

5

A CASE STUDY OF MAPPING STEPS

- **Step 1: Set Goals**
- **Step 2: Review Data**
- **Step 3: Make Maps**
- **Step 4: Assess Risks**
- **Step 5: Rank Assets**
- **Step 6: Implement**

CHAPTER 5 - Case Study: Mapping Ulster County, New York

This case example takes the reader through the Six Steps of Green Infrastructure planning discussed in prior chapters of the planning guide,* in order to demonstrate how green infrastructure maps are created and evaluated. This case study was conducted for Ulster County, New York, and provides a model for replication by other counties in New York State. This case study describes how the green infrastructure network was created by selecting the highest-value habitats; shows how the network was updated to reflect new development; and summarizes how other green infrastructure services, such as farming and forestry, are analyzed. Those who are interested in creating green infrastructure maps should refer to Chapter Seven and Appendix A for the technical instructions. However, before we describe the Ulster County case study, we discuss a few special factors that contribute to the richness of species diversity in New York.

NEW YORK'S DIVERSE LANDSCAPE

With its significant mountain ranges, ridge lines, escarpments, wetlands, marshes and large river valleys, the state offers a rich range of habitat types for a multitude of species. Its diverse terrestrial and aquatic habitats allow myriad species to thrive there. In fact, there are 2,863 known vascular plants, natural communities, and vertebrate animals native to New York State (NY Natural Heritage Program).

The glaciation of the late Pleistocene epoch, when an ice sheet covered almost all of New York State (except for the Pennsylvania border, and parts of Staten and Long Islands), caused the formation of broad, deep river valleys such as the Hudson. It also created unique features, such as the Finger Lakes Region. The 'end moraine' of this glacier is now Long Island.

Most of New York State is comprised of rural landscapes that support the rich biodiversity of its native flora and fauna. The state has a significant number of state parks, as well as private reserves and protected landscapes. The Adirondack Park, in the northern portion of the state, is the largest state park in the U.S. at 6.1 million acres.

The towering Catskill Range and the dramatic cliffs of the Shawangunk Ridge add to the rich diversity of species found there. For instance, Bicknell's thrush (*Catharus bicknelli*) is found only at higher elevations, where it prefers the cool upper slopes and stunted stands of spruce and fir found in

* *Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide*, published by the Green Infrastructure Center and available online at www.gicinc.org.

NUMBER OF SPECIES IN NEW YORK STATE

those mountains. There are other boreal forest species that occur only in higher elevation forests in the Catskill High Peaks, such as Swainson's thrush (*Catharus ustulatus*), blackpoll warbler (*Dendroica striata*), and yellow-bellied flycatcher (*Empidonax flaviventris*) – just three of the species that flourish within the Catskill High Peaks Complex.

While New York's rural lands support a rich diversity of species, even the state's urban areas host unique habitats such as Jamaica Bay, which is home to an astonishing 238 species of birds regularly observed each year, such as the red-throated loon (*Gavia stellata*) and the American avocet (*Recurvirostra Americana*). To learn more about the Catskills, see Significant Habitats And Habitat Complexes Of The New York Bight Watershed, Catskill High Peaks Complex #34, U.S. Fish and Wildlife Service On-Line library:
http://library.fws.gov/pubs5/web_link/text/chp_form.htm

Although Niagara Falls is perhaps the most famous water feature in New York, there are many other significant and high quality waters. Water from New York flows to the Great Lakes system (to Lake Erie and Lake Ontario) and to the Saint Lawrence River and Lake Champlain. Large portions of the waters in the southern tier of New York flow to the Susquehanna and Delaware Rivers and even to the Mississippi River through the Allegheny drainage. The Hudson River flows through the eastern part of the state and drains significant watersheds, contributing to the rich diversity of the state's species, as well as being a major economic and cultural resource. Part of central New York state makes up the upper watershed of the Chesapeake Bay, comprising over 6,250 square miles in 19 counties. New York has developed a tributary strategy to help efforts to restore the Chesapeake Bay.

New York's multiple ecoregions cover 49,000 square miles and host thousands of known species and up to tens of thousands of species yet to be discovered or fully catalogued. With the exception of Long Island, the state is classified as having a humid continental climate subject to cold winters and hot summers. This temperature variation contributes to the diversity of species that call New York home.

