resource combinations occur?
One goal of an NRI project is to identify areas in the community where key resources are located. Identification of these resources can provide helpful information for land protection projects and land-use planning measures to assure long-term resource protection. This analysis may point out a need for updating the comprehensive plan and re-evaluating zoning, for example.

Computer-generated analysis using GIS can be helpful for identifying areas with overlapping resources. This analysis overlays several of the individual data layers from the inventory to assist with prioritization. For example, if the floodplains of a tidal creek overlap with rare plant habitat, bald eagle nesting sites, a kayak launch, and a valued scenic vista, this could be an important area to focus conservation efforts. Overlapping resources can be displayed on a composite GIS map, and the NRI report can be referenced for detailed information on the individual resources.

While overlapping resource analysis can help to analyze some priority areas with regard to protection strategies, the significance of single resource values shouldn't be overlooked. Key single resources may be accorded high priority for conservation or consideration in land-use planning based on the extent and value of that resource for the community. For example, a highly productive aquifer area that is important for future water supply may receive high priority.

Activities on adjacent land can have impacts on abutting natural resource areas. To adequately protect sensitive resources, consideration should also be given to the management or protection of the surrounding areas. Protecting the buffers associated with particular resources, or using best management practices in adjacent areas, can be equally important to protecting the resource itself. For example, stream buffer protection can help to maintain stream bank stability, filter pollutants and sediment from runoff before it enters the stream, and provide shade and organic matter, supporting stream water quality and habitat value. GIS software can be used to map buffers for important resources and perform a number of related distance, acreage, and other measurement calculations.

GIS analysis can also be used to demonstrate the impacts of land-use regulation changes to protect natural resources. For example, if a community were to adopt a 100-foot stream buffer setback requirement for certain land uses, GIS could be used to query the NRI data to determine which areas would be impacted, and how much acreage those areas represented.

Why is the resource important to the community?
Which resources are important will vary from community to community, depending on perceived needs. For example, water resources may be a priority for one municipality, while in another municipality, agricultural land may top the list. Identifying the value of significant resources can help suggest an appropriate conservation strategy. Some resources, such as water supplies, are important to the health and safety of the community and may be appropriately protected through regulation. Others, such as recreational areas, may be more appropriately protected through public purchase or voluntary initiatives.

What are the threats to the continued availability of these important natural resources?
Determining threats to resource availability will involve an evaluation of the impact that current land-use regulations and land-use trends are having on the resource, as well as economic factors, climate change, etc. Consider whether land-use regulations are inhibiting or promoting the continuation of resource-dependent industries, such as farming or tourism. What would happen if the resource was lost?

Are there natural resources identified that are important to other communities or the region?
Natural resources don't respect political boundaries. Important resources such as streams or ridgelines frequently straddle several communities. Protection of these may require cooperative efforts with adjacent communities or local watershed groups.

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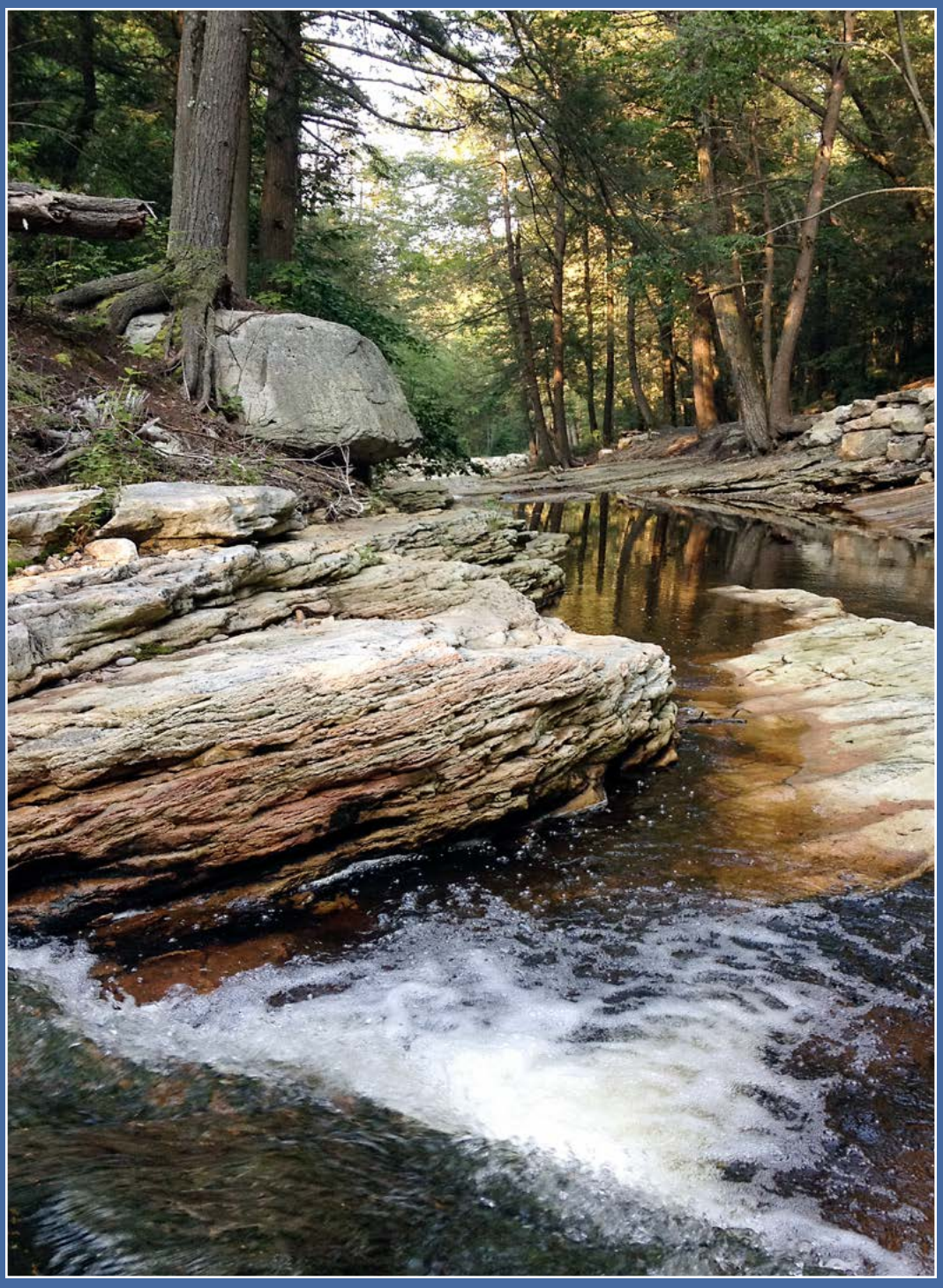

CHAPTER: 6

Putting the Inventory to work

A natural resources inventory provides a deeper understanding of community resources and a foundation for thinking about the future. Using the results of the NRI requires evaluating the community's long-term goals and how they relate to its resources, and enables planners to make decisions that reflect community needs and values. This view on the future can help preserve community character and quality of life, and ensure that residents continue to benefit from ecosystem services like clean water.

After completion of the NRI, the work group can devise a strategy for regular review of inventory data, incorporating updated information and revising inventory maps as appropriate, adding new goals as future community needs become apparent, and ensuring that the inventory becomes an integral part of community planning. For an NRI to be effective over the long term, the results should continually be in active use.

As major inventory goals are accomplished, planning boards, conservation advisory councils (CACs), and other town officials should consider a range of activities designed to protect sensitive natural resources from incompatible uses. Where natural resources extend beyond town boundaries, opportunities exist for intermunicipal cooperation. Open space planning (discussed later in this chapter) can be an effective way to implement the inventory results. Appendix G contains a model law for adoption of the municipal NRI.

Below are several suggestions for making good use of the NRI results.

Make the Inventory Available

The outcomes of the NRI work group's efforts will quickly be forgotten if there aren't some permanent reminders around for town officials and the public to use. Consider the various groups and individuals that might use the NRI maps and have additional copies made for them. These might include the planning board, CAC, consulting planner or engineer, and/or other organizations such as trusts and county planning departments. The likelihood of these decision-makers using the NRI may be higher if the work group presents the results of the NRI and suggestions on how it can be incorporated into municipal planning at a pre-scheduled board meeting or a special session.

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Display a selection of the inventory maps in a public area, such as the town hall (alongside tax maps if these are displayed) and library. GIS-generated maps can be easily reduced or enlarged for all or part of the study area to reflect the needs of specific boards or projects. If the municipality has a website, a digital copy of the NRI can be posted for viewing or download. Community and other related groups can be asked to share the NRI website link with their members or on their own web pages.

Public Education

An NRI provides a valuable opportunity to educate residents about the importance of the community's resources. The work group can develop an outreach plan to determine the best strategies for sharing the inventory results with the public. Early on, familiarity with the project can be fostered by publicizing the work group's meetings, through articles in local newspapers, updates on the community's website, and by engaging stakeholders at public meetings. Once the inventory is complete, the primary goal of outreach and educational programs should be to provide factual and objective information about the NRI project. Community events can be used as opportunities to display the inventory results and have NRI work group participants on hand to answer questions and provide information. Municipal meetings are a good time to present a display of inventory maps. A brochure or fact sheet describing the major findings of the inventory can help to get information out. Work with local landowners to encourage stewardship of the land, and to show them how they can contribute to the environmental health of the community.

The more informed the community is about the NRI, the more likely the inventory will be used on a regular basis, especially by local boards during municipal decision-making. Once key priorities for using the inventory have been decided, sponsor public education programs

The more informed the community is about the NRI, the more likely the inventory will be used on a regular basis, especially by local boards during municipal decision-making.

focused on those priorities. For example, if land protection is a priority, sponsor a land protection workshop for local landowners; if the objective is to evaluate water resources, focus on issues centered around that topic such as volunteer stream monitoring. Educational programs are an effective method for clarifying key natural resource issues and establishing the groundwork for their protection.

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Comprehensive Planning

The NRI provides an effective tool for developing or updating the natural resources section of a community's comprehensive plan. In New York, municipal land-use regulations must be adopted in accordance with a comprehensive plan (Town Law, Section 272-a, Village Law, Section 7-722 or General City Law, Section 28-a). Therefore, the comprehensive plan acts as a "blueprint" for local zoning and other land-use regulations. A successful comprehensive plan not only recognizes the importance of natural resources like streams, aquifers, wetlands, and forests, but it also presents recommendations and implementation strategies to protect those resources. These strategies can serve as the basis for future land-use regulations, and as a basis for acquisition and other conservation implementation strategies.

A successful comprehensive plan not only recognizes the importance of natural resources like streams, aquifers, wetlands, and forests, but it also presents recommendations and implementation strategies to protect those resources.

If an NRI is developed after a recent comprehensive plan update, it can be officially incorporated by a simple amendment to the comprehensive plan. The NRI can also serve the purpose of building on the natural resources information included in the comprehensive plan or implementing recommendations in the plan that pertain to natural resources such as the designation of Critical Environmental Areas (see below). If the comprehensive plan is outdated, the NRI can provide the basis for revising and updating the natural resources section of the plan. Whichever may be the case, an NRI can become an important decision-making tool to ensure that a community's natural resources are sustained into the future.

Watershed Plans

Some communities develop watershed plans to identify, prioritize, and manage their water resources. The information contained in an NRI can contribute to a watershed assessment or characterization report, which becomes part of a watershed plan. The *watershed characterization report* provides context for a watershed planning process and can be used to educate partners and stakeholders on watershed conditions, generate local support, and identify specific actions needed to improve watershed management. The characterization includes information similar to an NRI, including geographic setting and special features, review of existing data, and maps that show features such as subwatershed boundaries, municipal jurisdictions, water features, parcels, roads, land use, land cover, open space, zoning, and SPDES permit locations. Depending on the size of the watershed being assessed, an NRI's study area may contain all or part of the watershed; the watershed planning team would need to evaluate what data need to be added, updated, or analyzed to meet its goals and objectives. When watersheds cross municipal boundaries, check to see if adjacent communities have completed NRIs. *Watershed Plans Guidebook: Protecting and Restoring Water Quality* provides step-by-step guidance on the watershed planning process.

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Critical Environmental Areas

Municipalities may designate specific geographic areas within their boundaries as "Critical Environmental Areas" (CEAs) under the State Environmental Quality Review Act (SEQRA). According to the DEC, an area can be designated as a CEA if it has an exceptional or unique character with respect to one or more of the following:

- a benefit or threat to human health;
- an exceptional or unique natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space, and areas of important aesthetic or scenic quality);
- exceptional or unique agricultural, social, cultural, historic, archaeological, recreational, or educational values; or
- an inherent ecological, geological, or hydrological sensitivity to change that may be adversely affected by any physical disturbance.

A CEA designation can alert project sponsors to the community's concern for the resources contained within the CEA and it raises overall awareness of special environmental features in a community. This can include the decision-making processes of other units of government, such as highway departments or the State Department of Transportation. The information and maps in the NRI can provide the basis for identifying CEAs in a community.

Following designation, potential impacts to the characteristics of the CEA become relevant areas of concern that warrant specific, articulated consideration in determining the significance of any Type I or Unlisted actions pursuant to Section 617.7 of SEQRA. While the CEA does create a heightened sense of awareness of the importance of an area during SEQRA reviews, its designation does not ensure long-term protection or give the municipality any permitting authority, zoning restrictions, or other jurisdictions that did not already exist before designation of the CEA.

Open Space Inventories and Plans

NYS General Municipal Law Section 239-y defines *open space* as any area that is characterized by natural scenic beauty or whose condition or quality is such that it will enhance the present or potential value of surrounding developed lands, or would support desirable patterns of development or planning objectives in the community, or enhance the conservation of natural or scenic resources. Open space serves many purposes, whether publicly or privately owned, and can include parks, recreational sites, scenery, trails, forests and woodlands, wetland and stream corridors, rare or important habitats, farms, and historic properties.

Conservation Advisory Councils and Open Space Inventories

NYS General Municipal Law Section 239-y authorizes conservation advisory councils to "conduct research in the land area of the municipality for which it was created;" "…keep an inventory…of all open areas within the municipality with the plan of obtaining information pertinent to proper utilization of such open lands including lands owned by the state, any other municipality within the state or by the particular municipality itself;" and "keep an inventory and map of all open marshlands, swamps and all other wetlands in a like manner." The CAC "...may recommend to the governing body of the municipality a program for ecologically suitable utilization of such areas."

NYS General Municipal Law Section 239-y authorizes conservation advisory councils to complete an open space inventory prioritizing open areas in a municipality for preservation based on natural, scenic, and cultural values. A natural resources inventory provides the basis for prioritization in the open space inventory process. Upon adoption, the open space inventory becomes the munic-

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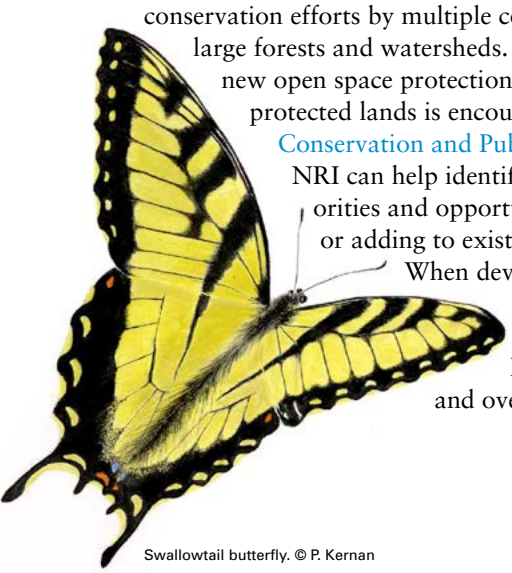
ipality's official open space index, and the council may advance to conservation board status. A conservation board remains advisory in nature; however, it becomes more formally involved in the environmental review process for any proposed actions on properties listed in the index.

An open space inventory is often developed within the context of a broader open space plan, which categorizes open space resources, identifies the community's priorities, outlines the best options for use and protection of priority lands, and lays out a plan for action. The NRI, combined with analysis and input from community members, provides a foundation for setting open space priorities. Sites that have overlapping resources and meet multiple objectives, such as aquifer recharge, scenic beauty, and wetland habitat, may rise to the top as a community's highest priorities.

The value of open spaces is greater when they are considered in the context of the overall environment, rather than viewed in isolation. For example, the open space plan provides opportunity to devise intermunicipal strategies for prominent features that require coordinated conservation efforts by multiple communities, such as large forests and watersheds. In addition, relating new open space protection priorities to existing protected lands is encouraged. A review of the Conservation and Public Lands map in the NRI can help identify land protection priorities and opportunities for connecting or adding to existing protected parcels. When devising natural resource protection strategies, communities should keep the "big picture" and overall context in mind.



Swallowtail butterfly. © P. Kernan

Open Space Plan Implementation

An important step in implementing an open space plan is to establish an adequate and stable land protection fund. Grants are available from various agencies, including the DEC and Hudson River Valley Greenway, and municipalities can use their local taxing and bonding authority for the matching funds often required by public and private foundations (Strong 2008). In New York, over 80% of local conservation finance measures successfully passed between 1998 and 2010. See New York State's *Local Open Space Planning Guide* for more information on sources and methods of financing open space planning and implementation. A combination of options may be the best approach for establishing a conservation fund that adequately addresses a given community's needs.

Voluntary land protection is another approach to implementing the open space plan. Throughout the process of public discussion and evaluation of natural resources, the work group can emphasize the opportunities that exist for voluntary land protection. An education and outreach component is recommended for any land protection program. Developing a working knowledge of land protection techniques will help the work group with its outreach to landowners. Local land trusts can be a valuable partner in this effort, as they have expertise in the various options for permanent land protection, including acquisition and conservation easements, as well as relationships with landowners. Education and outreach approaches could include public meetings to teach the concepts of land stewardship for natural resources protection, and to discuss what is involved in land protection; publications that encourage awareness of the value of the natural resource; and public workshops, such as the role of land protection in estate planning. Start a small reference library of land conservation publications that could be available through the public library or the town hall. Appendix A provides a listing of local land trusts in the Hudson Valley that may be available to assist with outreach efforts or to partner on open space conservation efforts.

Zoning and Subdivision Regulations

Whereas an open space plan focuses on protection of important natural resources on primarily undeveloped land, land-use regulations give the planning board, landowners, and developers the ability to do the best possible job of protecting important natural resources on developed properties. Land-use regulations are widely used in New York communities. About 70% of the state's municipalities have adopted comprehensive plans and about 78% have zoning regulations. Similarly, about 73% have adopted subdivision regulations and 70% have site plan regulations (New York State Legislative Commission on Rural Resources 2008). Municipal zoning and subdivision regulations often don't adequately protect natural

resources and there is frequently a disconnect between a community's plan and its land-use controls. For example, a comprehensive plan might have an overall goal to protect natural resources and open space but the zoning regulations assign every parcel of land to development of buildings and structures. Or a community may plan for large-lot subdivision as a method for protecting natural resources and controlling growth, but in many cases this strategy works against natural resource protection by spreading development over a much larger area than necessary and leaving important resources without any real protection. This can result in the loss of important farm and forest lands as they are converted into large house lots, often with expansive lawns and long driveways.

Before it is possible to establish more effective land-use regulations in a community, it may be necessary to make residents and public officials aware of the long-term impacts of existing land-use regulations. Build-out scenarios can be an effective tool for this purpose. These combine tax maps, resource inventory overlays, and existing land-use regulations to create maps that depict what the community's land use pattern might be if all possible properties were developed to their maximum, as allowed by local regulations. Guidance on effective land-use regulations and information on model ordinances (e.g., aquifer protection, watercourse protection, etc.) is available from a number of agencies and organizations, including county planning departments, the New York State Department of State, the New York Planning Federation, and the American Planning Association. Examples of how other NY communities have effectively protected their natural resources are presented in *Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River Valley* (Strong 2008), in the Pace University Land Use Law Center's *Gaining Ground Information Database*, and on a number of planning organization websites (see Appendices A and B). Many planning consultants are willing to talk about how they have helped other communities craft new land-use controls, and often do so without charge.

Build-out scenarios combine tax maps, resource inventory overlays, and existing land-use regulations to create maps that depict what the community's land use pattern might be if all possible properties were developed to their maximum, as allowed by local regulations.

Local laws, ordinances, and regulations should be reviewed to determine their adequacy for natural resource protection. Guidance for conducting in-depth code and ordinance review is available from a number of organizations, including the DEC Hudson River Estuary Program (see Appendix B). Municipalities can update local land use laws or ordinances to more effectively protect small wetlands, watercourses, floodplains, or forests, for example, or develop overlay zoning to protect certain areas like habitat, aquifers, and scenic or historic resources in the municipality. An NRI can provide much of the information needed to determine the location of such districts.

