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

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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.

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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.

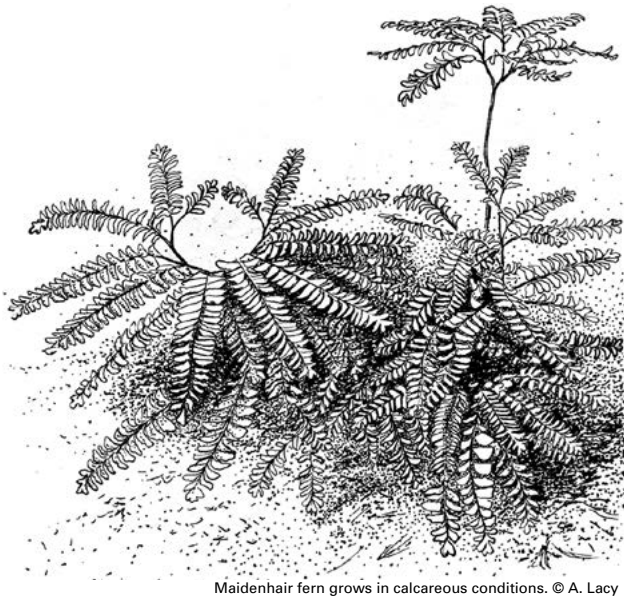
Soil information is critical for land-use planning as it helps to determine where it is appropriate or feasible to build. Each soil type has a certain set of characteristics defined by (but not limited to) properties such as permeability, drainage, available water capacity, pH, depth to bedrock, and 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

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*.

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

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

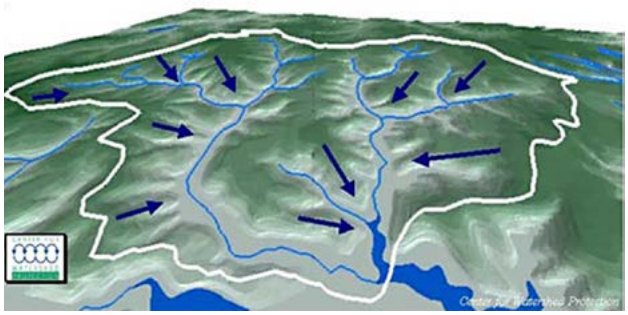
New York Rural Water Association
Local source water assessments, aquifer locations, ground water quality, maps

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.

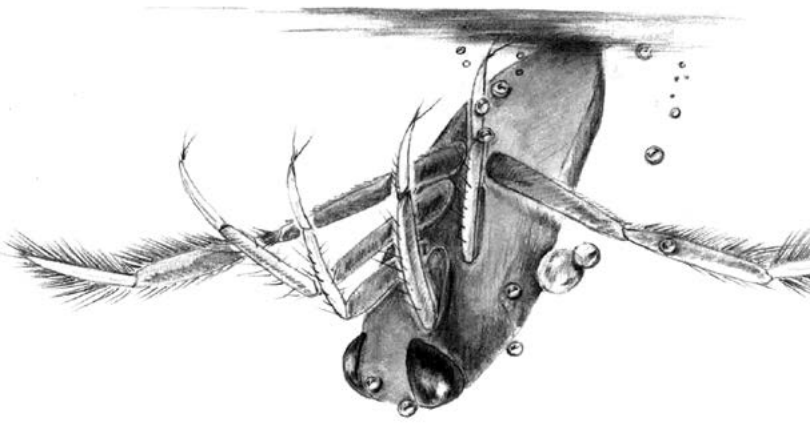
DEC Division of Water
- Water Quality Standards and Classifications
- Waterbody Inventory/Priority Waterbodies List
- DEC Lake Classification and Inventory Program
- DEC water quality monitoring data and reports
- Citizen science monitoring programs (CSLAP and WAVE)

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 short-nose 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

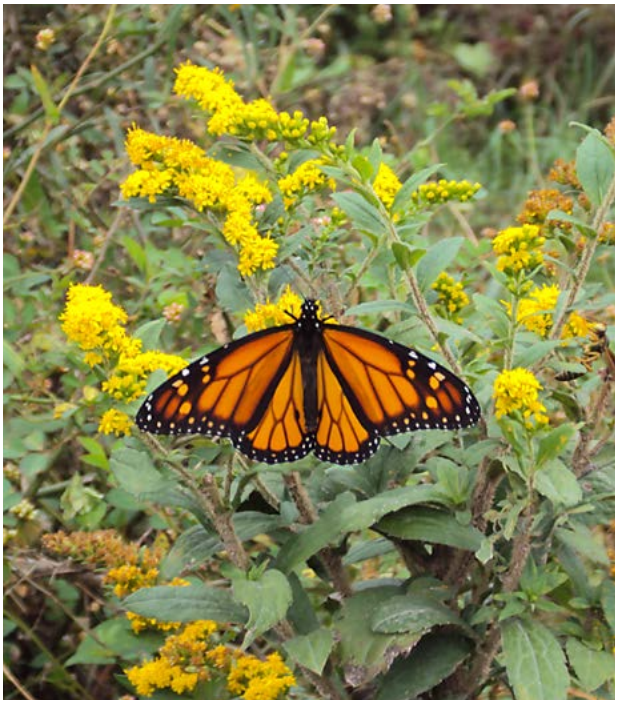
See Appendix A for organization contact information, Appendix B for publications and web resources, and Appendix C for sources of GIS data.