Algae: More than 2,000 freshwater species (include cyanobacteria (K: Eubacteria) and eukaryotic algae (K: Protoctista)).

Plants: 3,603 species of flowering plants, trees, shrubs and ferns; over 650 kinds of mosses, liverworts, and hornworts.

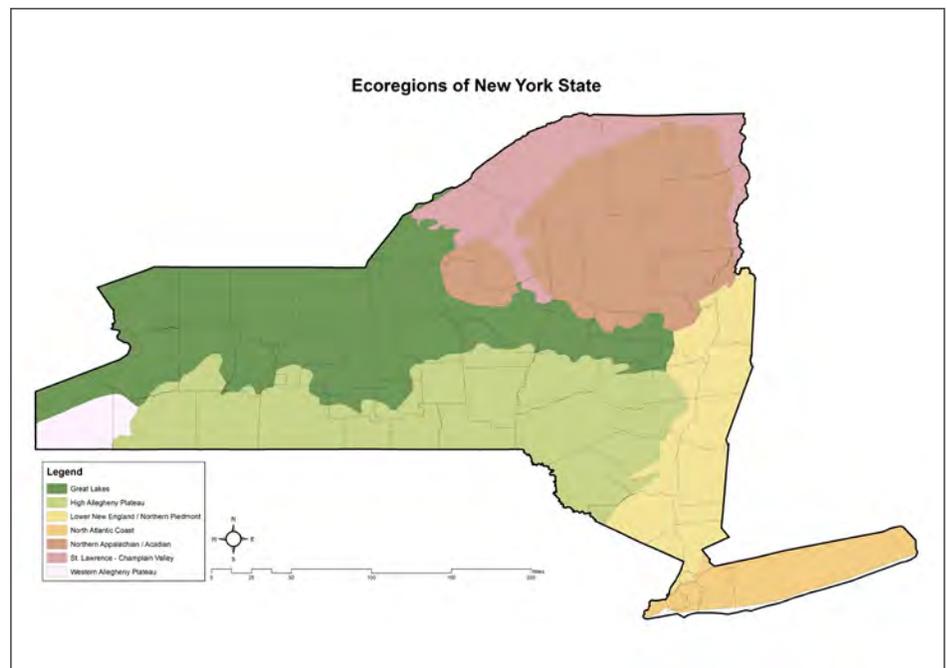
Animals: 32 amphibian species, 40 reptile species, 471 fish species (300 marine, 171 freshwater), 103 mammal species, and 462 bird species (247 breeding).

Insects and Spiders: 173 mayflies, 190 dragonflies and damselflies, 415 bees, 63 vespid wasps (e.g., hornets, yellowjackets, potter wasps), 142 butterflies and skippers, 3,300 moths, 4,120 species of beetles, and over 700 spiders.

Crab, Shrimp, and Crayfish: 74 species of crabs and shrimp, 13 species of crayfish.

Mussels and Snails: 41 pearly mussel species, 67 freshwater snails, and 126 species of land snails.

Note: These numbers include both native and non-native species and represent just a small sample of the many different species and species groups that can be found in the state. (Table Source: Johnson and Smith 2006)



Protecting large blocks of intact habitat and connecting them is critical to ensuring that the state's rich biodiversity is maintained over the long term.

PROJECT BACKGROUND

Green Infrastructure

Green infrastructure includes all the interconnected natural systems in a landscape, such as intact forests, woodlands, wetlands, parks and rivers, as well as agricultural soils. Natural systems are part of our 'infrastructure' because they provide support for people (clean air, drinking water and agricultural soils), as well as services to the built environment.

Green infrastructure planning provides a strategic landscape approach to open-space conservation, whereby local communities, landowners and organizations work together to identify, design and conserve their local land network, in order to maintain healthy ecological functioning. A green infrastructure plan entails assessing an area's existing natural resources to determine the greatest priorities for protection and restoration, along with implementation strategies.