Using the inventory data and GIS maps, proposed land-use or zoning changes can be evaluated to determine potential effects on natural resources. The tax map overlay can also be consulted to determine how and in what way landowners might be affected. "What if" scenarios can be run to summarize the total area impacted, and display the locations of impact. For example, a "what if" scenario of new buffer width requirements around wetlands would allow a municipality to see which additional lands would be impacted by a range of increasing widths.

A community's NRI can be referenced in municipal zoning and subdivision regulations, and use of the NRI for site plan or subdivision review can be required. See Appendix G for a model local law for adopting a municipal NRI.

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Prioritizing Resources at the Site Level

While all natural and cultural resources have some level of importance, the review of proposed development should be undertaken considering the relative importance of resources on a site. This can typically be done so that natural resources are ranked in terms of their highest to least suitability for protection. Resource prioritization should be carried out in consultation with the planning board and conservation advisory council or conservation board (if there is one) using the NRI as a basis, with additional fieldwork as appropriate. A site inspection by the applicant, the planning board, and conservation advisory council or board is a very important step in identifying and prioritizing resources to be conserved.

A site-level conservation analysis should identify the natural resources present, their configuration, and the site's context in relation to resource areas on adjoining and nearby properties. On the basis of these findings, along with local conservation priorities, practical considerations, and an applicant's development objectives, conservation areas should be delineated in a manner clearly indicating their boundaries, the types of resources present, and goals for protection. For example, if protecting prime farmland soils is a municipal goal, these areas should be preserved in their natural state with areas of poorer soils used for development purposes. In another example, if habitats for a species of greatest conservation need are present on a site, the habitats and sufficient buffer areas surrounding them may warrant conservation to protect the species. In either case, decisions are made on a case by case basis in an open dialogue between the community and applicant, with natural resource protection accorded early priority and development areas delineated around them during the design of the project.

Contributed by Ted Fink, AICP

Development Review

Information from the natural resources inventory can be used for reviewing development proposals in general terms (but note that NRI data aren't suitable for site specific analysis and are not a substitute for site visits). For this purpose, it is important that the information is applied consistently by municipal boards. One way of accomplishing this is through the use of checklists by planning and zoning boards to review subdivision and other land-use proposals. Appendix H provides a case study on the Town of Rhinebeck Planning Board's use of a site resource assessment checklist for subdivision review. Both the inventory maps and accompanying NRI report and source documents can be consulted for details about affected resources and their value to the community, and can be used as a reference tool in preparing maps of existing features for project applications. In addition, they can provide the planning board with context for site proposals. Whereas site plans typically only provide a parcel-scale view, the NRI enables planners to see how the parcel relates to its surroundings; for example, if the project is situated in a regionally-important forest or contains the headwaters of an ecologically-significant wetland.

Whereas site plans typically only provide a parcel-scale view, the NRI enables planners to see how the parcel relates to its surroundings.

Conclusion

Municipal planning is intended to protect the health, safety, and welfare of community residents. This cannot be achieved without information on the natural resources that deliver benefits like clean air and water, create opportunities such as agriculture and outdoor recreation, provide habitat for wildlife, and build climate change and economic resiliency in growing communities. Municipalities are encouraged to create a natural resources inventory, update it regularly, and use it to identify community priorities and inform land-use decisions. The foundation of information contained in an NRI can be a springboard for plans and policies that are designed to conserve important natural resources, and an insurance policy that protects the community's natural assets for current residents and future generations.

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Note: Documents and websites that are suggested as sources for additional information throughout the guidebook are listed in Appendix B.

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Appendices

TABLE OF CONTENTS

APPENDIX A – AGENCIES AND ORGANIZATIONS

The following list provides websites and phone numbers for agencies and organizations that are mentioned in this guidebook and additional sources for data and guidance on developing a natural resources inventory.

Federal Agencies

US Army Corps of Engineers
www.usace.army.mil
New York District
(917) 790-8007

US Department of Agriculture
Natural Resources Conservation Service
www.nrcs.usda.gov
Columbia, Greene, Ulster, Dutchess, Putnam, Westchester, Rockland and NYC Counties
(845) 883-7162

Albany and Rensselaer Counties
(518) 271-1740

US Department of the Interior
National Park Service
Hudson River Valley National Heritage Area
www.hudsonrivervalley.com
(518) 473-3835

Erie Canalway National Heritage Corridor
www.eriecanalway.org
(518) 237-7000

US Department of the Interior
US Fish and Wildlife Service
www.fws.gov
Northeast Regional Office 5
(413) 253-8200

New York Field Office
New York Ecological Services,
Partners for Fish and Wildlife
www.nyfo.fws.gov
(607) 753-9334

US Department of the Interior
US Geological Survey
www.usgs.gov
Albany District Office
(518) 431-4341

New York District Office
(518) 285-5600

US Environmental Protection Agency
www.epa.gov
Region 2
(212) 637-3000

New York State Agencies and Programs

Department of Agriculture and Markets
www.agriculture.ny.gov
(800) 554-4501

Division of Land and Water Resources
www.agriculture.ny.gov/SoilWater/land-and-water.html
(518) 457-3738

Department of Environmental Conservation
www.dec.ny.gov

Division of Fish, Wildlife, & Marine Resources
www.dec.ny.gov/about/634.html
(518) 402-8924

Division of Lands and Forests
www.dec.ny.gov/about/650.html
(518) 402-9405

Division of Environmental Remediation
www.dec.ny.gov/about/627.html
Hazardous Waste Management
www.dec.ny.gov/chemical/8486.html
(518) 402-9764

Division of Water
www.dec.ny.gov/about/661.html
(518) 402-8233

Ambient Groundwater Monitoring Program
www.dec.ny.gov/lands/36117.html

Hudson River Estuary Program
www.dec.ny.gov/lands/4920.html
(845) 256-3016

Conservation and Land Use Program
www.dec.ny.gov/lands/5094.html

Watershed Program
www.dec.ny.gov/lands/5098.html

Hudson River National Estuarine Research Reserve
www.hrnerr.org
(845) 889-4745

Office of Climate Change
www.dec.ny.gov/energy/44992.html
(518) 402-8448

DEC Region 2
Long Island City
(718) 482-4900

DEC Region 3
New Paltz
(845) 256-3000

DEC Region 4
Schenectady
(518) 357-2234

Department of Health
Source Water Assessment Program
www.health.ny.gov/environmental/water/drinking/swap.htm

Department of State
www.dos.state.ny.us

Division of Coastal Resources
(518) 474-6000

Division of Local Government
(518) 473-3355

Department of Taxation and Finance
Office of Real Property Tax Services
www.tax.ny.gov/about/orpts/albany.htm
(315) 471-1402

Department of Transportation
Scenic Byway Program
www.dot.ny.gov/scenic-byways
(518) 457-6277

Hudson River Valley Greenway
www.hudsongreenway.ny.gov
(518) 473-3835

Institute for Resource Information Sciences
Cornell University Department of Crop & Soil Sciences
www.css.cornell.edu/iris
(607) 255-0803

New York Farm Bureau
www.nyfb.org
(518) 436-8495

New York Natural Heritage Program
www.nynhp.org
(518) 402-8935

New York Planning Federation
www.nypf.org
(518) 512-5270

New York State Museum
www.nysm.nysed.gov
(518) 474-5877

New York State Geological Survey
www.nysm.nysed.gov/nysgs
(518) 473-6262

New York State Soil and Water Conservation Committee
www.nys-soilandwater.org
(518) 765-7923

Office of Parks, Recreation, and Historic Preservation
www.nysparks.com
(518) 474-0456

Office of Historic Preservation
www.nysparks.com/shpo/
(518) 237-8643

New York City Park Region
(212) 694-3608

Palisades Interstate Park Commission
(845) 786-2701

Saratoga/Capital District Park Region
(518) 584-2000

Taconic Park Region
(914) 889-4100

Statewide and Regional Nonprofit Organizations

American Farmland Trust
Northeast Regional Office
www.farmland.org
(518) 581-0078

Cary Institute of Ecosystem Studies
www.caryinstitute.org
(845) 677-5343

Catskill Center for Conservation and Development
www.catskillcenter.org
(845) 586-2611

Center for Watershed Protection
www.cwp.org
(410) 461-8323

Ducks Unlimited
Eastern New York Chapter
www.ducks.org/new-york
(518) 944-6664

Hudson River Watershed Alliance
www.hudsonwatershed.org

Hudsonia Ltd.
hudsonia.org
(845) 758-7053

Land Trust Alliance of New York
www.landtrustalliance.org
(518) 587-0774

National Audubon Society
New York State Office
www.ny.audubon.org
(518) 869-9731

The Nature Conservancy
New York State Office
www.nature.org
(518) 690-7850

Eastern New York Chapter
(518) 690-7878

New York City Chapter
(212) 997-1880

New York Rural Water Association
www.nyruralwater.org
(518) 828-3155

New York/New Jersey Trail Conference
www.nynjtc.org
(201) 512-9348

New York State Snowmobile Association
www.nysnowmobiler.com
(888) 624-3849

Open Space Institute
www.osiny.org
(212) 629-3981

Pace Land Use Law Center
Pace University School of Law
www.pace.edu/lawschool/landuse
(914) 422-4262

Partnerships for Regional Invasive Species Management (PRISMs)
http://nyis.info/?action=prism_main

Preservation League of New York State
www.preservenys.org
(518) 462-5658

Rails to Trails Conservancy
www.railstotrails.org
(202) 331-9696

Scenic Hudson
www.scenichudson.org
(845) 473-4440

Teatown Lake Reservation, Inc.
www.teatown.org
(914) 762-2912

Trout Unlimited
New York State Council
www.nytu.org

Trust for Public Land
Mid-Atlantic Regional Office
www.tpl.org
(212) 677-7171

County Agencies, Programs, and Land Trusts

Note: Local land trusts are listed for the counties that have them. To find additional land trusts in your area, visit the Land Trust Alliance website at www.lta.org.

Albany County
www.albanycounty.com

Economic Development, Conservation and Planning Department
(518) 447-5670

Capital District Regional Planning Commission
www.cdrpc.org
(518) 453-0850

Soil & Water Conservation District
(518) 765-7923

Cornell Cooperative Extension
www.ccealbany.com
(518) 765-3500

Mohawk Hudson Land Conservancy
www.mohawkhudson.org
(518) 436-6346

Columbia County
www.columbiacountyny.com

Planning Department
(518) 828-3375

Soil & Water Conservation District
www.ccswcd.org
(518) 828-4386 (4385) ext. 3

Cornell Cooperative Extension
www.ccecolumbiagreene.org
(518) 828-3346

Columbia Land Conservancy
www.clctrust.org
(518) 392-5252

Farmscape Ecology Program at Hawthorne Valley Farm
www.hvfarmscape.org
(518) 672-7994

Dutchess County
www.dutchessny.gov

Department of Planning and Development
(845) 486-3600

Environmental Management Council
www.dutchessemc.wordpress.com

Soil & Water Conservation District
www.dutchessswcd.org
(845) 677-8011 (8199) ext. 3

Cornell Cooperative Extension
www.ccedutchess.org
(845) 677-8223

Dutchess Land Conservancy
www.dutchessland.org
(845) 677-3002

Oblong Land Conservancy, Inc.
www.oblongland.org
(845) 855-5993

Winnakee Land Trust
www.winnakeeland.org
(845) 876-4213

Greene County
www.greene-ny.com

Department of Economic Development, Tourism and Planning
(518) 719-3290

Soil & Water Conservation District
www.gcswcd.com
(518) 622-3620

Cornell Cooperative Extension
www.ccecolumbiagreene.org
(518) 622-9820

New Baltimore Conservancy
www.newbaltimoreconservancy.org
(518) 436-2955

Greene Land Trust
www.greenelandtrust.org
(518) 731-5500

Orange County
www.co.orange.ny.us

Department of Planning
(845) 291-2318

Water Authority
(845) 615-3868

Soil & Water Conservation District
www.ocsoilny.org
(845) 343-1873

Cornell Cooperative Extension
www.counties.cce.cornell.edu/orange
(845) 344-1234

Orange County Land Trust
www.orangecountylandtrust.org
(845) 343-0840

Putnam County
www.putnamcountyny.com

Division of Planning and Development
(845) 878-3480

Soil & Water Conservation District
(845) 878-7918

Cornell Cooperative Extension
www.putnam.cce.cornell.edu
(845) 278-6738

Hudson Highlands Land Trust
www.hhlt.org
(845) 424-3358

Putnam County Land Trust
www.pclt.net
(845) 228-4520

Rensselaer County
www.rensco.com

Department of Economic Development and Planning
(518) 270-2914

Capital District Regional Planning Commission
www.cdrpc.org
(518) 453-0850

Soil & Water Conservation District
(518) 271-1740 ext. 1764

Cornell Cooperative Extension
www.ccerensselaer.org
(518) 272-4210

Rensselaer Land Trust
www.renstrust.org
(518) 659-5263

Rensselaer Plateau Alliance
www.rensselaerplateau.org
(518) 712-9211

Rockland County
www.co.rockland.ny.us

Department of Planning
(845) 364-3434

Department of Environment Resources
(845) 364-2670

Soil & Water Conservation District
(845) 364-2667

Cornell Cooperative Extension
www.rockland.cce.org
(845) 429-7085

Ulster County
www.co.ulster.ny.us

Planning Department
(845) 340-3340

Department of the Environment
(845) 338-7287

Environmental Management Council
www.ucenvironment.org
(845) 338-7287

Soil & Water Conservation District
(845) 883-7162 ext. 202

Cornell Cooperative Extension
www.cce.ulster.org
(845) 340-3990

Cragsmoor Conservancy
www.cragsmoorconservancy.info
(845) 647-4716

Esopus Creek Conservancy
www.esopuscreekconservancy.org
(845) 247-0664

Mohonk Preserve
www.mohonkpreserve.org
(845) 255-0919

Rondout-Esopus Land Conservancy
www.relandconservancy.org
(845) 626-3140

Shawangunk Conservancy
www.shawangunks.org
(845) 687-4759

Shawangunk Ridge Biodiversity Partnership
www.mohonkpreserve.org/sites/default/files/files/PDF/SRBPcommunity.pdf
(845) 255-9051

Wallkill Valley Land Trust
www.wallkillvalleylt.org
(845) 255-2761

Woodstock Land Conservancy
www.woodstocklandconservancy.org
(845) 679-6481

Westchester County

www.westchestergov.com

Department of Planning
(914) 285-4402 (4404)

Environmental Management Council
(914) 995-4424

Soil & Water Conservation District
(914) 995-4422

Cornell Cooperative Extension
www.cce.cornell.edu/westchester
(914) 285-4640

Mianus River Gorge Preserve, Inc.
www.mianus.org
(914) 234-3455

North Salem Open Land Foundation
www.nsolf.org
(914) 669-5860

Pound Ridge Land Conservancy
www.prlc.net
(914) 372-1290

Westchester Land Trust
www.westchesterlandtrust.org
(914) 234-6992

New York City

Division of City Planning
www.nyc.gov/html/dcp/
(212) 720-3300

Department of Parks and Recreation
www.nycgovparks.org

Soil & Water Conservation District
www.nycswcd.net
(212) 637-3877

New York City Watershed
New York City Department of Environmental Protection
www.nyc.gov/watershed

Natural Areas Conservancy
www.naturalareasnyc.org

APPENDIX B: PUBLICATIONS AND WEB RESOURCES FOR FURTHER READING AND RESEARCH

The following list includes documents and websites suggested in this guidebook along with other resources that may be helpful in creating and implementing an NRI. Resources are listed under headings that correspond with sections in Chapter 4.

Geology and Soils

County soil surveys. Dates vary. http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=NY

New York State Department of Environmental Conservation. New York State Mined Land Reclamation Database. www.dec.ny.gov/cfmx/extapps/MinedLand/

United States Geological Survey. 1976. Geological and Water Supply Reports and Maps: New York. babel.hathitrust.org/cgi/pt?id=uc1.b4143689;view=1up;seq=1

United States Geological Survey. 2003. Geology of the New York City Region. 3dparks.wr.usgs.gov/nyc/

Water Resources

Bode, R., M. Novak, L. Abele, D. Heitzman, and A. Smith. 2004. 30 Year Trends in Water Quality of Rivers and Streams in New York State. New York State Department of Environmental Conservation Division of Water's Stream Biomonitoring Unit. Albany, NY. 364 pp plus appendices. www.dec.ny.gov/chemical/78979.html

Calhoun, A. and M. Klemens. 2002. Best Development Practices: Conserving Pool-breeding Amphibians in Residential and Commercial Developments in the Northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, NY. 57 pp. www.nae.usace.army.mil/Portals/74/docs/regulatory/VernalPools/BestDevelopmentPractices20Oct2014.pdf

Center for Watershed Protection. 2010. New York State Stormwater Management Design Manual. Center for Watershed Protection for New York State Department of Environmental Conservation. 642 pp. www.dec.ny.gov/chemical/29072.html

Chazen Companies. 2006. Dutchess County Aquifer Recharge Rates & Sustainable Septic System Density Recommendations. Dutchess County Water & Wastewater Authority. Poughkeepsie, NY. 36 pp. www.co.dutchess.ny.us/CountyGov/Departments/WaterandWaste/ratesanddensityrecommendations.pdf

Chemung County Soil and Water Conservation District. 2006. Stream Processes: A Guide to Living in Harmony with Streams. 74 pp. www.chemungcountyswcd.com/PDF/Soil%20&%20Water%20Guide.pdf

Environmental Law Institute. 2008. Planner's Guide to Wetland Buffers for Local Governments. Washington, D.C. 25 pp. www.elistore.org

Hudson River Watershed Alliance. 2013. Watershed Atlas. www.hudsonwatershed.org/maps-resources/maps-atlas/hudson-river-watershed-atlas.html

Kendall, B. 1998. Local Strategies for Wetland and Watercourse Protection: An Educational Guide. The Dutchess County Environmental Management Council and Cornell Cooperative Extension of Dutchess County. Millbrook, NY. 21 pp. plus appendices.

Lindley Stone, A., and F. Mitchell (editors). 2013 update. Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire. University of New Hampshire Cooperative Extension, Durham, NH. nhmethod.org

Morgan, D. and A. Calhoun. 2012. The Maine Municipal Guide to Mapping and Conserving Vernal Pools. University of Maine, Sustainability Solutions Initiative, Orono, ME. 115 pp. maineaudubon.org/wp-content/uploads/2012/08/MeAud-ME-Municipal-Guide-to-Mapping-and-Conser-ving-Vernal-Pool.pdf

New York State Federation of Lake Associations, Inc. (NYSFOLA). 2009. Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management. 2nd edition. NYSFOLA in cooperation with DEC. www.dec.ny.gov/chemical/82123.html

New York State Department of Environmental Conservation. Citizen Statewide Lake Assessment Program. www.dec.ny.gov/chemical/81576.html

New York State Department of Environmental Conservation. Lake Classification and Inventory Program. www.dec.ny.gov/chemical/31411.html

New York State Department of Environmental Conservation. 2008. Lower Hudson River Waterbody Inventory/Priority Waterbodies List. www.dec.ny.gov/chemical/36740.html

New York State Department of Environmental Conservation. Water Quality Standards and Classification. www.dec.ny.gov/chemical/23853.html

New York State Department of Environmental Conservation. Woodland Pool Conservation. www.dec.ny.gov/lands/52325.html

New York State Department of State. 2009. Watershed Plans Guidebook: Protecting and Restoring Water Quality. NYSDOS Office of Coastal, Local Government, and Community Sustainability. Albany, NY. 101 pp. www.dos.ny.gov/opd/programs/pdfs/Guidebooks/watershed/WatershedPlansGuidebook%20wo%20secretary.pdf

Habitats and Wildlife

Audubon New York. 2009. Hudson River Valley Priority Birds website and fact sheets. ny.audubon.org/hudson-river-valley-conservation

Center for Watershed Protection. 2008. Watershed Forestry Resource Guide. www.forestsforwatersheds.org/forests-and-drinking-water/

Cornell Cooperative Extension Invasive Species Program. New York Invasive Species Clearinghouse. http://nyis.info

Hudson River National Estuarine Research Reserve. Guidance on Shoreline Ecology and Engineering. www.hrnerr.org/hudson-river-sustainable-shorelines/

Kiviat, E., and G. Stevens. 2001. Biodiversity Assessment Manual for the Hudson River Estuary Corridor. New York State Department of Environmental Conservation. Albany, N.Y. 508 pp.