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.

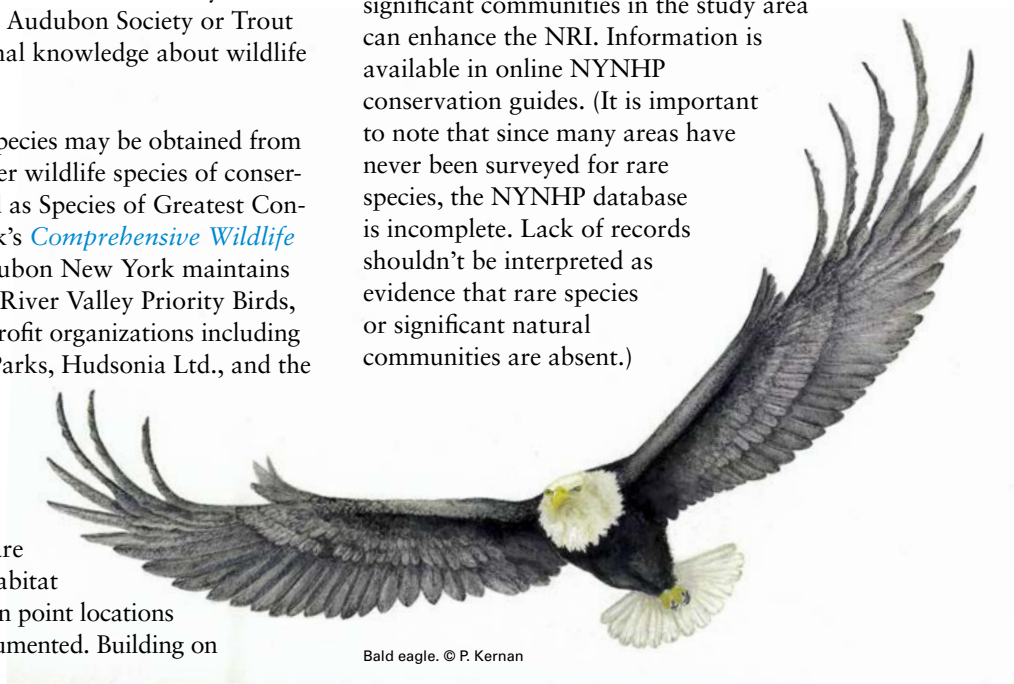
Current legal status of rare species may be obtained from the DEC website. Many other wildlife species of conservation concern are identified as Species of Greatest Conservation Need in New York's *Comprehensive Wildlife Conservation Strategy*. Audubon New York maintains an online listing of Hudson River 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

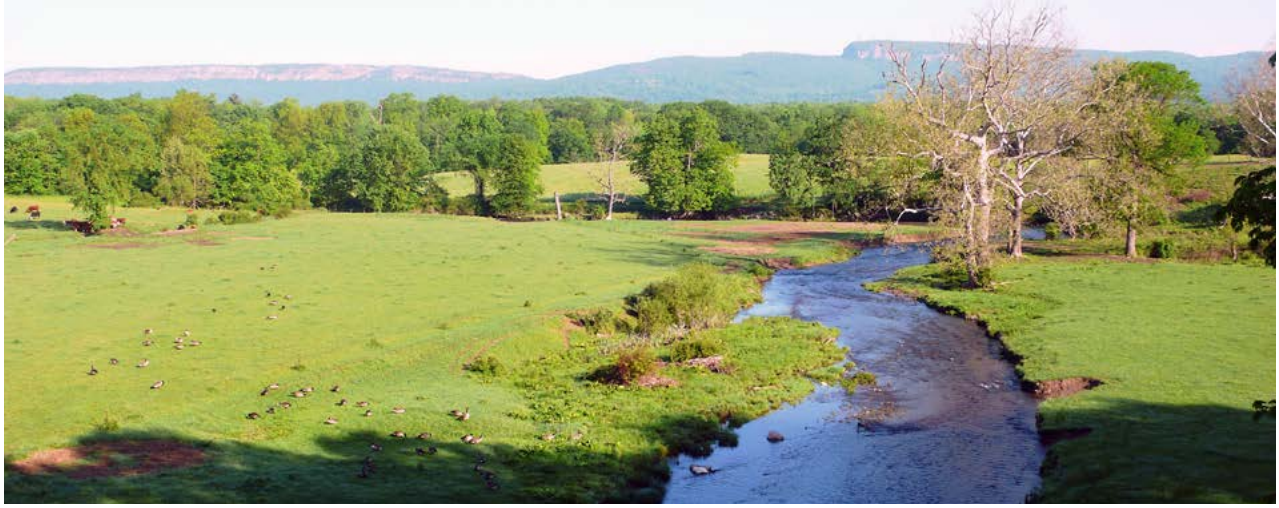
Preservation League of New York State
- Technical assistance, grants

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



© L. Heady

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.

© I. Haeckel

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, white-water, 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.

© L. Heady

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.

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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