New York Planning Federation, New York State Department of Environmental Conservation, and Empire State Forest Products Association. 2005. The Municipal Official's Guide to Forestry in New York State. 31 pp. www.dec.ny.gov/docs/lands_forests_pdf/guidetoforestry.pdf

New York Natural Heritage Program. 2012. Animal, Plant, and Community Guides. www.guides.nynhp.org

New York Natural Heritage Program. New York iMapInvasives Database. www.nyimapinvasives.org

New York State Department of Environmental Conservation Division of Lands and Forests. Forest Stewardship Program website. www.dec.ny.gov/lands/4972.html

New York State Department of Environmental Conservation. List of Endangered, Threatened, and Special Concern Fish & Wildlife Species. www.dec.ny.gov/animals/7494.html

New York State Department of Environmental Conservation. List of Species of Greatest Conservation Need. www.dec.ny.gov/docs/wildlife_pdf/appendixd2.pdf

New York State Department of Environmental Conservation. 1990-1999. New York State Amphibian and Reptile Atlas. www.dec.ny.gov/animals/7140.html

New York State Department of Environmental Conservation. 2000-2005. New York State Breeding Bird Atlas. Release 1.0. www.dec.ny.gov/animals/7312.html

New York State Department of Environmental Conservation. 2006. New York State Comprehensive Wildlife Conservation Strategy. DEC, Albany, NY. 1,569 pp. www.dec.ny.gov/docs/wildlife_pdf/cwcs2005.pdf

New York State Department of State. Dates vary. Maps and narrative for designated Significant Coastal Fish and Wildlife Habitat areas. www.dos.ny.gov/opd/programs/consistency/scfwhabitats.html

Penhollow, M., P. Jensen, and L. Zucker. 2006. Wildlife and Conservation Framework: An Approach for Conserving Biodiversity in the Hudson River Estuary Corridor. New York Cooperative Fish and Wildlife Research Unit and New York State Department of Environmental Conservation, Hudson River Estuary Program, Ithaca, NY. 139 pp. www.dec.ny.gov/lands/5096.html

Watershed Agricultural Council Forestry Program, New York State Department of Environmental Conservation, and Empire State Forest Products Association. 2011. New York State Forestry Best Management Practices for Water Quality. 85 pp. www.dec.ny.gov/docs/lands_forests_pdf/dlfbmpguide.pdf

Climate Conditions and Projections

Climate Smart Communities. 2014. Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities Version 2.0. DEC, Albany, NY. 51 pp. www.dec.ny.gov/docs/administration_pdf/csrptool.pdf

Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W.Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

New York State Department of Environmental Conservation. Climate Smart Communities Program. www.dec.ny.gov/energy/96511.html

New York State Department of Environmental Conservation Hudson River Estuary Program. Climate Change in the Hudson Valley. www.dec.ny.gov/lands/39786.html

NYS 2100 Commission. 2013. The NYS 2100 Commission Report: Recommendations to Improve the Strength and Resilience of New York State's Infrastructure. www.governor.ny.gov/assets/documents/NYS2100.pdf

Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grabhorn (editors). 2011. Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Synthesis Report. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

Cultural Resources

Library of Congress Panoramic Map Collection website. www.memory.loc.gov/ammem/pmhtml/panhome.html

National Park Service. National Register of Historic Places Research Program website. www.nps.gov/nr/research

New York State Department of Environmental Conservation. Assessing and Mitigating Visual Impacts. www.dec.ny.gov/docs/permits_ej_operations_pdf/visual2000.pdf

New York State Department of State. Scenic Areas of Statewide Significance. www.dos.ny.gov/opd/programs/consistency/scenicass.html

New York State Department of Transportation. Bicycling in New York website. www.dot.ny.gov/bicycle/maps

New York State Office of Parks, Recreation, and Historic Preservation. Recommended Standards for Historic Resources Surveys. nysparks.com/shpo/survey-evaluation/documents/Recommended-StandardsHistoricResourcesSurvey.pdf

Shawangunk Mountains Regional Partnership. Scenic Resources in the Shawangunk Mountains Region: A Guide for Planning Boards. LandWorks, Middlebury, VT. 97 pp. mtnscenicbyway.org/planning-board-guide.html

United States Geological Survey. Historic USGS Maps of New England and New York. Dimond Library at the University of New Hampshire website. docs.unh.edu/nhtopos/nhtopos.htm

Land Use

American Farmland Trust. 2011. Planning for Agriculture in New York: A Toolkit for Towns and Counties. 81 pp. www.dec.ny.gov/lands/36117.html

Arendt, R. 1994. Rural by Design: Maintaining Small Town Character. American Planning Association Planners Press, Chicago, IL. 441 pp.

Duany, A., Speck, J., and M. Lydon. 2010. The Smart Growth Manual. McGraw Hill, New York, NY. 240 pp.

Eisenman, T., J. Anzevino, S. Rosenberg, and S. Spector (eds.) Revitalizing Hudson Riverfronts: Illustrated Conservation & Development Strategies for Creating Healthy, Prosperous Communities. Scenic Hudson, Poughkeepsie, NY. 102 pp. www.dos.ny.gov/opd/programs/pdfs/Guidebooks/Revit_Hudsonguide.pdf

Firehock, K. 2013. Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide. New York Guide. The Green Infrastructure Center, Inc., Charlottesville, VA. 149 pp. www.gicinc.org

Forman, R., Olson, J., and W. Dramstad. 1996. Landscape Ecology Principles in Landscape Architecture and Land Use Planning. Harvard University Graduate School of Design, Island Press and the American Society of Landscape Architects. Washington, DC. 80 pp.

Hudson River Valley Greenway. Technical Assistance Toolbox website. www.hudsongreenway.ny.gov/Tech_Assist.aspx

Kennedy, C., J. Wilkinson, and J. Balch. 2003. Conservation Thresholds for Land Use Planners. Environmental Law Institute, Washington, DC. www.eli.org/sites/default/files/eli-pubs/d13-04.pdf

McElfish, J. 2004. Nature-Friendly Ordinances. Environmental Law Institute, Washington, DC. www.elistore.org

New York State Department of Environmental Conservation Hudson River Estuary Program and New York State Water Resources Institute in cooperation with the Center for Watershed Protection. 2011. Code and Ordinance Worksheet for New York State. www.dec.ny.gov/docs/remediation_hudson_pdf/cownys.pdf

New York State Department of State. 2009. Making the Most of Your Waterfront: Enhancing Waterfronts to Revitalize Communities. 94 pp. www.dos.ny.gov/opd/programs/pdfs/Guidebooks/lwrp/LWRP_guidebook.pdf

New York State Department of State. 2004. Local Open Space Planning Guide. 64 pp. www.dos.ny.gov/lg/publications/Local_Open_Space_Planning_Guide.pdf

New York State Department of Environmental Conservation. Critical Environmental Areas. www.dec.ny.gov/permits/45500.html

Nolon, J. 2002. Well Grounded: Using Local Land Use Authority to Achieve Smart Growth. Environmental Law Institute, Washington, D.C. 470 pp. www.elistore.org

Nolon, J. (editor). 2005. Breaking Ground: Planning and Building in Priority Growth Districts: A Guide for Local Leaders. Yale School of Forestry & Environmental Studies and Pace University School of Law. 148 pp.

Pace University Land Use Law Center's Gaining Ground Information Database. landuse.law.pace.edu

Plunkett, K. (editor). 2003. A Local Leader's Guide to Open Space Preservation. Starting Ground Series. Pace University Land Use Law Center. White Plains, NY. 86 pp.

Strong, Karen. 2008. Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit at Cornell University for NYSDEC Hudson River Estuary Program. pp.101. www.dec.ny.gov/lands/50083.html

APPENDIX C: RECOMMENDED GIS DATA SOURCES

Table C-1: List of recommended GIS data sources for natural resources inventory components described in Chapter 4 and contact information for where to obtain them. Many GIS data sets are also available for viewing using online mapping tools listed in Chapter 3, Table 1. Additional data sets in kmz format for viewing in Google Earth are available for download at www.dec.ny.gov/pubs/42978.html.

Feature	Available data online	Web site	Notes
Aerial photography	Digital orthoimagery since 1994	gis.ny.gov	High resolution aerial photos can be used to identify and map natural areas or particular habitats.
Political boundaries	State, city, town and village boundaries; named geographic and cultural features	gis.ny.gov	
Transportation	Roads, railroads	gis.ny.gov	
Utilities	Electric and gas transmission lines	gis.ny.gov	
Topography	Contour lines	gis.ny.gov	
Topography	USGS topo quadrangles	nationalmap.gov/ustopo	
Geology	Bedrock and surficial geology	www.nysm.nysed.gov/gis	
Soils	Soil units and attribute tables	datagateway.nrcs.usda.gov	
Aquifers	Unconsolidated aquifers	gis.ny.gov	Locations of large sand and gravel aquifers based on surficial and bedrock geology maps
Watersheds	10- and 12-digit HUC watershed boundaries	nhd.usgs.gov	Delineate subwatersheds using the USGS StreamStats tool.
Surface water	Streams, waterbodies	nhd.usgs.gov	
NYS Protected streams and waterbodies	DEC Water Quality Classifications	gis.ny.gov	All water bodies in the state are provided a water quality classification based on existing, or expected best usage.
Trout waters	DEC Water Quality Classifications, T or T(S) attribute	gis.ny.gov	Indicates areas suitable for trout and trout spawning.
Floodplains	Flood hazard area maps developed by the Federal Emergency Management Agency (FEMA)	www.rampp-team.com/ny.htm	Floodplain maps are in the process of being updated by FEMA.
Wetlands	National Wetlands Inventory	www.fws.gov/wetlands	NWI maps are not complete for all areas of the Hudson Valley.
Wetlands	New York State Freshwater Wetlands	cugir.mannlib.cornell.edu	Maps of wetlands protected by New York State 12.4 acres and larger
Wetlands	Hydric soils, poorly and somewhat poorly drained soils	datagateway.nrcs.usda.gov	Soil drainage class can indicate possible wetlands.
Significant Biodiversity Areas	Significant biodiversity areas for the Hudson Valley	gis.ny.gov	
Coastal habitats	Significant coastal fish and wildlife habitats, Hudson River shoreline habitat type, tidal wetlands, and documented submerged aquatic vegetation (SAV)	gis.ny.gov	Information used for state coastal consistency analysis
Forests	Large forest acreages for the Hudson Valley	gis.ny.gov	Forest cover based on analysis of 2010 C-CAP data
Significant Ecosystems	Significant natural community occurrences documented in NYS; important areas for documented rare plants, rare animals, and significant ecosystems for the Hudson Valley	gis.ny.gov	Information collected by the New York Natural Heritage Program
Historic sites	National Register sites, NYS historic sites and park boundaries, NYS Heritage Areas	nysparks.com/shpo	
Recreation sites	Outdoor recreation destinations, DEC lands and campgrounds, DEC points of interest, DEC roads and trails, NYS landmarks, NYS recommended public fishing sites	gis.ny.gov	
Land use/land cover and impervious surfaces	National Land Cover Database (NLCD)	www.mrlc.gov	Data derived from 30-meter resolution satellite imagery; most useful at townwide scale
Land cover	Coastal Change Analysis Program (C-CAP) land cover data	coast.noaa.gov/digitalcoast	Data derived from 30-meter resolution satellite imagery; most useful at townwide scale
Farmland soils	Prime farmland, farmland of statewide importance	datagateway.nrcs.usda.gov	
Agricultural districts	Agricultural district boundaries	gis.ny.gov	
Protected lands	NY Protected Areas Database	www.nypad.org	
Conservation easements	National Conservation Easement Database	conservationeasement.us	

APPENDIX D: INFORMATION ABOUT COMMONLY USED MAPS

Maps contain a wealth of information that can contribute to the data used in a Natural Resources Inventory (see Chapter 4), provide the basis for map analysis used in biodiversity assessment (see Appendix E), and enable remote analysis of project sites for environmental review. When using map and air photo resources, it's important to recognize their limitations. Make note of the publication date; it is usually printed in the legend or in a margin. Depending on when it was created, it's possible that changes on the landscape are not reflected on the map. Also check the scale of the map. Several of the maps discussed below are produced at a 1:24,000 scale; this indicates that one inch on the map equals 24,000 inches, or 2,000 feet on land. Being mindful of the scale at which the map was produced and the inherent inaccuracies of maps will help to prevent over-interpretation of the information they contain. (See Chapter 3 for more information on map scale.)

The following maps, which are widely available, are described below:

- USGS Topographic Maps
- NRCS County Soil Survey Maps
- National Wetlands Inventory Maps
- Aerial Photographs.

Use of these maps, and complementary sources like the NYS Freshwater Wetlands map, is also discussed in the Soils, Wetlands, and Wetland Habitat sections of Chapter 4. A summary of how to obtain paper copies of these maps and air photos is contained in Table D-1.

Table D-1. Commonly used paper map resources and air photos and contact information for obtaining copies.

Map	How to Obtain
7.5 minute Topographic Quadrangles	United States Geological Survey store.usgs.gov County Soil and Water Conservation District offices; USGS distribution centers; certain local book, map, or outfitting stores
Bedrock and Surficial Geology Maps	New York State Museum Publication Sales www.nysm.nysed.gov/pubsforsale/detailcfm?-publD=5261 (518) 402-5344
County Soil Surveys	County soil and water conservation district offices
National Wetland Inventory (NWI) Maps	Institute for Resource Information Systems (607) 255-6520
New York State Freshwater Wetlands	Syracuse Blue Print Company (315) 476-4084
Aerial Photography from the National Agricultural Imagery Program (NAIP)	Farm Service Agency office or website http://www.fsa.usda.gov/FSA/apfoap?area=home&subject=prog&topic=landing (801) 844-2922

USGS Topographic Maps

USGS topographic maps (see Figure D-1) convey information about physical and ecological features of the landscape, including elevation, landscape contours, surface water features, significant cultural features, general forest cover, and some wetlands. Topographic maps have a relatively high level of accuracy (depending on when published), are low cost (or free), and readily available.

Topographic maps may be purchased from many bookstores and outdoor supply stores, by calling 1-888-ASK-USGS, or through the website, http://store.usgs.gov. To order or purchase topographic maps, determine the name(s) of the quadrangles in the study area using an index of topographic maps from the USGS, available from the toll free number or website given above. Note that it may be necessary to obtain several adjacent maps to ensure coverage of the whole study area.

USGS topographic maps are also available digitally for free through the USGS website at http://nationalmap.gov/ustopo/. Some advantages of this digital data are:

- maps may be seamlessly joined for a selected study area
- scale may be adjusted to match the scale of other maps used in the inventory
- features identified on the topographic map may be translated into coordinates that can be used in GIS applications
- other features available as GIS data can be shown as overlays on a topographic base map.

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Topographic Quadrangles

The US Geological Survey (USGS) uses the geographic grid to determine the position of individual map sheets in a series. A single map sheet, or *quadrangle,* is bounded on the right and left hand margins by meridians, and on the top and bottom by parallels which are a specified number of minutes or degrees apart. In this way, individual map sheets can be fitted together to form unified groups.

Most municipalities span several USGS topographic quadrangles. All of the quadrangles including portions of the municipality (or study area) should be obtained and matched to make a composite topographic map of the whole town. NOTE: This step is unnecessary if using seamless digital data.

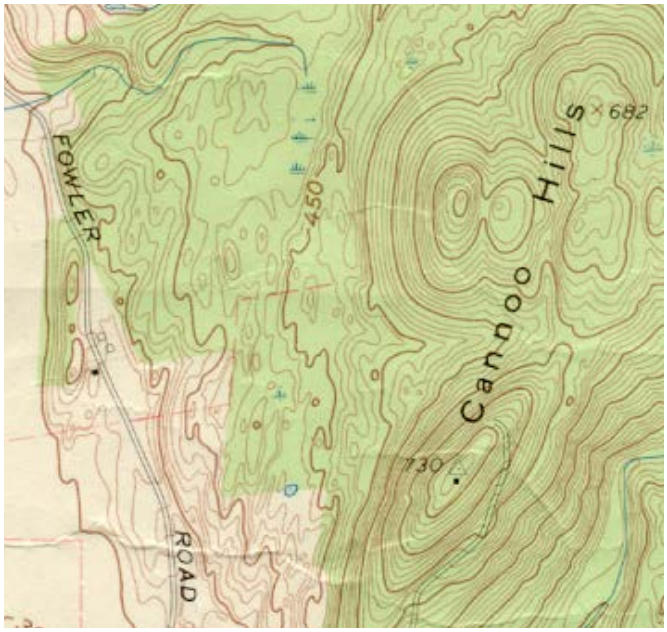

Figure D-1: Sample of USGS topographic map.

Topographic maps are a useful resource for biodiversity assessment (see Appendix E), and can help to identify steep slopes, intermittent streams, wetlands, small waterbodies, and groundwater seepage areas, among other features that are often absent from other publicly available map resources. When analyzing topo quads, it is useful to note the map scale, year, contour interval, and the date of any revisions. Historic topographic maps, some dating back to the 1880s, are available at http://ngmdb.usgs.gov/maps/TopoView/ and at http://docs.unh.edu/nhtopos/NewYorkList.htm. They can be useful for identifying changes in land use over time.

USGS topographic maps are also used by the StreamStats Tool, available on the USGS website at http://water.usgs.gov/osw/streamstats/new_york.html. This program can help identify and delineate subwatersheds below the 12-digit HUC level and calculate estimated stream flows via a statewide interactive map. Note that field inspections are important to determine the accuracy of computer-generated watershed delineations, which are defined strictly by topography and are unable to detect alterations to natural drainage areas like stormwater diversions (e.g., ditches) and infrastructure (e.g., pipes). Instructions for how to use StreamStats are available at http://water.usgs.gov/osw/streamstats/UserInstructions-20120427.pdf.

NRCS County Soil Survey Maps

The USDA Natural Resources Conservation Service (NRCS) has mapped the soils for each of New York's counties at various times. Published soil surveys include maps and detailed information about the types of soils found in the survey area, and the uses and limitations associated with each soil type. They provide valuable information to farm and forest landowners, developers, planners, and natural resource managers.

To classify soils, soil scientists study the landscape and dig test holes to expose and compare soil profiles. A *soil profile* is a sequence of natural layers referred to as horizons. These differ from one another because of physical, chemical, and biological properties and the effects of weathering and human activity. Soil horizons extend from the surface to the *parent material,* a zone that hasn't been altered by leaching or the action of plant roots.

Soil maps classify soils into series, types, and phases. *Soil series* delineates soils originating from the same parent materials and having relatively uniform structural engineering properties except for texture. Each soil series is named for a town or geographic feature near the place where it was first observed and mapped. Soil series is the main unit of a county's detailed soil survey. Within a series, differing soils are broken down into *soil phase* categories according to slope and other properties. The polygons or *map units* displayed on the soil maps are differentiated at the phase level.

The soil survey map (see Figure D-2) uses 2-3 letter codes to differentiate soil mapping unit locations. Slope is indicated by the last upper case letter in the soil symbol, and ranges from gentle slopes ("A") to the steepest slopes ("F"). For example, soils mapped with the code "SkD" in the Dutchess County soil survey belong to the Stockbridge soil series and have slopes that are strongly sloping to steep or hilly, ranging between 15 and 20 percent.

Paper copies of county soil survey maps can be purchased from the county soil and water conservation district and show the relative location of a soil series overlaid onto black-and-white aerial photographic base maps. Digital soil survey data are also available through the NRCS SSURGO database website at http://datagateway.nrcs.usda.gov and can be viewed online using the Web Soil Survey tool. An example of a soil survey map follows.

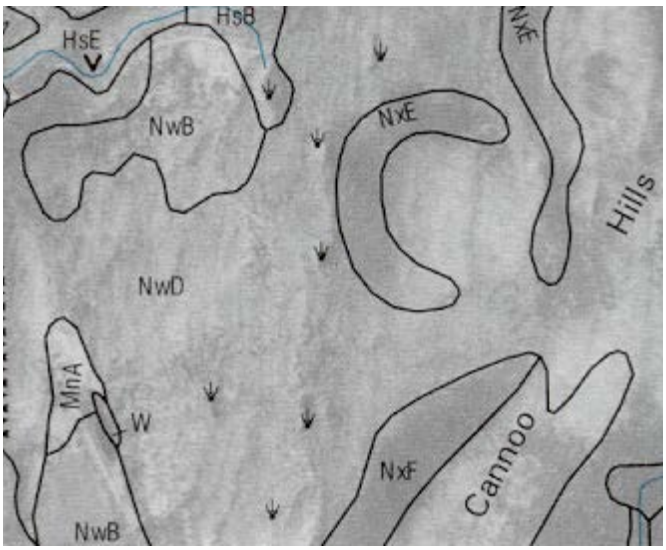

Figure D-2: Sample of soils map.

National Wetlands Inventory Maps

The following information about National Wetlands Inventory maps was compiled from a number of sources including, "Open Space Lands, A Community Resource," Jeanie McIntyre, Upper Valley Land Trust, and "Classification of Wetland and Deepwater Habitats of the United States," Lewis Cowardin, US Fish and Wildlife Service.

In the mid-1970s, the US Fish and Wildlife Service (USFWS) undertook the National Wetland Inventory (NWI) to map all the wetlands in the United States. NWI maps are produced on a USGS topographic base at a scale of 1:24,000 (Figure D-3). These maps provide information about the wetland vegetation classes, flooding regime, and location in the landscape.

In New York State, the Cornell University Institute for Resource Information Sciences (IRIS) is the official distribution center for hard copy maps generated through the inventory program, which may be purchased for a relatively low cost. The maps are identified by their corresponding USGS quadrangle name. Digital NWI data are available for free for much of the state through the USFWS website, http://www.fws.gov/wetlands. You can also view wetlands data on the site using the Wetlands Mapper.

National Wetlands Inventory (NWI) maps for New York were developed by USFWS using small-scale color infrared aerial photography taken from 1974 forward. From these aerial photographs, preliminary maps were then randomly field checked for accuracy. NWI maps show wetlands of all sizes, but some wetlands are missing and boundaries are often inaccurate.

The USFWS classifies wetlands using a hierarchical method of classification that combines plant, soil, and frequency of flooding information. This method classifies wetlands by System, Subsystem, Class, Subclass, and Dominance Type. System and Subsystem are the most general levels of classification. Class, Subclass, and Dominance Types are very specific.

Wetlands on NWI maps are grouped into five major **Systems:** Marine, Estuarine, Riverine, Lacustrine, and Palustrine. The *Marine System* is comprised of open ocean areas with salinities in excess of 30%. *Estuarine System* areas are semi-enclosed by land, have sporadic or obstructed access to the open ocean, and salinities ranging from 30% to 0.5%. *Riverine Systems* are associated with all freshwater rivers and streams. *Lacustrine Systems* are primarily associated with lakes and include bodies of open water that are greater than 20 acres with depths exceeding 6.6 feet. *Palustrine Systems* are non-tidal marsh and swamp associated wetlands dominated by trees, shrubs, or persistent emergent herbaceous plants.

The **Subsystem** level is next. All but the Palustrine System have Subsystems. Subsystem defines whether the wetlands system is tidal or nontidal, perennial or intermittent, limnetic (deepwater), or littoral (shallow).

The **Class** level describes the general appearance of the wetland habitat in terms of either the dominant life-form of the vegetation or the nature of the substrate underlying the wetland. Vegetation is used to define the Class level if it covers 30% or more of the substrate.

Subclass is identified for some Classes when additional detail is desirable and can be determined accurately. Subclass is usually noted for only forested and scrub-shrub classes.

Water Regime describes the frequency and duration of water on each wetland.

Special Modifiers are sometimes added to the classification to describe certain circumstances that are pertinent to the description of the wetland. For example, the modifiers "excavated" or "partially drained" denote impacts to the wetland System.

Example: The classification information about each wetland is abbreviated and displayed on NWI maps according to the hierarchical order described. Figure D-3 provides an example of an NWI wetlands map from the USFWS Wetlands Mapper. If for example, a wetland is coded as PEM1E, the legend would indicate that the classification is as follows: **P**alustrine (System), **EM**ergent (Class), **1** broad-leaved deciduous (Subclass), **E** seasonally saturated (Water Regime).

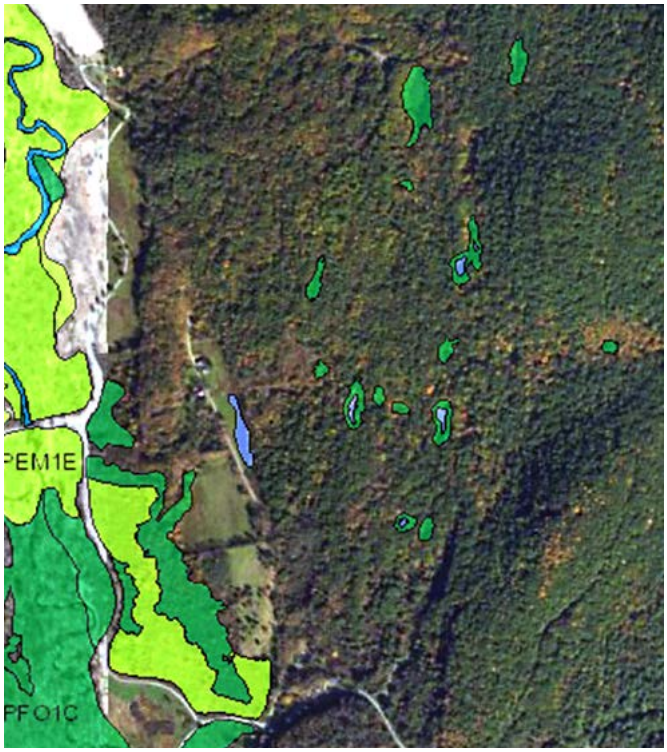

Figure D-3: Sample of NWI map from the USFWS Wetlands Mapper.

Aerial Photographs

Aerial photographs are useful for verifying or updating maps generated from other sources. Comparison of older photographs with more recent images can provide a visual overview of land use changes, such as land clearance, development, beaver activity, or forest regrowth.

Digital orthophotography, or orthoimagery, refers to aerial photography that has been geometrically corrected ("orthorectified") to remove distortion caused by camera optics, camera tilt, and differences in elevation. The resulting scale is uniform and the images can be overlain onto maps. Thus, orthoimagery can be used as a base map in GIS and displayed with other digital data sources.

New York State's first set of 1-meter statewide digital orthoimagery was produced from 1994-1999 through a partnership between the USGS National Aerial Photography Program (NAPP) and DEC. The NAPP series contains color-infrared imagery, which is particularly useful for predicting the occurrence of habitats in biodiversity assessment (see Appendix E). The New York Statewide Digital Orthoimagery Program (DOP) has been producing orthoimagery since 2001. High-resolution, 1-2 foot 4-band orthoimagery is available statewide outside of New York City. The 4-band imagery contains both color and infrared bands. Many counties have multiple years of DOP coverage. The program's goal is to continue obtaining imagery for the entire state on a 4 to 5 year cycle. All digital orthoimagery is available for download from the NYS GIS Clearinghouse, and may be viewed using the NYS Orthos Online website.

In addition to digital orthoimagery, statewide aerial photographic coverage is available for New York at about ten year intervals starting in the 1950s through the US Department of Agriculture National Agriculture Imagery Program (NAIP). Digital or print imagery can be obtained through Farm Service Agency offices or the Farm Service Agency website. NAIP imagery products are available either as digital ortho quarter quad tiles (DOQQs) or as compressed county mosaics (CCM), or in print reproduction on paper sizes that range from 10 inches by 10 inches to 38 inches by 38 inches.

Figure D-4: Sample of color-infrared orthophoto.

APPENDIX E: BIODIVERSITY ASSESSMENT OVERVIEW

In 2001, the New York State Department of Environmental Conservation (DEC) published the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (2001) by Erik Kiviat and Gretchen Stevens of Hudsonia Ltd. The manual profiles 38 ecologically significant habitat types of New York's Hudson Valley, including tidal and non-tidal wetlands and uplands; discusses the plants and animals of conservation concern each habitat may support; and provides recommendations for protecting the biodiversity values of those habitats. The manual also provides an approach for using existing map resources and air photos to predict the locations of ecologically significant habitat in the Hudson River estuary watershed. This method is described in greater detail in the *Biodiversity Assessment Guidebook* (Heady and Stevens 2011).

The biodiversity assessment method was designed for use by community volunteers, such as members of conservation advisory councils (CAC) and planning boards, as well as professional biologists and planners working in the region. Assessment involves use of readily-available data sources to identify potential locations of habitats. Map information such as soil drainage, bedrock chemistry, wetlands, and slope is paired with air photo signatures to identify habitats such as upland forest, wet clay meadow, intermittent stream, tidal marsh, and carbonate crest. Use of Geographic Information Systems (GIS) can enhance the process but is not necessary. Finally, site visits are recommended to verify habitat predictions and refine the habitat map.

Volunteers display completed habitat maps. © M. Taylor

Since 2002, hundreds of municipal officials, land trust staff, planners, and community volunteers have completed training in biodiversity assessment through a partnership with Hudsonia and the DEC Hudson River Estuary Program. Many participants have used the approach to pursue habitat mapping projects and to advance conservation practices in their community.

The biodiversity assessment project process involves the following steps:

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Form a team. It is recommended to include both municipal officials and community volunteers in the assessment team. A good-sized group has about 7 to 10 members, but the most important factor is finding members willing to make a time commitment to learning the techniques and applying them to the study area and municipal planning.

Identify a study area. The size of the study area will depend on the capacity of the group, but a goal of several thousand acres is a good start. Criteria for selecting a study area may include potential threats, conservation opportunities, important resources, or lack of information. The area can include both public and private lands.

Gather materials. Once a study area is selected, it is recommended that the group first gather existing information about the study area, such as local biological surveys or environmental review documents. Next, the group will need to acquire the resources necessary to conduct map and air photo analysis. These include bedrock geology maps, topographic maps, county soil surveys, wetland maps, stereoscopic aerial photos, and digital orthoimagery. Many of the resources gathered for the municipal NRI will be valuable for this process. See Appendix C for sources of GIS data and Appendix D for how to obtain commonly used paper maps and aerial photos.

Analyze the information. There are properties of maps and air photos that are particularly useful to biodiversity assessment, and combinations of signatures that are indicative of particular habitats. The manual and guidebook both provide guidance on map analysis, and the Hudson River Estuary Program and Hudsonia offer periodic trainings and short courses for hands-on learning of these skills. The process involves compiling information for the study area and then sketching out where several predictors of habitats occur. For example:

> *Topographic maps* can be used to identify steep slopes with potential for rocky habitats and intermittent streams, and find low-lying or level areas where wetlands may occur or knoll-and-basin terrain where vernal pools may be located.
>
> *Soils maps* can be used to characterize the drainage, chemistry, and depth to bedrock in the study area, which can help to predict the occurrence of wetlands, rocky habitats, and pH-dependent habitat types.
>
> *Air photos* can be used to inform the map-based habitat predictions by looking at vegetation type, wetland signatures, and land use.

Using a base map such as orthoimagery or a topographic map and reviewing the other maps, the group can analyze overlapping resources and draw boundaries to indicate where particular habitats may occur. Groups with GIS capacity can digitize the habitat boundaries onto a suitable base map.

Field verify. Once habitat predictions have been sketched or digitized, field visits will help to confirm the habitat type. For example, although there are several map signatures that can help to predict the location of vernal pools, a site visit is needed to look at and verify the wetland. Similarly, map analysis may suggest the location of a wet meadow, but a site visit to look at plants will determine whether it is a wet clay meadow or calcareous wet meadow. Conducting field verifications requires contact with landowners to get permission to access private lands. Local land trusts may be helpful as they often have good working relationships with landowners. Where permission is not granted, sometimes a visual survey from the road or adjacent lands may help confirm habitat types.

Finalize the map and documentation. After revising the draft habitat map based on field work, the group should be on its way to having a habitat map that can be added to the NRI and used for environmental reviews, municipal planning, and education. The map will be most useful if it's digitized and able to be used in GIS (see Figure E-1). Habitats on the map should be labeled and the map should include a title, scale bar, north arrow, legend, and a disclaimer that clearly states the appropriate uses of the habitat map and limitations for site-level planning given the scale and predictive nature of the habitat mapping.

Communities that have undertaken a biodiversity assessment project have been successful in implementing follow-up conservation actions, including expanding the study area to new parts of their community, creating habitat assessment protocols for planning board reviews, and incorporating their habitat maps into a municipal NRI (see Appendix J).

Helpful resources:

Heady, L. and G. Stevens. 2011. Guidebook for Biodiversity Assessment: A Companion to the Biodiversity Assessment Manual for the Hudson River Estuary Corridor. Hudsonia Ltd., Annandale, NY. 86 pp.

Kiviat, E. and G. Stevens. 2001. Biodiversity Assessment Manual for the Hudson River Estuary Corridor. NYS Department of Environmental Conservation, Albany, NY. 507 pp.

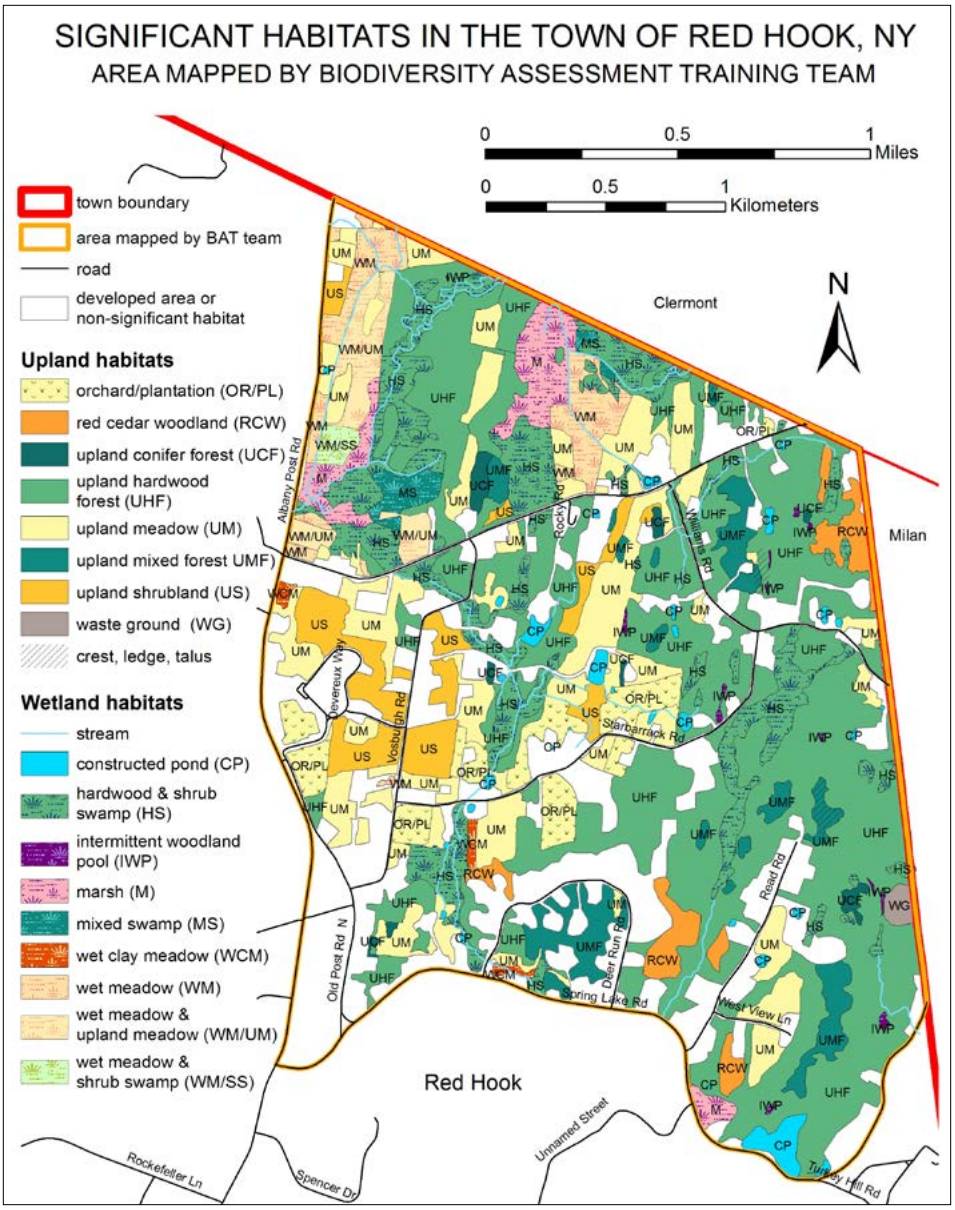

Figure E-1: Example of a habitat map created by a volunteer biodiversity assessment team and digitized for use in GIS.

APPENDIX F: HUDSON VALLEY CLIMATE RESILIENCE

New York's changing climate presents new challenges and opportunities for communities. It is vital for local decision-makers to understand their community's vulnerability to changing climatic conditions and consider their natural resources as an important asset in planning for resilience, managing climate risks, and recovering quickly from extreme weather events.

The New York State Energy Research and Development Authority (NYSERDA) has been studying, documenting, and modeling the impacts of climate change in New York State for several years. This appendix presents climate trends and projections for the East Hudson and Mohawk River Valleys from NYSERDA's *Responding to Climate Change in New York State* (ClimAID) (Rosenzweig et al. 2011, Horton et al. 2014), as well as opportunities from the New York Climate Smart Communities program for putting a natural resources inventory to action for building climate resilience. A summary of projections for the West Hudson Valley, New York City, and Long Island can be obtained at www.dec.ny.gov/docs/remediation_hudson_pdf/cphv.pdf.

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Climate Hazards in New York State

Three significant climate hazards are expected to affect New York State residents during the 21st century: increasing temperatures, rising sea level, and changing precipitation patterns.

Increasing Temperatures

Annual average temperatures have been steadily rising in New York State. Since 1970, they have been increasing at a rate of 0.6 degrees Fahrenheit (F) per decade. In winter months, this warming effect is even greater, at 1.1 degrees F per decade.

Since 1970, temperature increases in New York have surpassed national and global averages:

- Global annual average temperature up nearly **1°F**
- U.S. annual average temperature up **1.8°F**
- New York annual average temperature up nearly **2°F**
- New York winter temperatures up almost **5°F.**

Models project that annual average temperature in the Hudson Valley region will rise by an additional 4 to 6°F by 2050; and 6 to 11 °F by 2100.

Air Temperature Projections (°F)	Baseline 1971-2000	2020s	2050s	2080s	2100
Annual average air temperature	50°F	52.3 - 53.2°F	54.5 - 56.2°F	55.6 - 59.7°F	56.1 - 61.4°F
Increase in annual average	—	2.3 - 3.2°F	4.5 - 6.22°F	5.6 - 9.72°F	6.1 - 11.4°F

Rising Sea Level

Global sea level is rising due to various factors, including thermal expansion from warmer water temperatures and melting of land-based ice. Because the Hudson River estuary is connected to and influenced by the sea, it experiences tides, contains saltwater in its lower reaches, and its water level is rising with global sea level. Sea level rise along New York's coastline is greater than the global average due to readjustment of the Earth's crust from the last ice age and other local factors. Since 1900, sea level in the lower Hudson has risen one foot. Sea level in New York harbor has risen 15 inches in the last 150 years. It is projected to increase another 11 to 21 inches or more by 2050. At the upper range of projections, it is possible that Hudson riverfront communities could experience as much as six feet of sea level rise by the end of the 21st century.

Sea Level Rise Projections (inches)	Baseline 1971-2000	2020s	2050s	2080s	2100
Mid-range estimate of rise for Troy Dam	—	3 - 7″	9 - 19″	14 - 36″	18 - 46″
Mid-range estimate of rise for NYC	—^	4 - 8″	11 - 21″	18 - 39″	22 - 50″

Changing Precipitation Patterns

Precipitation has become more variable and extreme, whereas total rainfall has changed only marginally. Annual rainfall occurring in heavy downpour events increased 74% between the periods of 1950-1979 and 1980-2009. Projections indicate that total annual precipitation could increase almost 15% by mid-century.

In the future, Hudson Valley communities can expect more dry periods intermixed with heavy rain events and decreased snow cover in winter.

Precipitation Projections (inches)	Baseline 1971-2000	2020s	2050s	2080s	2100
Total annual precipitation	51″	52″ - 54.5″	53″ - 57″	53.5″ - 58.5″	53.5″ to 61.5″
% Increase in annual precipitation	—	2 - 7%	4 - 12%	5 - 15%	5 - 21%
# Days with precipitation > 1″	10	14 - 15	14 - 16	15 - 17	*
# Days with precipitation > 2″	1	3-4	4	4-5	*

* No data available

Climate Risks

Increasing temperatures, rising sea levels, and changing precipitation patterns will lead to climate risks that Hudson Valley communities can start preparing for now. This section introduces major climate risks associated with these hazards.

Heat Waves

Increasing annual temperatures will lead to more frequent, intense, and long-lasting heat waves during the summer, posing a serious threat to human health. The number of days above 95 degrees F is expected to more than triple by 2050 and rise dramatically by 2080, while the number of days below freezing will steadily decrease.

Heat Wave Projections	Baseline 1971-2000	2020s	2050s	2080s	2100
# Days per year above 90°F	10	26-31	39 - 52	44 - 76	*
# Days per year above 95°F	1	2 - 4	3 - 10	6 - 25	*
# Heat waves per year	2	3 - 4	5 - 7	6 - 9	*
Average # days of each heat wave	4	5	5 - 6	5 - 7	*
# Days per year ≤ 32°F	134	52 - 58	42 - 48	30 - 42	*

* No data available

Short-term Drought

Soil moisture will likely decrease with warmer, less snowy winters, fewer steady rainfall events, and higher evaporation from increased temperatures. This could lead to more frequent and intense periods of short-term drought, threatening local drinking water supplies, base flow in streams, and agricultural production.

Flooding

Increased sea level rise and intense precipitation events could lead to more frequent flooding along the Hudson River and its tributaries, threatening waterfront assets such as homes, businesses, sewage infrastructure, roads, and more. To manage flood risk, communities should consider projected sea level rise and flooding when planning future development.

Flood projections for New York State show a dramatic increase in the probability and flood height of today's *100-year storm* (i.e., the storm with a 1% or greater chance of occurring in any year).

Flooding Projections	Baseline 1971-2000	2020s	2050s	2080s	2100
Increase in probability of 100-year flood	0%	20 - 50%	70 - 190%	140 - 610%	*
Flood height of 100-year flood (feet)	15′	15.3 - 15.7′	15.9 - 16.8′	16.5 - 18.3′	*

Scenic Hudson's online sea level rise mapper can be used to explore projected sea level rise along the Hudson River at www.scenichudson.org/slr/mapper.

Building Resilience through Adaptation

Federal and state policies can be expected to mandate strong coastal and floodplain construction standards and pre-disaster mitigation planning in order for municipalities to secure hazard mitigation funding; however, local decision-makers often have the greatest capacity to influence resilience in their communities. A natural resources inventory can be used to identify risk-prone areas as well as inform an adaptation strategy that takes advantage of the services provided by natural systems, such as floodwater retention in wetlands or reduction of heat impacts by urban forests.

Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities, *Version 2.0* (2014) and the Climate Smart Communities Certification Program provide frameworks for assessing vulnerability and implementing actions to reduce risk from climate impacts. Suggested actions that can benefit from the data in an NRI include the following:

- conserve wetlands and forests to manage stormwater, recharge groundwater, and mitigate flooding
- conserve, revegetate and reconnect floodplains and buffers in riparian areas
- discourage new construction in flood-prone areas
- protect bluffs or eroding cliffs from disturbance or development
- increase tree canopy to reduce heat impacts
- integrate sea level projections into zoning and building codes for new shoreline development.

Work groups may want to consider undertaking detailed inventory studies that contribute to resiliency planning; for example, maps of sea level rise projection along Hudson shorelines or of flood-prone areas may be especially valuable. Refer to Chapter 4 to see how these could integrate with the recommended NRI components. See Appendix B for publications and web resources for further reading.

Helpful resources:

New York State Climate Smart Communities Climate Smart Resiliency Planning: A Planning Evaluation Tool for New York State Communities Version 2.0. 2014. www.dec.ny.gov/docs/administration_pdf/csrptool.pdf

Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W.Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grabhorn (editors). 2011. Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Synthesis Report. New York State Energy Research and Development Authority (NYSERDA), Albany, NY. www.nyserda.ny.gov/climaid

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APPENDIX G: MODEL LOCAL LAW TO ADOPT THE NRI

This model local law for adopting a municipal Natural Resources Inventory was written by Ted Fink, AICP, of GREENPLAN, Inc. The template provides a starting point for integrating an NRI into municipal decision-making and can be customized to reflect the interests and needs of the community.

[Village, City, Town] of _____

Local Law No. _____ of the Year _____

A local law to adopt the [village, city, town] of _____ Natural Resources Inventory.

Be it enacted by the [village board, town board, common council] of the _____ of _____ as follows:

SECTION 1. LEGISLATIVE INTENT

This local law amends the Code of the [village, city, town] to adopt the Natural Resources Inventory prepared by _____ and to expressly integrate use of such Inventory into all land use decision-making within the [village, city, town] of _____.

SECTION 2. AMENDMENTS TO THE [village, city, town] CODE

A new Chapter ____, adopting and implementing the [village, city, town] of _____ Natural Resources Inventory, is added to the Code of the [village, city, town] _____ as follows:

> *[Commentary: Generally, a new chapter number must be assigned for any new local law that is to be added to the municipal code. This model local law should be viewed as a starting point for integrating a natural resources inventory into municipal decision-making. To effectively integrate the inventory into all decision-making, New York State provides a wide range of tools including comprehensive plans, environmental review, incentive zoning, overlay zoning, floating zones, transfer of development rights, purchase of development rights, establishment of community preservation plans (i.e. real estate transfer tax), wetland protection, steep slope protection, clustered development, tree preservation, issuance of municipal bonds, and others. Excerpts of this chapter can also be added, with modification, to the municipal subdivision regulations as well as the site plan approval procedures. It is recommended that the Inventory be added as an amendment to the municipal comprehensive plan to strengthen its application and integration with other laws and regulations. Municipalities should consult with county planning departments or professional planners on which approaches are right for the community.]*

A. Purpose. The purpose of this Chapter is to protect natural resources in the [village, city, town] of _____ by adopting a Natural Resources Inventory, thereby enabling management and use of natural resources for present and future residents. The [village, city, town] of _____'s protection and sustainable use of its natural resources will protect the rights of residents, both present and future, to clean air, pure water, and the natural, scenic, and aesthetic values of the environment, as set forth in Article XIV, Section 4 of the New York State Constitution. The [village, city, town] of _____'s quality of life will be enhanced by the sustainable management of its natural resources, including diverse habitats, natural systems and cultural resources. Such features have been identified in the [village, city, town] of _____ Natural Resources Inventory, as it may be amended from time to time. The mapping of natural resources by the [village, city, town], in accordance with the New York General Municipal Law § 239-y and the [village, city, town] Comprehensive Plan, constitutes the [village, city, town]'s Natural Resources Inventory (NRI). The incorporation of natural and cultural resource information into the decision-making processes identified herein will enable the [village, city, town] to balance its responsibility to promote the economic well-being of [village, city, town] residents, while protecting the integrity and value of the [village, city, town] of _____'s natural areas, including the [village, city, town]'s soils, water resources, habitats and wildlife, and other significant environmental resources. This Local Law, adopted pursuant to New York Municipal Home Rule Law, § 10(1)(ii)(a)(11), requires that all new development subject to [village, city, town] subdivision, site plan and special use permit review and approval, shall take into consideration the [village, city, town] NRI.

> *[Commentary: The purposes of a local law must be clear and unambiguous. Relating the purposes of incorporating a natural resources inventory into municipal decision-making, with one of the few land use objectives found in the New York State Constitution, elevates the significance of local natural resource information. Equally important is to cite relevant sections of New York State's General Municipal Law, which authorizes the development of a natural resources inventory, and Municipal Home Rule Law, which authorizes local governments to adopt land use laws "for the protection and enhancement of its physical and visual environment."*
>
> *The model has been structured to function either as a guideline or a standard. If it is to be used as a "guideline," use of the term "should" will be selected. If it is to be used as a "standard," use of the term "shall" will be selected. In both cases, the NRI will become an integral part of the review and approval process of the community because natural resource information will be considered during the review and approval of all applications subject to it.]*

B. Intent. It is the intent of the [village, city, town] of _____ to establish an NRI review process to guide land use development decision-making, by facilitating New York State Environmental Quality Act (SEQR) requirements during reviews of proposed subdivision, site plan, and special use permit applications, and by incorporating protection of natural resources into the design of projects. The NRI review process will enable applicants to know well in advance what will be required during the [village, city, town]'s review of applications, thus avoiding unnecessary delay and expense during the review process. The [village, city, town] NRI [shall/should] be used as a basis for identifying natural and cultural resources on a property subject to [village, city, town] review under subdivision, site plan, and special use permit review and approvals, but because of its general nature, additional on-site assessment surveys may be necessary. The NRI review process enables the [village, city, town] to make better planning decisions, establish consistent [standards/guidelines] for development proposals, fulfill regulatory obligations imposed by SEQR, and to protect and maintain natural resources while preserving economic viability as follows:

[Commentary: The intent of a Local Law is memorialised through findings. The findings of a local law help to correlate relevant legal standards to the decisions made by a municipal board. The board which clearly memorialises detailed and carefully written findings gives itself the best insurance against successful challenge.]

1. Integrating the NRI review process into the planning, design, review and approval processes of the [village, city, town] of _____ facilitates biodiversity conservation, preserves surface and groundwater resources, helps maintain natural areas, reduces impacts on agriculture and especially irreplaceable prime farmland soils, protects visual resources, scenic areas and recreational opportunities, supports community values, protects and enhances property values, and provides ecological connections throughout the community.
2. The [village, city, town] of _____ intends to use the NRI as a starting point for more detailed greenspace protection planning that includes a variety of locally identified factors, such as agricultural soils, important habitats or natural features, significant views, settings for historic structures, or potential for public access. It is the intent of the [village, city, town] of _____ to maintain the NRI as a dynamic resource base, and to update the information contained within it on an on-going basis, to ensure accuracy, as new data becomes available.
3. Land development may be associated with negative impacts to watersheds, which may result in degraded water quality, reduced water supply, increased pollution, erosion and sedimentation, damage to streams and wetlands, poor drainage and flooding.
4. Healthy natural systems comprise the landscapes valued by [village, city, town] residents. Ecological imbalances resulting from improperly sited development and its adverse impacts can lead to degraded landscapes and a loss of ecosystem values.
5. It is ultimately more cost effective for the [village, city, town] to protect significant natural resources rather than attempt to restore them once they have been damaged or lost. This proactive stance will guide development, not prohibit it, and can greatly influence decisions about how development occurs on a particular site.
6. The [village, city, town] of _____ intends to use the NRI as a starting point for more detailed greenspace protection planning that includes a variety of locally identified factors, such as agricultural soils, important habitats or natural features, significant views, settings for historic structures, or potential for public access.
7. The intent of these regulations is to make the [village, city, town] of _____ a more sustainable community, one that develops and prospers without depleting or destroying the environmental, historic, and visual resources that provide the basis for that prosperity.

C. Natural Resource Identification. Specific resources identified in the NRI [shall/should] be incorporated into the Planning Board's review process. In all land use decisions subject to this Chapter, integration of the NRI information will be a valuable tool for planning land uses that are compatible with existing natural resources by minimizing impacts and providing acceptable mitigation measures when impacts cannot be avoided. Proposed lot layouts and development should be designed and arranged to avoid impacts to features identified in the Natural Resources Inventory. NRI resources are to include, but are not limited to:

1. Water resources including aquifers; streams and waterbodies with their State water quality classification; floodplains; wetlands and vernal pools, whether or not they are protected by local, state or federal regulations.
2. Vegetation including community types; forested areas; grasslands, meadows, and shrublands; significant trees defined as all trees over [X" or XX"] in diameter at breast height, trees at the limit of their range, and trees over 100 years old; New York State listed endangered, threatened, rare, and exploitably vulnerable plants or the New York State rare plant status lists; locally significant vegetation; rare or high quality examples of natural ecological communities; stream and riparian habitats; tidal wetlands and shoreline habitats; unfragmented habitat blocks and significant biodiversity areas; and vegetation resources on parcel that connect to such resources on adjoining or nearby public lands/protected areas.

3. Wildlife "Species of Greatest Conservation Need," as defined by the State of New York, including but not limited to breeding birds, reptiles, amphibians and mammals.
4. Geology and soils with particular attention to hydric, prime farmland, and soils of statewide significance.
5. Elevation, aspect and slope including rock outcrops, steep slopes of 10% to 15% and 15% or greater, ridgelines, stone walls, and unique geologic features.
6. Cultural resources including locally significant as well as State and National historic sites, buildings, and districts; scenic resources; recreation resources; agricultural districts; active farmland; and lands conserved through public ownership or private conservation restrictions.

D. Applicability. Use of the NRI review process is required for all subdivision, special permit uses, uses requiring site plan approval, or other [village, city, town] development reviews that are subject to SEQR. Each application shall contain a conservation analysis, consisting of inventory maps, description of the land, and an analysis of the conservation value of various site features identified from the NRI. The conservation analysis shall show lands with conservation value, including but not limited to: Land exhibiting recreational, historic, ecological, water resource, scenic or other natural resource value, as shown in the NRI. *[Option. When the NRI review process is "encouraged" rather than made "mandatory" under Section C above, it is suggested that the following statement (or similar one) be made in the above paragraph on applicability: "While use of the NRI review process is non-binding but should be used in the Board's exercise of discretion when reviewing an application subject to this section. Such discretion should include a finding that the public interest in natural resources is protected, the subdivision or site plan is in keeping with the general spirit and intent of these regulations, and full compliance with SEQR is provided].*

> *[Commentary: Each municipality will choose what aspects of its land use controls to include in the section on applicability. The three most common forms of land use control authority have been included. Zoning amendments, zoning variances and other forms of community decision-making (such as municipally sponsored actions) can be included or excluded in this subsection. Ideally, the sections of zoning, subdivision regulations, and site plan regulations that outline what information must be included on any application for approval, should also be amended to reference or incorporate this Chapter of the Code].*

E. Interpretation. This chapter shall be deemed an exercise of the powers of the [village, city, town] of _____ to preserve and improve the quality of the physical and visual environment on behalf of the present and future inhabitants thereof. This chapter is not intended and shall not be deemed to impair the powers of any other public corporation.

F. Definitions. Except as defined herein, all words used in this Local Law shall carry their everyday dictionary definition. Unique terms used throughout this Local Law are defined as follows:

Open Space Inventory. An inventory of open areas within the [village, city, town] with each such area identified, described and listed according to priority of acquisition or preservation.

Open Space Index. The open space inventory and natural resources inventory maps after acceptance and approval by the [village, city, town] [board, council].

Natural Resources Inventory. Any area characterized by natural scenic beauty or, whose existing openness, natural condition or present state of use, if preserved, would enhance the present or potential value of abutting or surrounding development or would establish a desirable pattern of development or would offer substantial conformance with the planning objectives of the [village, city, town] or would maintain or enhance the conservation of natural or scenic resources.

SECTION 3. SEVERABILITY.
The invalidity of any word, section, clause, paragraph, sentence, part or provision of this Local Law shall not affect the validity of any other part of this Local Law, which can be given effect without such part or parts.

SECTION 4. EFFECTIVE DATE.
This local law shall take effect immediately upon filing in the office of the Secretary of State of New York as provided by law.

APPENDIX H: SAMPLE CHECKLIST FOR ASSESSING SITE RESOURCES DURING SUBDIVISION REVIEW

The Town of Rhinebeck in Dutchess County, New York created a "Site Resource Analysis Assessment" checklist to provide guidance to applicants and the planning board during the subdivision review and approval process. The checklist could be equally useful during site plan review and approval or other development review processes of local government. Rhinebeck's zoning, subdivision regulations, and a local wetlands law were prepared by its planning consultant, Ted Fink, AICP and adopted by the town in 2009. Dutchess County's Department of Planning and Development initially developed a similar checklist in their Model Subdivision Regulations.

The checklist is used in conjunction with a "Site Resource Analysis Map" prepared by applicants under the town's subdivision regulations. The checklist is integral to the town's "Conservation Design" (cluster development) requirements but the new review process integrates a four step design process. Review of new subdivisions and other development projects in the town use this four step process to identify important natural and cultural resources on project plans; new development is then designed to avoid those areas and important natural resources are preserved as open space on the project site. All new subdivisions are subject to conservation design, unless an applicant can demonstrate that conventional subdivision will similarly protect natural and cultural resources (a special use permit is required for a conventional subdivision).

New development is subject to other design guidance including signage, lighting, landscaping, stormwater management, scenic viewshed protection, green building standards, historic building protection, and habitat management using Hudsonia Ltd.'s townwide biodiversity assessment entitled "Significant Habitats in the Town of Rhinebeck." Agriculture and forestry are encouraged in Rhinebeck as viable economic uses of open space by new "farmer-friendly" and "forester-friendly" allowances, and solar and wind energy systems have been promoted and encouraged by removing obstacles to them in the town's zoning. New provisions, also subject to the conservation design process, allow for the voluntary transfer of development rights within certain zoning districts.

Applicants initially prepare the checklist and it is then verified by the planning board during subdivision review. A pre-application process is mandatory, where applicants have an opportunity to relate the Site Resource Analysis Map and the Site Resource Analysis Assessment to the conservation of natural and cultural resources for their project. The findings from this pre-application process allow the planning board and applicants to adjust proposals early on in their design, well before more costly engineering designs are undertaken. This helps applicants in the long run because it avoids or minimizes disturbance to important resources, some of which may be costly to develop (such as steep slopes). An active Town Conservation Board also participates in the design and review of projects.

Town of Rhinebeck Site Resource Analysis Assessment

Name of subdivision: _____

Address: _____

	Yes	No	Not Sure
Are there streams, wetlands, waterbodies or watercourses that require protective buffer areas?			
Is there active farmland on the parcel(s)?			
Will the active farmland be preserved?			
Is there active farmland contiguous to or within 500 feet of the subject parcel(s)?			
Is this an Agricultural Exempt parcel(s)?			
Are there ridgelines that the Town desires to be kept clear of development?			
Could development alter the visual character from offsite areas dramatically?			
Could development alter viewshed vantage points within the property?			
Have visual mitigation measures been discussed?			
Are there high-quality trees and significant groups of trees that should be preserved?			
Is there the potential for significant wildlife habitats or wildlife migration areas?			
Do any of these significant natural areas extend into abutting properties?			
Have mitigation measures been discussed?			
Are there stone walls and rock outcrops on the site?			
Is the parcel adjacent to a public recreational area?			
Are there possibilities for walkway, bikeway and/or trail connections?			
Are there special cultural, archaeological and/or historic features that should be preserved?			
Is the parcel adjacent to or within a National, State or locally designated Historic site or district?			
Is the parcel adjacent to or within an officially designated Scenic District or Scenic Road?			
Is the parcel adjacent to or within an officially designated Critical Environmental Area (CEA)?			
Is the parcel within the Local Waterfront Revitalization Area?			
Can the development be connected to a community water supply system?			
Can the development be connected to a community sewage disposal system?			
Will affordable housing be addressed by the subdivision?			

Priority resources that should be preserved on the site:

_____

_____

_____

Recommendations:

_____

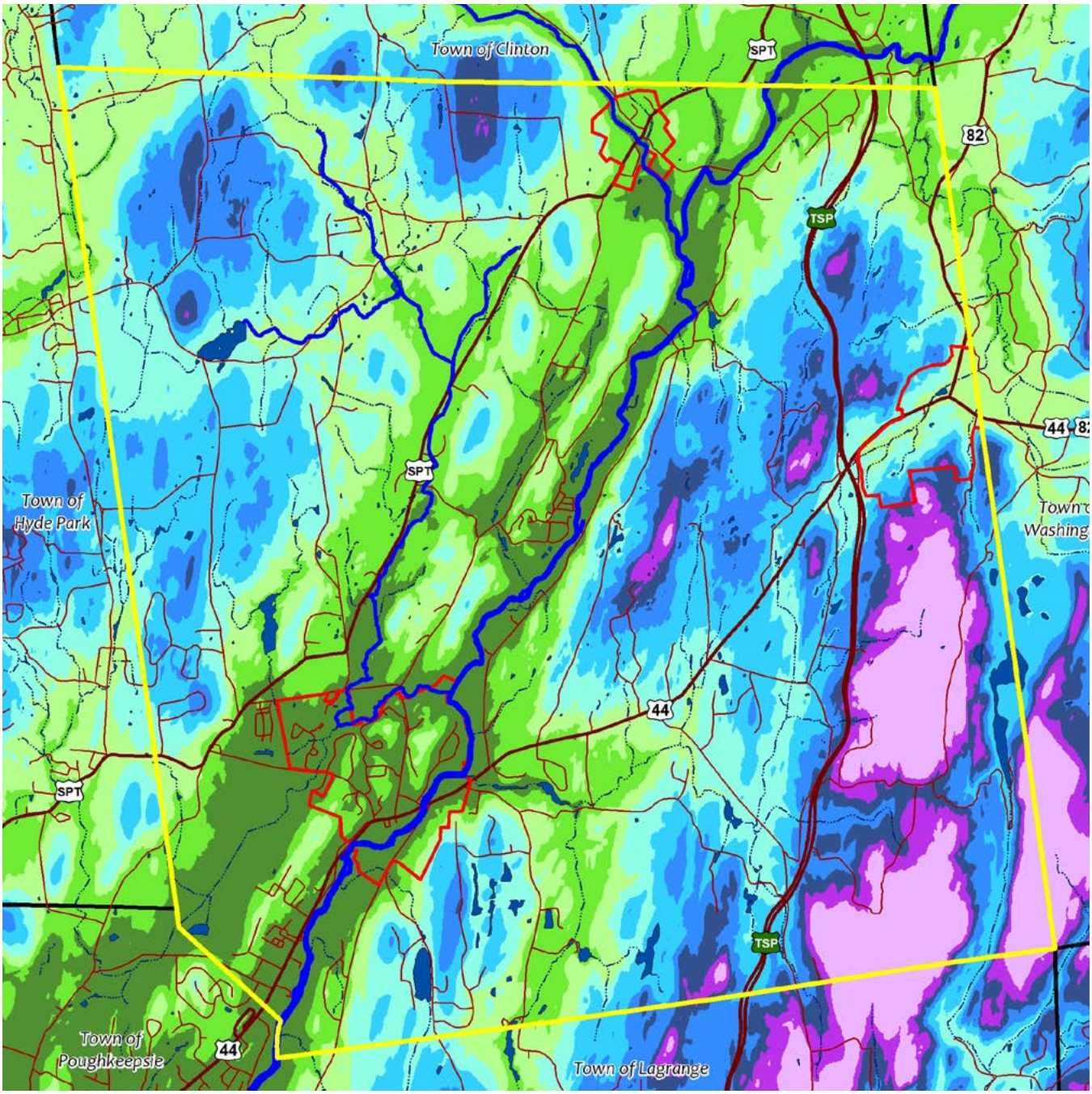
_____

Date of Planning Board site visit: _____

APPENDIX I: EXAMPLES OF MAPS FROM A MUNICIPAL NRI

The Town of Pleasant Valley in Dutchess County, NY completed an Open Space and Farmland Plan in 2013. The purpose of the plan is to assist the town with protection of significant open space and farmland resources by providing information on the importance of those resources, offering a guide on voluntary land protection and financing options, and providing short-term and long-term recommendations that will contribute to the protection of the environmental and economic health of the community. The plan includes a townwide inventory of existing natural and cultural resources, and identifies six significant resource areas. The entire plan can be viewed on the town's website at http://pleasantvalley-ny.gov/resources/reports/Open-Space-and-Farmland-Plan-2013. The following selection of maps comes from the natural and cultural resources chapter and is used with permission from Taconic Site Design & Landscape Architecture and AKRF.

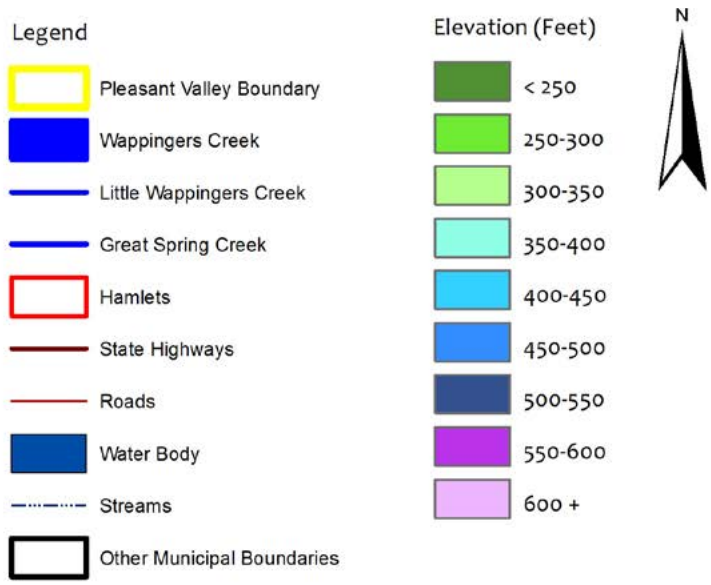
TOPOGRAPHY



The committee that worked on the plan included the following in its introductory statements:

"We propose and hope that the current and future Pleasant Valley residents and elected officials continuously consider through careful thought, the proposals stated herein when bringing the Town of Pleasant Valley into the future. We also hope that each and every one of you have clean drinking water, get to eat yogurt made from the milk from a cow who lives up the road, catch a fish in the Wappingers Creek, take a walk on a trail, eat a tomato that traveled less than 15 miles to get to your plate, play in a playground that looks like a train, see a Blanding's turtle, shop in a viable Town center, live amongst your neighbors, and take a breath of fresh air. All of that is possible through continuous careful thought of what is contained in this plan."

— Pleasant Valley Open Space Committee, 2013

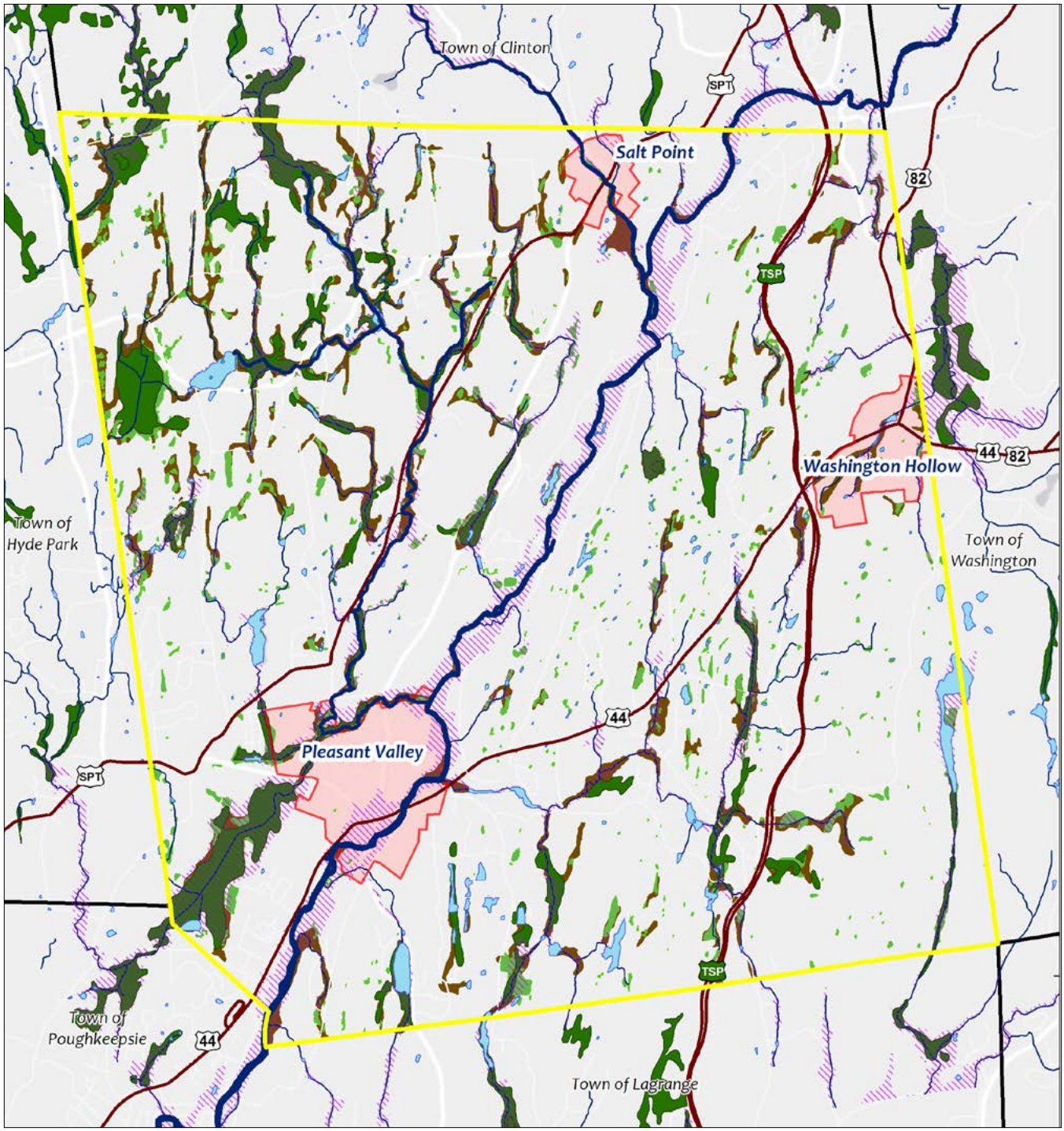


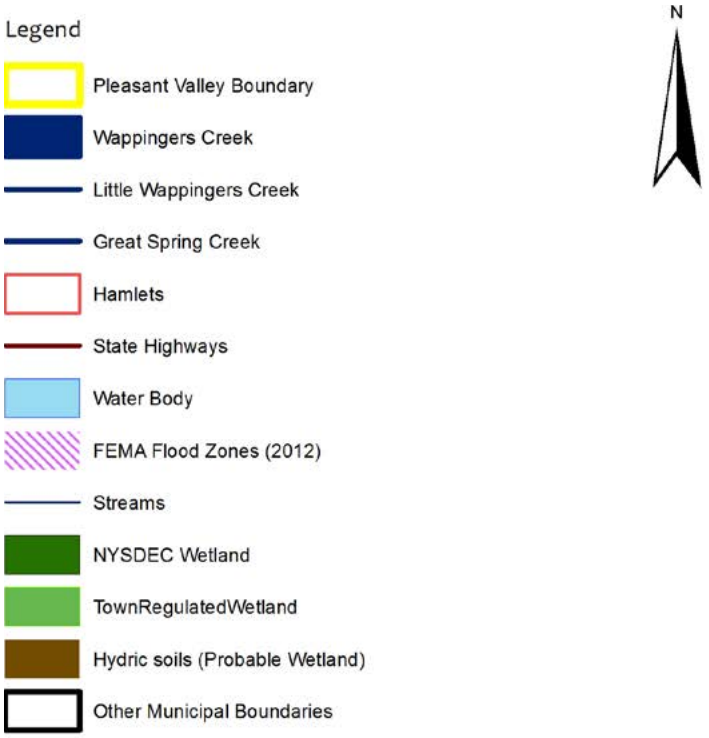
Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse

1 Miles

AKRF taconic site design & landscape architecture

SURFACE HYDROLOGY





Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Cary Institute of Ecosystem Studies

1 Miles

AKRF

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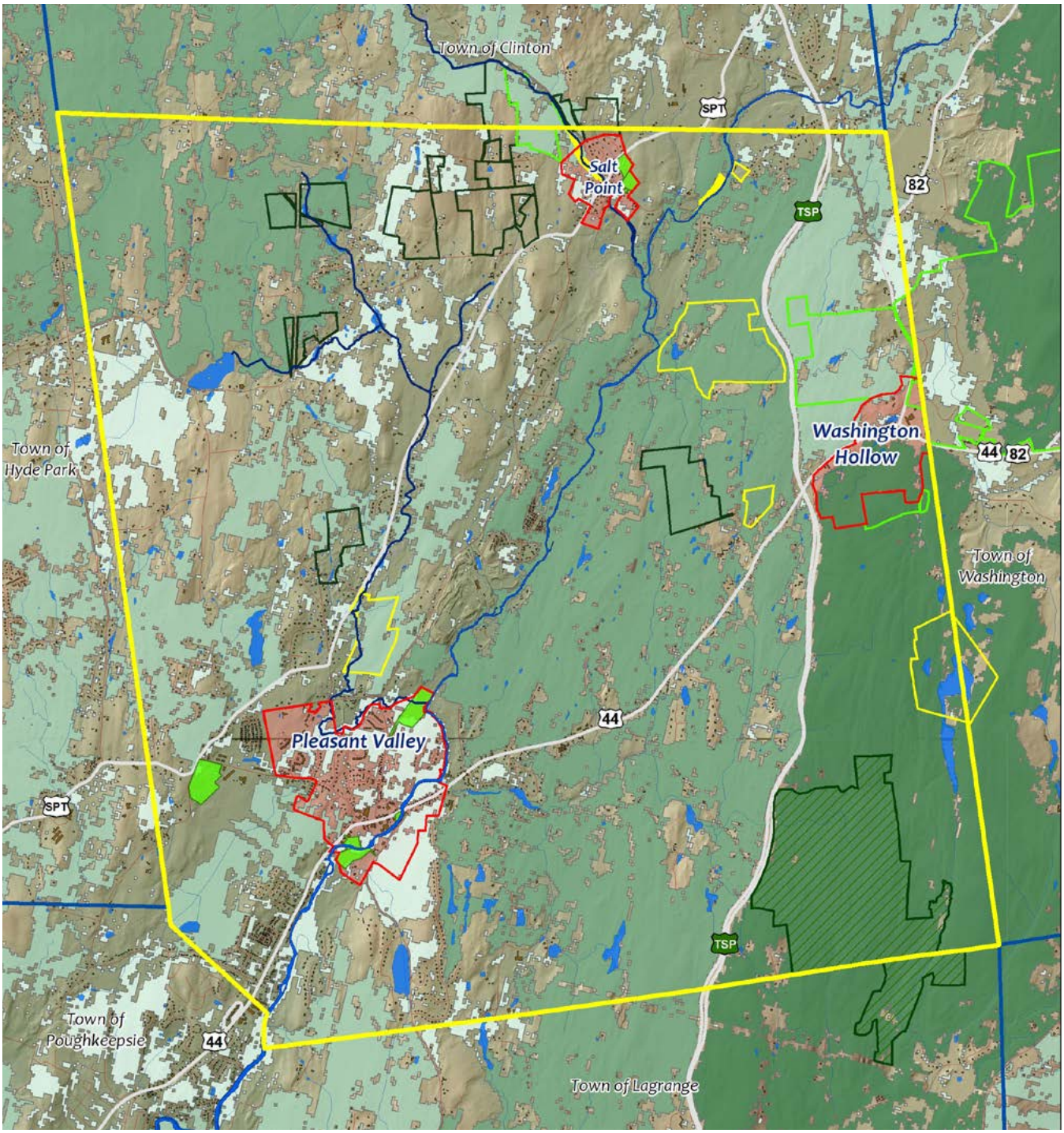
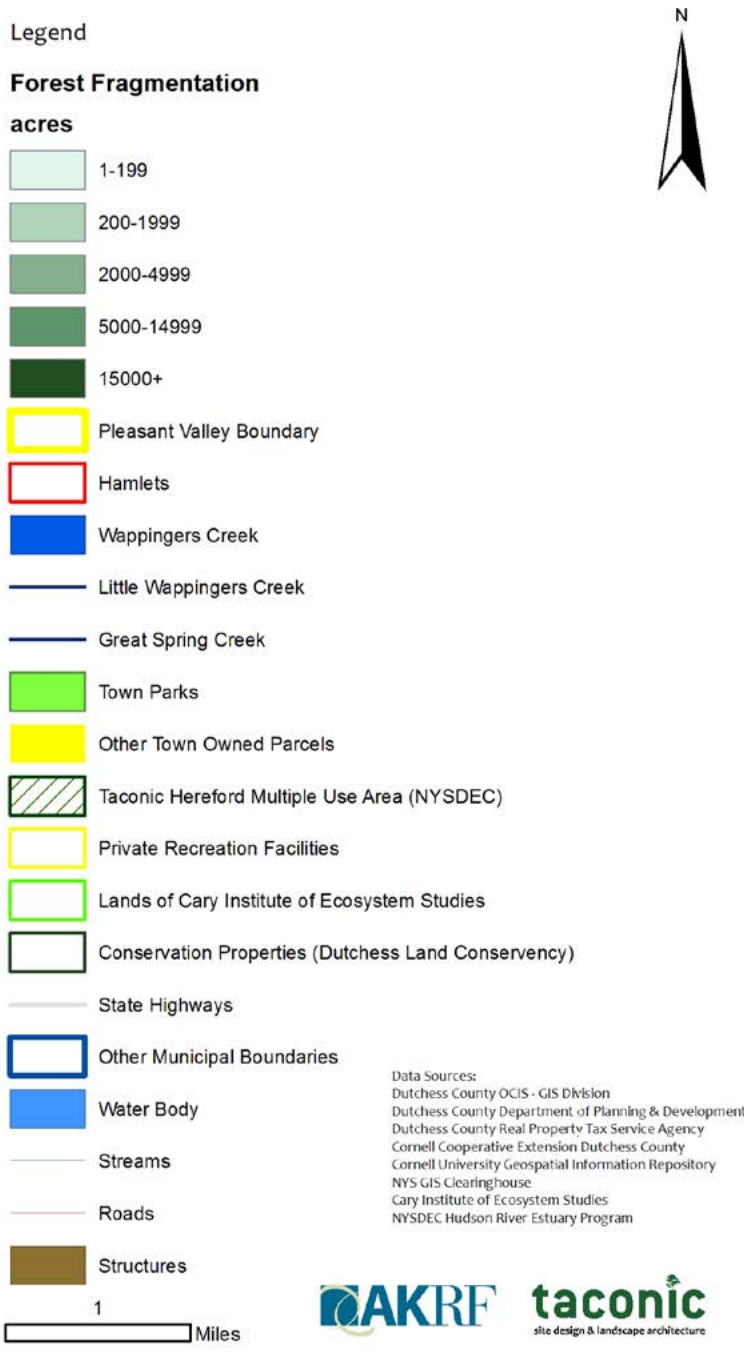
WOODLANDS


Town of Clinton
SPT
Salt Point
82
TSP
Washington Hollow
44
82
Town of Hyde Park
Town of Washington
Pleasant Valley
44
SPT
TSP
Town of Poughkeepsie
44
Town of Lagrange


Legend
Forest Fragmentation
acres
1-199
200-1999
2000-4999
5000-14999
15000+
Pleasant Valley Boundary
Hamlets
Wappingers Creek
Little Wappingers Creek
Great Spring Creek
Town Parks
Other Town Owned Parcels
Taconic Hereford Multiple Use Area (NYSDEC)
Private Recreation Facilities
Lands of Cary Institute of Ecosystem Studies
Conservation Properties (Dutchess Land Conservency)
State Highways
Other Municipal Boundaries
Water Body
Streams
Roads
Structures
1
Miles
N
Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Cary Institute of Ecosystem Studies
NYSDEC Hudson River Estuary Program
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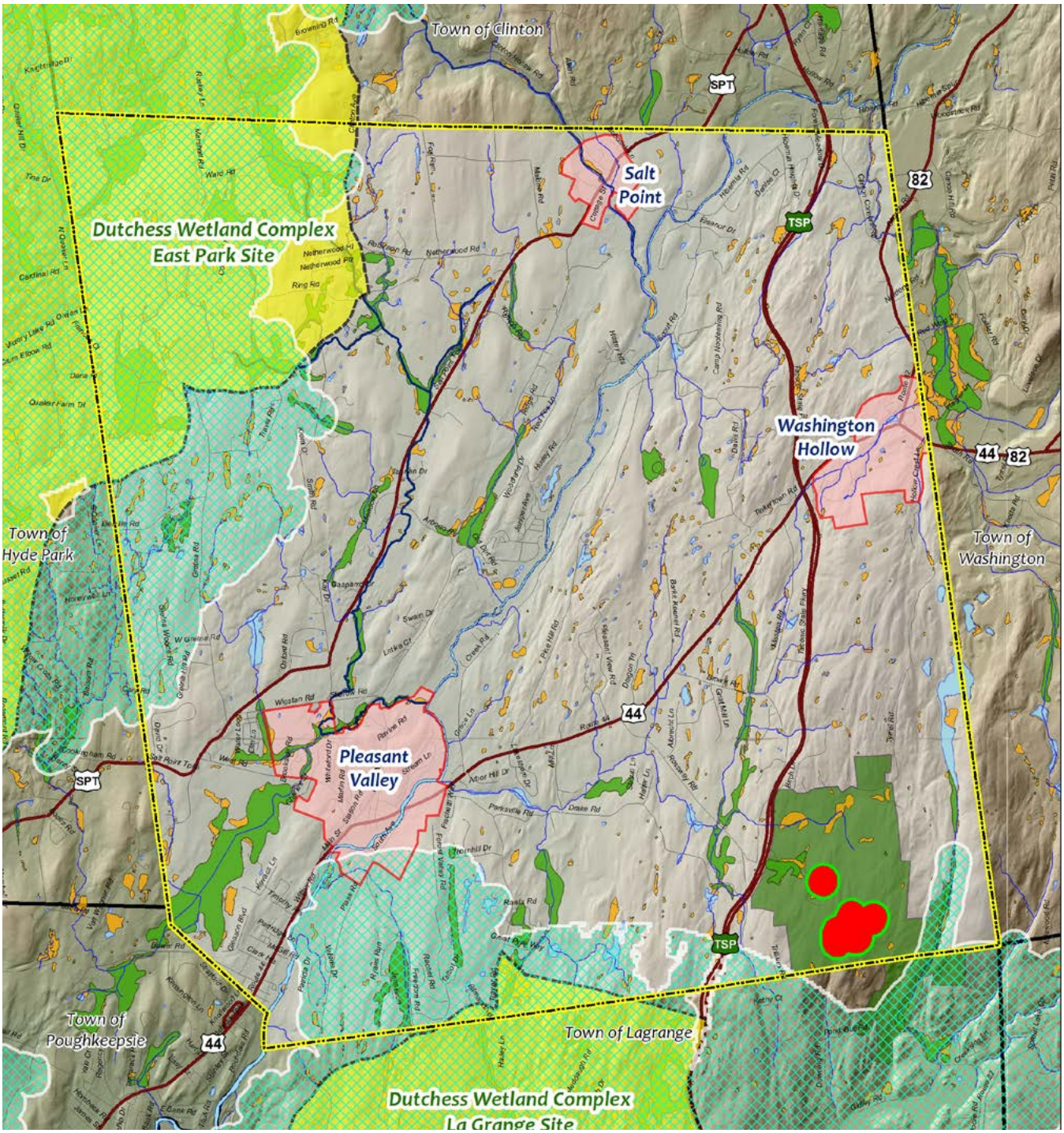
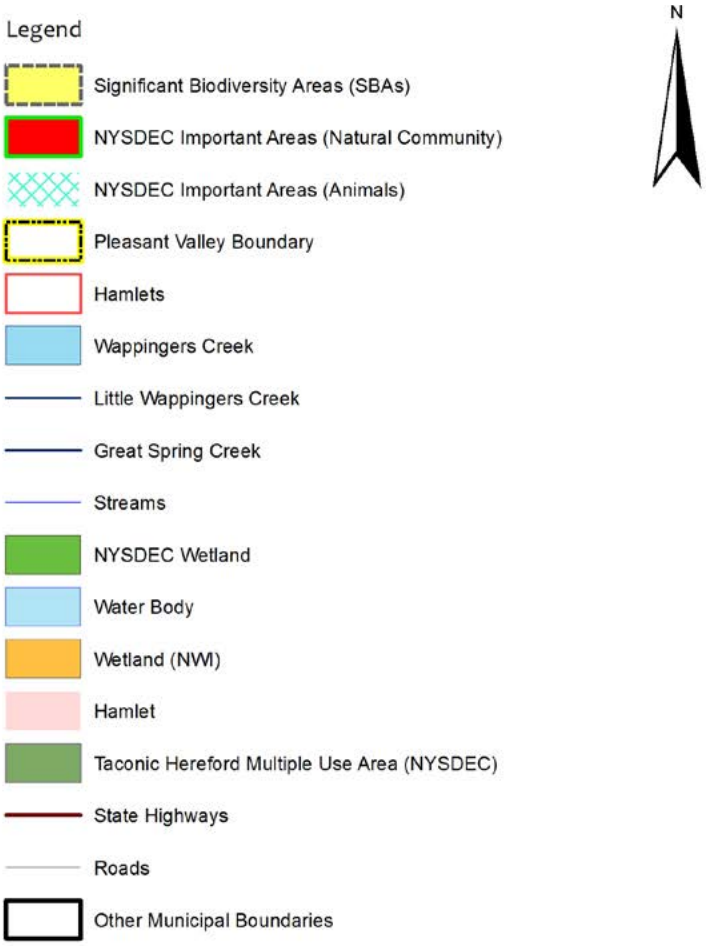
SIGNIFICANT ECOSYSTEMS





Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Gary Institute of Ecosystem Studies
NYSDEC Natural Heritage Program

1 Miles

AKRF

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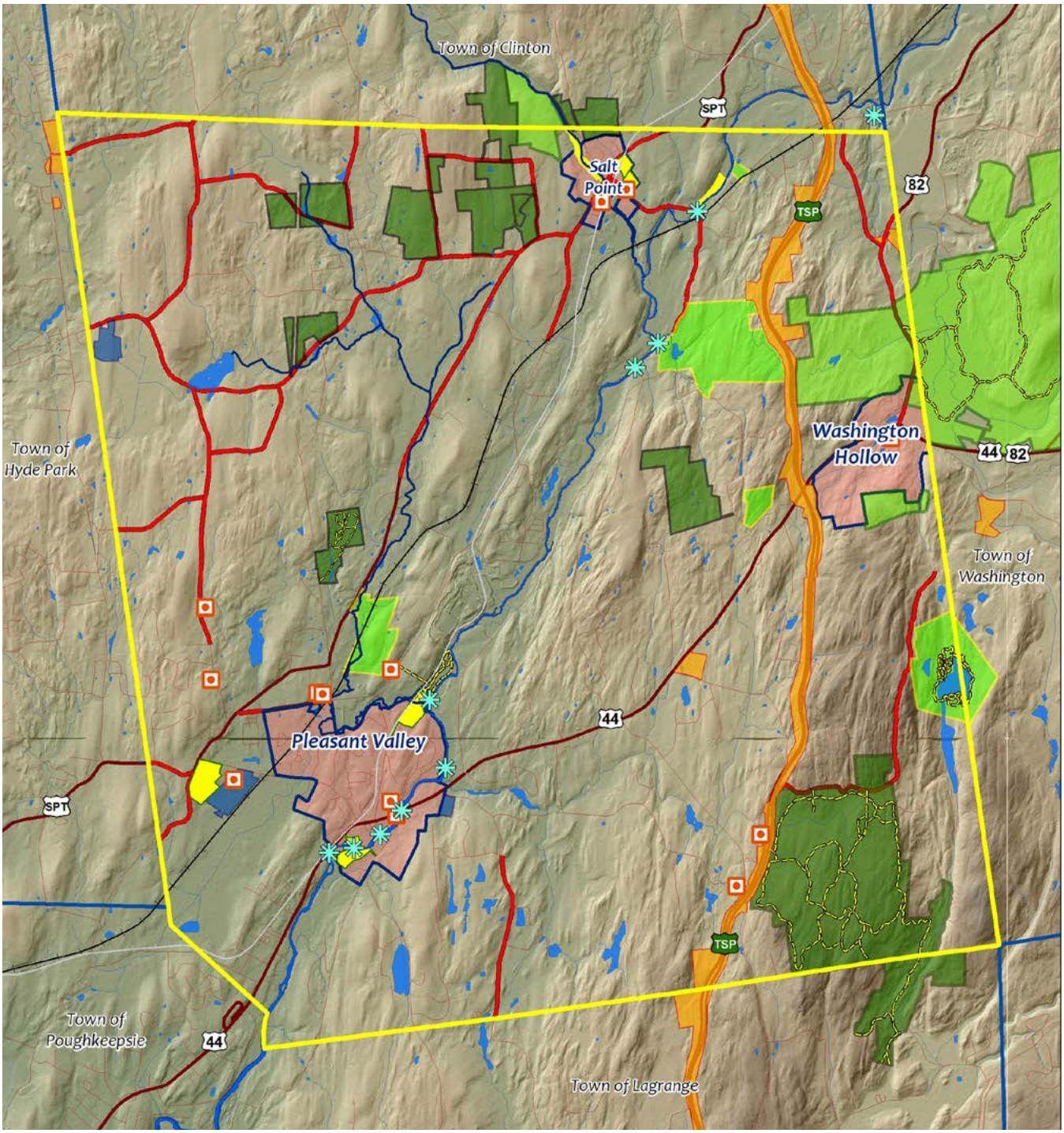
RECREATIONAL, SCENIC, AND HISTORIC RESOURCES, AND CONSERVATION LANDS




Legend
N
Town Parks
Taconic Hereford Multiple Use Area (NYSDEC)
Walking Trails (Open to Public)
Public Fishing Access Points
Private Recreation Facilities
Other Town Owned Parcels
Lands of Cary Institute of Ecosystem Studies
Conservation Properties (Dutchess Land Conservency)
Public School
Scenic Roads
Local Historic Sites
Sites with Historic Status
Historic P&E Railroad
Historic P&C Railroad
Wappingers Creek
Little Wappingers Creek
Great Spring Creek
Water Body
Streams
Pleasant Valley Boundary
Other Municipal Boundaries
Hamlets
State Highways
Roads
1
Miles
Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Cary Institute of Ecosystem Studies
Dutchess Land Conservency
AKRF
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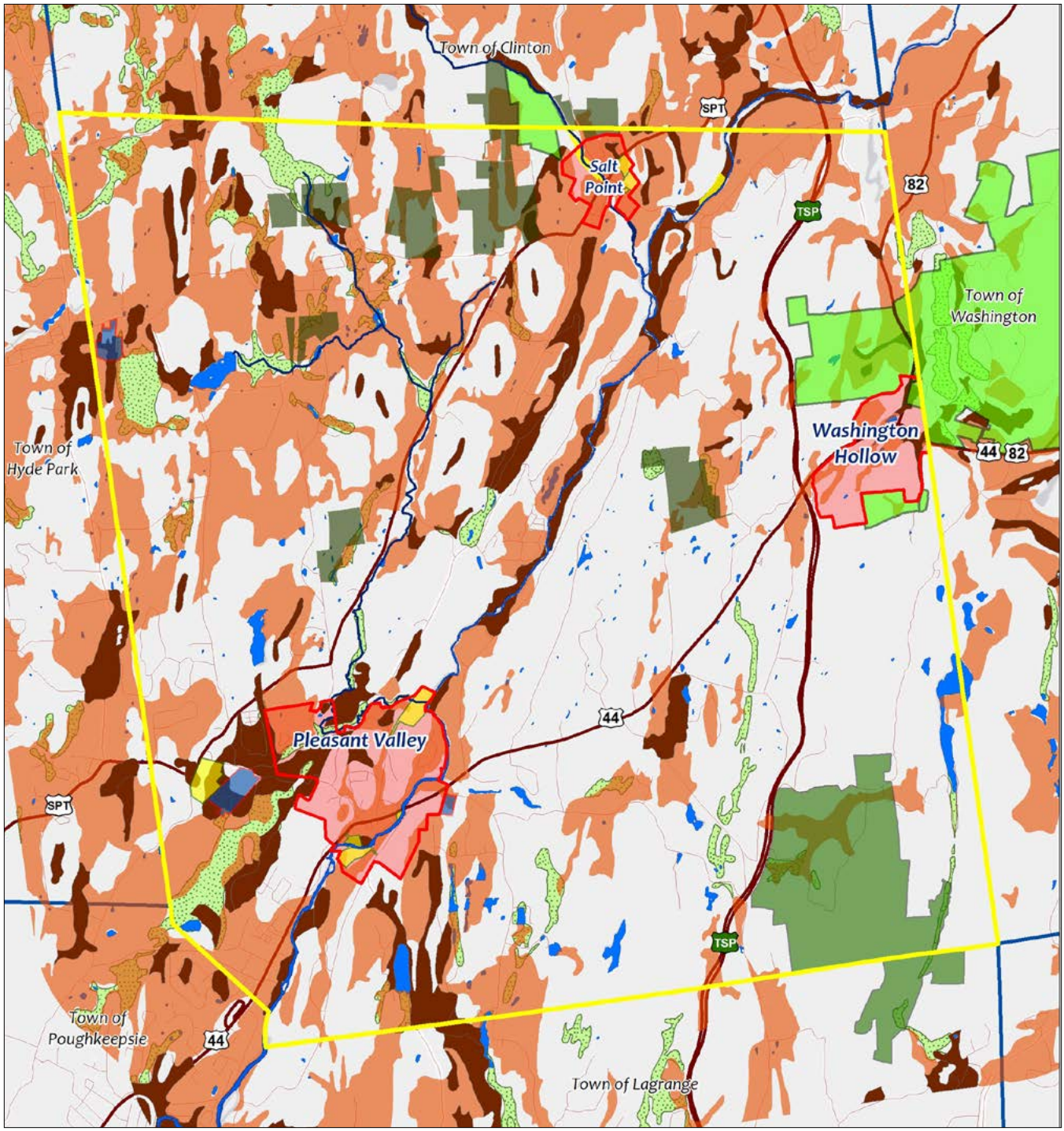
FARMLAND SOILS



Data Sources:
Dutchess County OCIS - GIS Division
Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Cary Institute of Ecosystem Studies

1 Miles

AKRF

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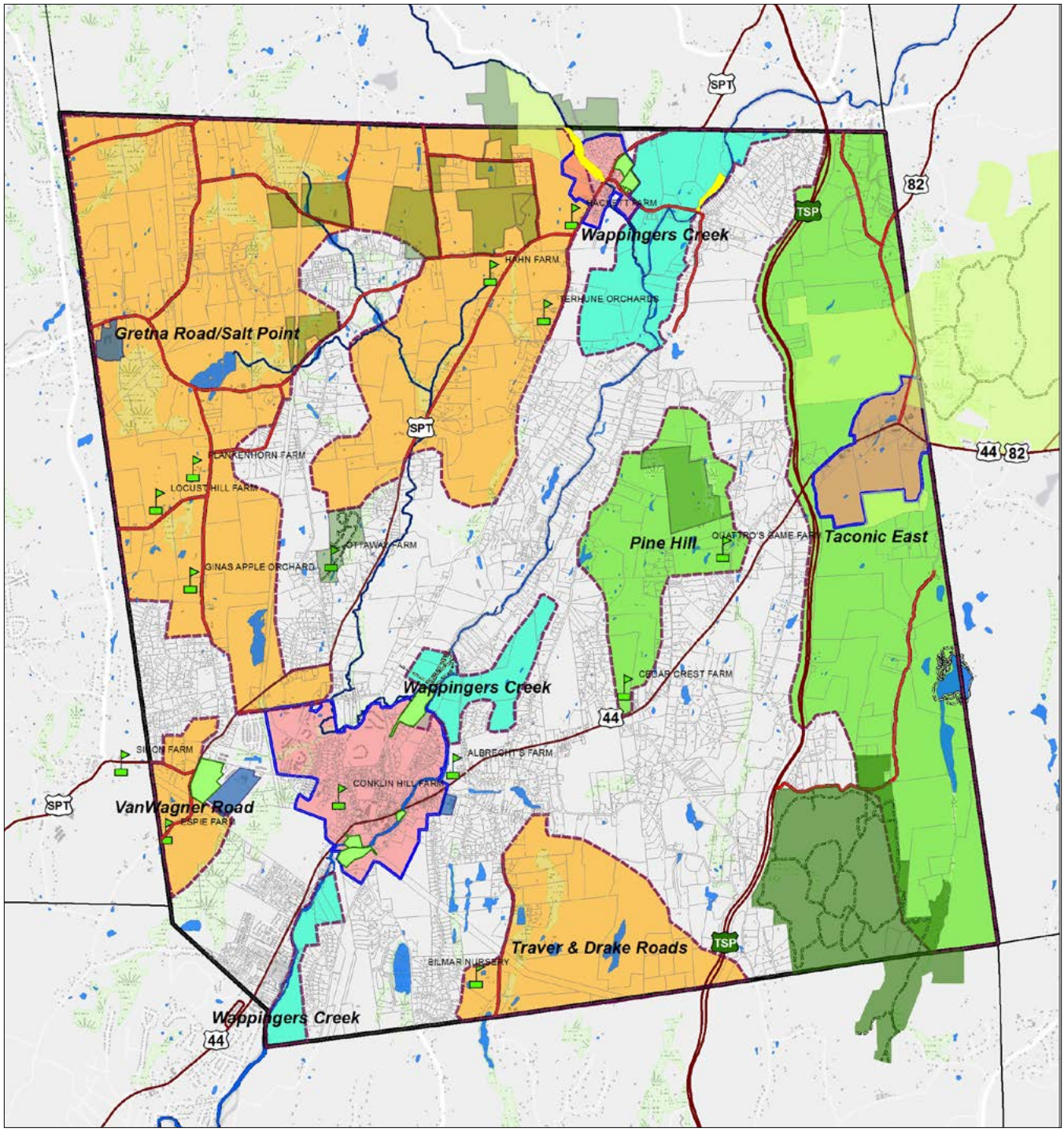
PRIORITY OPEN SPACE AREAS




Legend
N
Priority Area (Agriculture/Habitat)
Priority Area (Forest/Habitat)
Priority Area (Water Quality/Habitat)
Town Parks
Taconic Hereford Multiple Use Area (NYSDEC)
Public School
Other Town Owned Parcels
Lands of Cary Institute of Ecosystem Studies
Conservation Easements (Dutchess Land Conservency)
Pleasant Valley Tax Parcels
Hamlets
Scenic Roads
Farms
Pleasant Valley Boundary
Wappingers Creek
Little Wappingers Creek
Great Spring Creek
Trails (Open to Public)
Water Body
NYSDEC Wetland
State Highways
Structures
Other Municipal Boundaries
Data Sources:
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Dutchess County Department of Planning & Development
Dutchess County Real Property Tax Service Agency
Cornell Cooperative Extension Dutchess County
Cornell University Geospatial Information Repository
NYS GIS Clearinghouse
Cary Institute of Ecosystem Studies
1
Miles
AKRF
taconic
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APPENDIX J: EXAMPLES OF INVENTORY PROJECTS

The following examples demonstrate the variety of approaches that can be used to accomplish a natural resources inventory. Many have a town-wide focus; others give examples of regional, watershed, and county inventories. Some required very little budget and were completed by volunteers or graduate students, while others had grant funding and consultant assistance. The case studies described below include:

- Town of Rosendale Natural Resources Inventory
- Town of Berne Inventories of Forests, Wildlife, and Wetlands
- Town of Shawangunk Open Space Inventory and Analysis
- Town of Ancram Natural Resources Conservation Plan
- Town and Village of New Paltz Open Space Plan
- Shawangunk Mountains Regional Open Space Plan
- Wappinger Creek Natural Resource Management Plan
- Dutchess County Natural Resources Inventory

Town of Rosendale Natural Resources Inventory

Link for download: www.evolutiontechs.com/clients/rosendale/NRI.pdf

Study area: Town of Rosendale, Ulster County

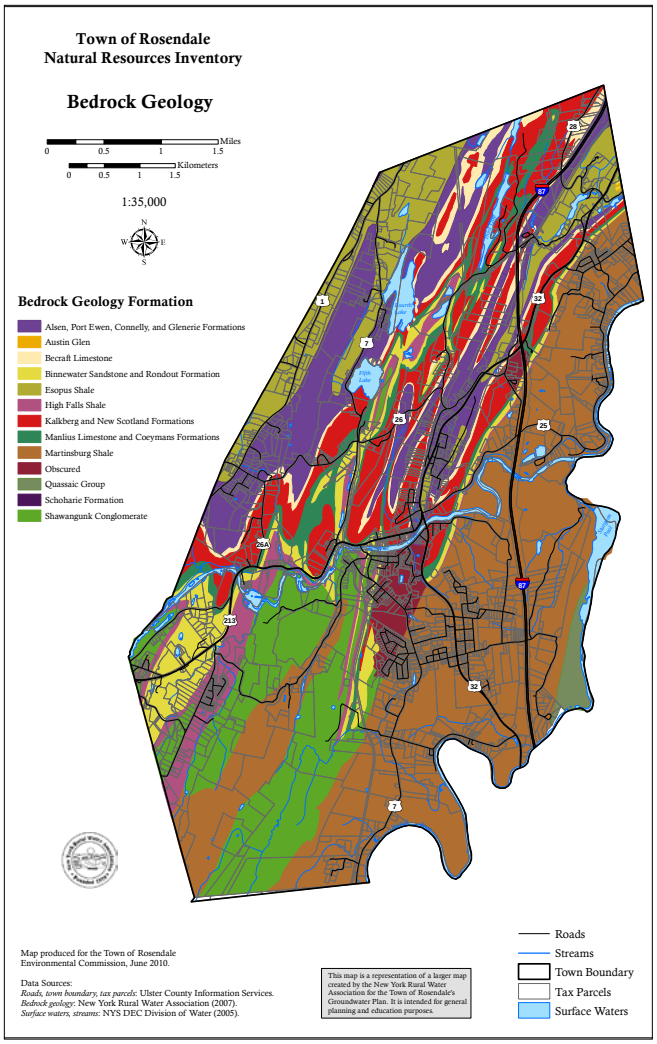
Date completed: 2010

Project goals: To provide baseline information for helping town officials, developers, and residents make informed and environmentally sound land-use decisions, and a public education and classroom resource for teaching environmental studies, geography, biology, and other subjects.

Study done by: Town volunteers, primarily members of the Rosendale Environmental Commission, with technical and mapping assistance from various individuals and organizations, including the Ulster County Department of the Environment, Hudsonia Ltd., New York Rural Water Association, and Cornell Cooperative Extension of Dutchess County. Minimal costs (purchase of GIS software and laptop, and small amount of mapping assistance) were covered by the environmental commission's budget.

Description: The Town of Rosendale is a rural community in Ulster County with a population of around 6,000 people. The town is known for its limestone mining history and it shares significant regional features like the Shawangunk Ridge, Wallkill River, and Rondout Creek with other municipalities. Its 2007 comprehensive plan highlighted residents' interests in conserving the town's natural and historical resources and recommended a strategic plan for open space preservation.

The *Town of Rosendale Natural Resource Inventory* includes 21 maps, which help to demonstrate how its resources and topography have shaped the town's history and development. The maps illustrate Rosendale's geology, soils, surface and ground water, habitats, historical sites, cultural and recreational sites, agricultural lands, and other resources and land uses, both natural and human-made. In addition to utilizing existing data, the environmental commission added original data that they collected themselves, including historical sites, cultural sites, and protected open space. They also incorporated the results of a 4,300-acre habitat map that was developed by a volunteer team who completed the Biodiversity Assessment Training offered by Hudsonia Ltd. and the DEC Hudson River Estuary Program in 2004 (see Appendix E). Most of the GIS mapping work was done by an environmental commission member who was a GIS professional.



In order to share the results of the NRI with the community, the environmental commission matted all of the maps and exhibited the series in the spirit of an art opening at a local café. The set of maps is now permanently on display in the town community center, where many meetings and events are held. The NRI continues to be used by the town planner and environmental commission for environmental reviews. The commission intends for the inventory to be an evolving document, periodically updated to reflect the availability of more accurate data and the natural and human changes to the landscape over time.

Town of Berne Inventories of Forests, Wildlife, and Wetlands

Links for download: http://berneny.org/wp-content/uploads/cons-Forest-and-Wildlife.pdf and http://berneny.org/wp-content/uploads/cons-Wetlands.pdf

Study area: Town of Berne, Albany County

Date completed: Forest and Wildlife Inventory (1978), Inventory of Wetlands over 12.4 Acres (1981), comprehensive plan update (2011)

Project goals: To develop a natural resource overlay map and provide data to support land use decisions and wetland protection.

Study done by: Town of Berne Environmental Commission; subsequently designated a conservation board. There was no dedicated funding for this project.

Description: Berne is a rural hilltown with a population under 3,000 in western Albany County. The town's environmental commission became a conservation board several decades ago when it completed inventories of forests, wildlife, and wetlands. The initial forest and wildlife inventory developed an overlay map of forest, shrubland, agricultural, and developed areas based on analysis of stereoscopic aerial photography and limited field verification. In addition, the inventory lists forest landowners and properties under forest management, and summarizes harvest records of local furbearers and deer. The report discusses habitat composition and wildlife values. A separate inventory of regulatory freshwater wetlands greater than 12.4 acres was carried out, including fairly detailed wetland classification and assessment.

More recently, members of the conservation and planning boards identified and mapped 3,500 acres of town habitats as part of a training program with Hudsonia Ltd. and the DEC Hudson River Estuary Program. The program also resulted in a report describing the habitats that were identified, as well as a series of recommendations to conserve high-quality habitats in Berne. The board members worked together to include the habitat map and conservation recommendations in a 2011 comprehensive plan update.

Over the years, the interaction between the conservation board and planning board has had many positive effects on the community's quality of life and helped to maintain Berne's natural resources. The conservation and planning boards, along with the town board and zoning board of appeals, meet regularly to discuss proposed development projects. To support project review, the conservation board conducts site visits and prepares a written report of findings that they present to the planning board. The conservation board's well-defined relationship with the planning board leads to valuable input and new insights in the land use review process. The natural resources inventories and biodiversity assessment training have helped conservation board members to identify wetland and other sensitive habitats during site plan review and to negotiate design modifications with applicants that preserve intact habitats and the benefits they provide the community.

Town of Shawangunk Open Space Inventory and Analysis

Link for download: www.shawangunk.org/pdf/enviro/Shawangunk-Open-Space-Analysis.pdf

Study area: Town of Shawangunk, Ulster County

Date completed: 2004

Project goals: To create an open space inventory and plan to encourage preservation of large areas of open space.

Study done by: A team of three graduate students from the Conway School of Landscape Design, one of whom was a town resident, conducted the inventory and analysis. The town's open space committee provided guidance, information, and materials. Minimal costs for the Conway School were covered by the town board.

Description: Shawangunk is a rural town of 12,000 residents in Ulster County. *The Shawangunk Open Space Inventory and Analysis* was an outgrowth of the town's comprehensive plan, which was completed in July 2003 and included a recommendation for an open space inventory. The town's identity and heritage are closely tied to agriculture and many significant natural features are shared with adjacent towns, including the Shawangunk Ridge, the Wallkill River, Shawangunk Kill, and the Shawangunk Grasslands National Wildlife Refuge. The community recognized that these open space resources add to quality of life in Shawangunk and require proactive planning to ensure preservation for the future. The inventory project intended to provide the town with a tool for evaluating the need to purchase or otherwise protect available land for public open space use, as well as a tool for working with project sponsors to develop properties in a manner that least disturbs important open space resources.

Using comprehensive planning surveys and information from the open space committee, six open space categories were determined to be vital to the town's future: agricultural land, scenic views, historical sites, recreation land, water quality protection zones, and wildlife habitat. These six categories, and subcategories within them, were inventoried and analyzed in the report. The inventory included a composite layer of each open space category, which can be overlain with each other in various combinations to further explore open space in Shawangunk. The work group felt this technique for processing information served as an easy-to-update, interactive planning tool for open space protection efforts and for guiding careful development practices.

The inventory report includes an in-depth analysis for each of the six open space categories, including overall importance of the particular resource and recommendations for open space protection. Some of the inventory maps were developed using further GIS analyses, including wetlands and floodplains with protective buffer zones; contiguous riparian travel corridors; and unfragmented forest habitat in excess of 150 acres.

The inventory has been used by members of the town's environmental commission to evaluate and document resources for planning board project reviews. One of the inventory authors, a former member of the commission, also completed the 10-month Biodiversity Assessment Training offered by Hudsonia Ltd. and the DEC Hudson River Estuary Program, with a team from the neighboring Town of Gardiner. Her involvement was a catalyst for intermunicipal cooperation on habitat mapping and a joint Estuary Grant received in 2006, which was used to purchase GIS software, train volunteers, and cover costs of consulting biologists. The project resulted in town-wide habitat maps for Shawangunk and Gardiner, which enable the municipalities to easily recognize shared resources as well as have finer-scale habitat data for town planning.

Town of Ancram Natural Resources Conservation Plan

Link for download: http://townofancram.org/CAC/

Study area: Town of Ancram, Columbia County

Date completed: 2014

Project goals: To identify and prioritize natural resources of conservation concern in the town and set forth guidelines and recommendations to inform landowner stewardship and municipal land-use policies and practices.

Study done by: Ancram Conservation Advisory Council and Hudsonia Ltd. Funding was provided by the Hudson River Valley Greenway, Hudson River Bank and Trust Foundation, and the Town of Ancram.

Description: Ancram is a small community on the edge of the Taconic Ridge in Columbia County with a population under 2,000. The town continues to support extensive agricultural lands and natural systems and has attracted a large number of new residents and second homeowners from the New York City metropolitan region. Ancram officials and residents began the process of identifying ecologically significant habitats in their town during the first 10-month Biodiversity Assessment Training offered by Hudsonia Ltd. and the DEC Hudson River Estuary Program in 2001-2002. The training led to the formal establishment of a conservation advisory council (CAC), which has continued biodiversity assessment work through volunteer efforts and with technical assistance from Hudsonia supported by the Estuary Program. The idea to prepare the townwide *Natural Resources Conservation Plan* (NRCP) was born out of the 2010 Town of Ancram Comprehensive Plan, which set forth goals of preserving open space and important scenic views, and developing policies and programs to protect groundwater, watersheds, streams, wetlands, woodlands, ridgelines, and wildlife habitats. The NRCP also complements the findings of the Ancram *Agriculture and Farmland Protection Plan* (2011) and the *Heritage Resources Plan* (2012), and shares many of the goals and recommendations of those documents.

The plan draws upon the CAC's detailed biodiversity assessment study, which has been completed for approximately half of the town's area, in addition to a thorough overview of existing public data for natural resources, including information compiled in a habitat summary report prepared for the town by Estuary Program staff. The plan identifies concrete actions for landowners and local officials that will help carry out the comprehensive plan goals for resource conservation and identifies conservation tools (including regulatory and non-regulatory measures) and partners to achieve them. The CAC and Hudsonia presented the NRCP at a public meeting that included interactive learning stations where residents and officials were introduced to the plan's detailed maps and learned highlights about a broad array of natural resources. The CAC intends to use the maps to assist the town planning board with project reviews and to continue public education and outreach about resources of concern, including public lectures and an ongoing biodiversity newsletter series.

New Paltz Open Space Plan: A Framework for Conservation for the Town and Village of New Paltz, New York

Link for download: www.townofnewpaltz.org/building/pages/open-space-plan-2006

Study area: Town and Village of New Paltz, Ulster County

Date completed: 2006

Project goals: To identify, prioritize, and implement protection of the community's open spaces.

Study done by: A joint committee composed of citizens from the Village of New Paltz and the Town of New Paltz as a cooperative intermunicipal effort, aided by several community planning consultants throughout the project, including Allee King Rosen & Fleming (AKRF), Inc. (for inventory services in 2003), Shingebiss Associates (for fiscal/conservation finance research services in 2004), and final assistance from Behan Planning Associates, LLC (for open space planning consulting services and plan report preparation). The Town of New Paltz provided funding, with Village support for the 2004 Open Space Inventory.

Description: The Town of New Paltz is a small community in Ulster County, which, combined with the more densely populated Village of New Paltz, has a total population of about 13,500 residents. The town included protection of environmentally-sensitive areas and natural resources as a priority in its comprehensive plan (1995), and to implement that recommendation, formed an open space committee in 2000. In subsequent years, the committee gathered information, including an open space inventory (2004); gathered community input; and generated public interest and involvement through a photo contest and computer screen-saver

Public presentation of the Ancram Natural Resources Conservation Plan. © B. Docktor

that included images from the town. The *New Paltz Open Space Plan* was adopted in 2006 and included an open space vision map with seven defining character areas of the New Paltz landscape, and selection criteria for evaluating potential conservation projects for the town and village. The plan's three key recommendations were to 1) create and implement a local land conservation program that works with willing landowners to conserve valued open space; 2) develop conservation financing to enable the community to purchase open space and conservation easements from willing landowners; and 3) plan for development in New Paltz that respects and conserves open space, by working with developers and landowners through the site planning process when development proposals are put forward.

Shortly after its adoption, a build-out and fiscal analysis were conducted and demonstrated that important places in town were vulnerable. The town successfully passed a $2 million Clean Water and Open Space Protection Bond in 2006, receiving 63% approval on the measure and marking the first time Ulster County residents authorized the creation of funding for open space conservation. A volunteer-comprised New Paltz Clean Water and Open Space Protection Commission is responsible for reviewing parcels and coordinating protection strategies. Since its formation, several significant parcels with important conservation values have been protected through the actions of the commission.

Shawangunk Mountains Regional Open Space Plan

Link for download: http://mtnscenicbyway.org/images/openspace-plan.pdf

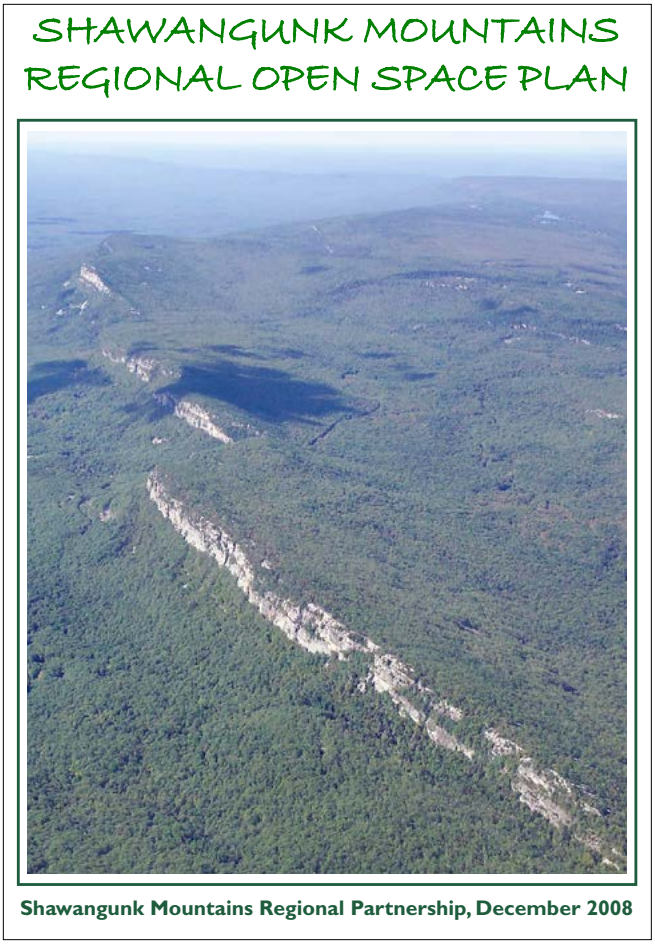
Study area: Shawangunk Mountains region of Ulster County, including 9 towns and 2 villages: Towns of Crawford, Gardiner, Marbletown, Montgomery, New Paltz, Rochester, Rosendale, Shawangunk, and Wawarsing; Village of Ellenville; and Village of New Paltz.

Date completed: 2008

Project goals: To promote a regional, intermunicipal approach to open space planning to conserve the natural resources and scenic values of the Shawangunk Mountains.

Study done by: The 11 municipalities of the Shawangunk Mountains Regional Partnership, with project consulting provided by Behan Planning Associates. Funding was obtained through a combination of sources including the NYS Department of State Quality Communities Program; the Federal Highway Administration's National Scenic Byways Grant Program administered by the NYS Scenic Byways Program of the NYS Department of Transportation; the municipalities of the Shawangunk Mountains Regional Partnership; Mohonk Preserve; and the Shawangunk Ridge Biodiversity Partnership.

Description: Nine towns and two villages in the Shawangunk Mountains region began working together in 2000 with the goal of establishing the Shawangunk Mountains Scenic Byway, which was officially designated by New York State in 2006 based on the statewide significance of the scenic, natural, recreational, and historic resources of the region. By recognizing the connections between communities of the northern Shawangunk Mountains, the byway is helping to establish a regional identity. Through an



Shawangunk Mountains Regional Partnership, December 2008

Once the byway was designated, the partnership decided to implement one of the major recommendations of the *Corridor Management Plan:* to develop the *Shawangunk Mountains Regional Open Space Plan*. The open space plan grew out of the conviction that local economic growth, tourism, and the quality of life depend on the continued preservation of shared regional resources. The partnership applied for and was awarded funding by federal and state sources, and the boards in each of the towns and villages voted to contribute additional funds to the undertaking.

The objectives of the regional open space plan were to augment the various comprehensive and open space plans of the individual towns and villages by contributing a regional dimension, to provide resources that might not be available on a local level, and to engage in projects that could be carried out more efficiently on a regional level. The plan describes the region's rich resources, including the natural communities of the Shawangunks and areas for regional natural area connectivity, as well as the significant waterways, forests, agricultural resources, and scenic views. Strategies for preserving regional open space resources are outlined, including partnerships with land trusts, conservation financing options, and municipal land-use planning and decision-making.

The partnership went on to fulfill one of the strategies outlined in the regional open space plan by developing a *Scenic Resources Guide* for planning boards. The guide provides tools to assess scenic views in open space and to help minimize the impact of potential development during site plan review.

Wappinger Creek Natural Resource Management Plan

Link for download: www.wappingersfallsny.gov/pdf/Natural%20Resource%20Planning.pdf

Study area: Region of Dutchess County drained by the Wappinger Creek, including 11 towns and 2 villages in Dutchess County: Towns of Clinton, Hyde Park, LaGrange, Milan, Pine Plains, Pleasant Valley, Stanford, Fishkill, Poughkeepsie, Wappinger, and Washington; Village of Millbrook; and Village of Wappingers Falls.

Date completed: 2000

Project goals: To inventory and analyze natural resources, water quality, and pollution sources as the basis for watershed management activities and protection in the Wappinger Creek watershed.

Study done by: Dutchess County Environmental Management Council (EMC), Dutchess County Soil and Water Conservation District, Wappinger Creek Watershed Planning Committee, and Dutchess County Water Quality Strategic Committee. Funding provided through an EPA Wetlands Demonstration Grant, NYS-DEC Watershed Planning Grant, Rural New York Grant Program, and Dutchess County.

Description: The *Natural Resource Management Plan for the Wappinger Creek Watershed* was developed to assist the 13 watershed communities in planning for the future of their water resources. In order to implement the management plan, the Wappinger Creek Intermunicipal Council (WIC) was formed to facilitate communication and help complete cooperative projects, with the mission of addressing common issues affecting the quality of the watershed. This council primarily consists of municipal officials and their representatives from the 13 municipalities and provides a forum for municipal governments, nonprofit organizations, and concerned citizens to discuss existing conditions, research and management needs, and to identify implementation opportunities within the watershed. This framework has been very successful, and the WIC continues to meet and move forward with coordinated projects.

The management plan includes a comprehensive inventory of natural resources in the watershed derived from existing data sources, followed by results from several detailed water quality monitoring studies and a subwatershed-level analysis of pollution sources. The plan outlines a broad range of strategies for achieving water quality goals and objectives, including best management practices, incentives, and education, as well as recommendations for amending or adopting land use planning or zoning provisions.

Using the natural resources inventory in the management plan, WIC and the Dutchess County EMC, along with various local partners, have been successful in identifying and implementing local streambank restoration projects along Wappinger Creek to reduce sedimentation and improve habitat. Steep slopes along the creek's natural buffer are threatened by erosion. In an effort to address these erosion issues, the intermunicipal council developed a framework for restoring the streambank and provided an avenue for a coordinated volunteer effort to put the restoration plan into action. With technical assistance from the Dutchess County EMC, the two groups developed site-specific restoration designs and settled on a two-phase program to rebuild, strengthen, and re-vegetate the streambank.

Dutchess County Natural Resources Inventory

Link for download: www.co.dutchess.ny.us/countygov/departments/planning/16138.htm

Study area: Dutchess County

Date completed: 2010

Project goals: To provide a comprehensive understanding of the natural environment for municipalities and landowners that will help inform land-use decisions, guide in the development of policies, identify areas for natural resource conservation and management, and educate residents.

Study done by: A collaboration between several agencies and organizations, including Cornell Cooperative Extension Dutchess County's Environment and Energy Program (lead agency), Cary Institute of Ecosystem Studies, Dutchess County Department of Planning and Development, Dutchess County Environmental Management Council (EMC), Dutchess County Office of Computer Information Systems, and the Vassar College Environmental Research Institute. The NRI steering committee provided guidance for the entire project, and collaborated with local experts and scientists to update each chapter of the NRI. Limited funding was provided by Dutchess County.

Description: The 2010 *Dutchess County Natural Resources Inventory* is a comprehensive update of a 1985 inventory, containing new information about the county's natural resources, maps created with the most current GIS data, and references to research findings. It provides a snapshot of the current state of natural resources in the county, how they are regulated or classified, and trends and changes seen over time, as well as emerging threats such as climate change. In addition to statewide public datasets, the inventory includes many data sources developed through detailed studies at the county level, such as water quality and aquifer monitoring results and the identification of undeveloped biodiversity blocks. Each chapter includes a discussion of the resource, how is it regulated, trends and changes seen over time, implications for local decision-making, and resources for additional information.

The NRI is a key tool intended to guide the work of EMC members, municipal officials, planning boards and zoning boards of appeals, conservation advisory councils, and watershed organizations. A new chapter titled "Implications for Decision- Making" includes a discussion of how to effectively use the State Environmental Quality Review Act (SEQRA) and other more recent planning initiatives, such as the Dutchess County Greenway Compact, to conserve important natural resources, in addition to applications for the comprehensive planning process and for preparation and review of proposed development plans. Members of the public, students, and teachers can use the NRI as a general source of information about the county, and to enhance their place-based environmental curriculum and teaching.

The inventory's findings were debuted at a conference held at Vassar College and inventory partners made an effort to bring the inventory to the attention of town officials, conservation advisory councils, planning boards and the public. Since completion of the inventory, the EMC has created lesson plans for schools to use the NRI.