Resilience

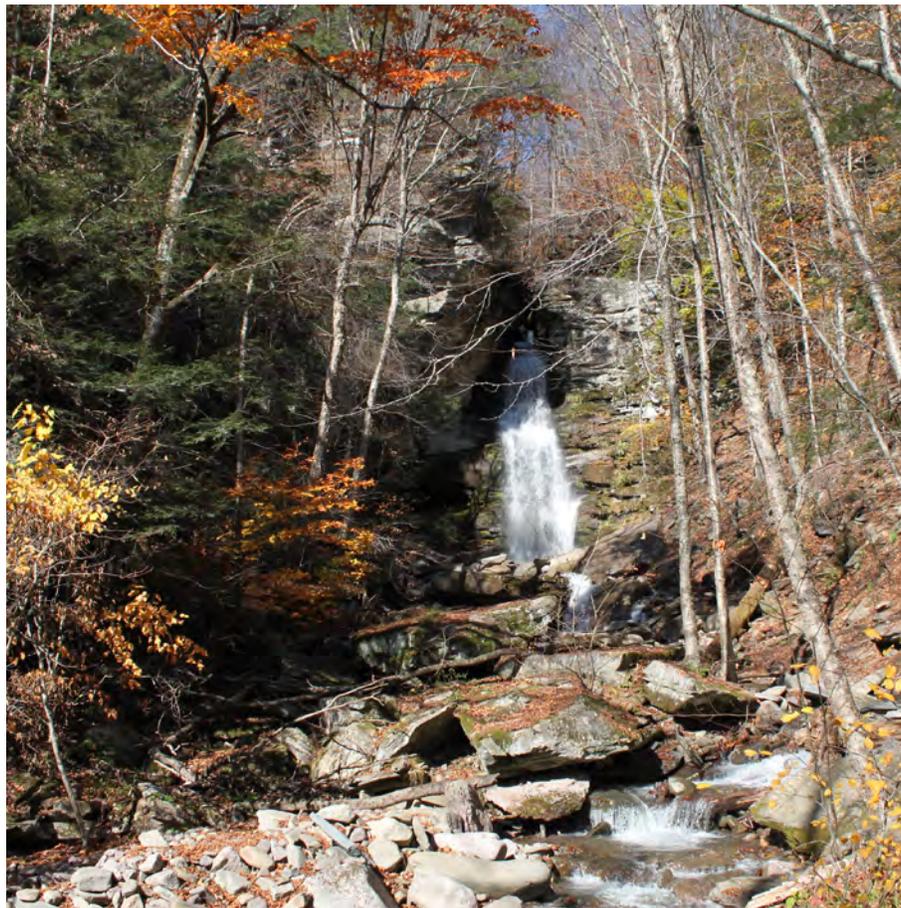
A key emphasis of New York's ecological future is the notion of *resilience*. Resilience is the amount of change a system can undergo and still retain the same controls on its function and structure (Holling 1973). A resilient ecosystem has the ability to withstand more impacts, such as storm damage, human impact or diseases, and still maintain its core functions. In Chapter One of this guide we described how a green infrastructure approach can create a more resilient ecosystem.

Following the recent devastating floods and wind damage from Hurricane Irene and 'superstorm' Sandy, planners are looking to return some areas to a more natural state. They hope to lessen future economic impacts by removing built structures

subject to flood and wind damage and to provide a natural buffer against storm surges. Even inland areas can become more 'resilient' if they are better managed to ensure fewer pests, diseases and invasive species. The less altered the natural landscape, the more intact and healthful it is, the more resilient it can be to withstand future changes and damage.

EPA's Healthy Watersheds Initiative

The U.S. Environmental Protection Agency's (EPA) Healthy Watersheds Initiative provided the State of New York, and Ulster County, New York, with green infrastructure planning support through a contract with The Cadmus Group and the Green Infrastructure Center. This project serves as a model for other localities in the state to implement their own landscape-scale green infrastructure plans. To learn more about EPA's Healthy Watersheds Initiative visit <http://epa.gov/healthywatersheds>. As part of this support, the GIC developed a green infrastructure assessment for Ulster County and a model process methodology for New York.



Ulster's forested landscape protects sensitive headwater streams.

The GIC, partnering with the NYSDEC, selected Ulster County based on an evaluation of ten proposals submitted by interested counties. The criteria utilized to select a county included the county's data management and GIS planning capacity, ability to access and analyze data, a demonstrated commitment to collaborative learning and availability to begin and complete the project with GIC in the eight month window provided by the contract. Another criterion that related to developing a model approach for other counties was choosing a county having landscape features and land cover that were somewhat typical for New York. Ulster County, located in the Hudson River Valley and Catskills Region was selected as the best choice to implement the project.

Ulster County Case Study

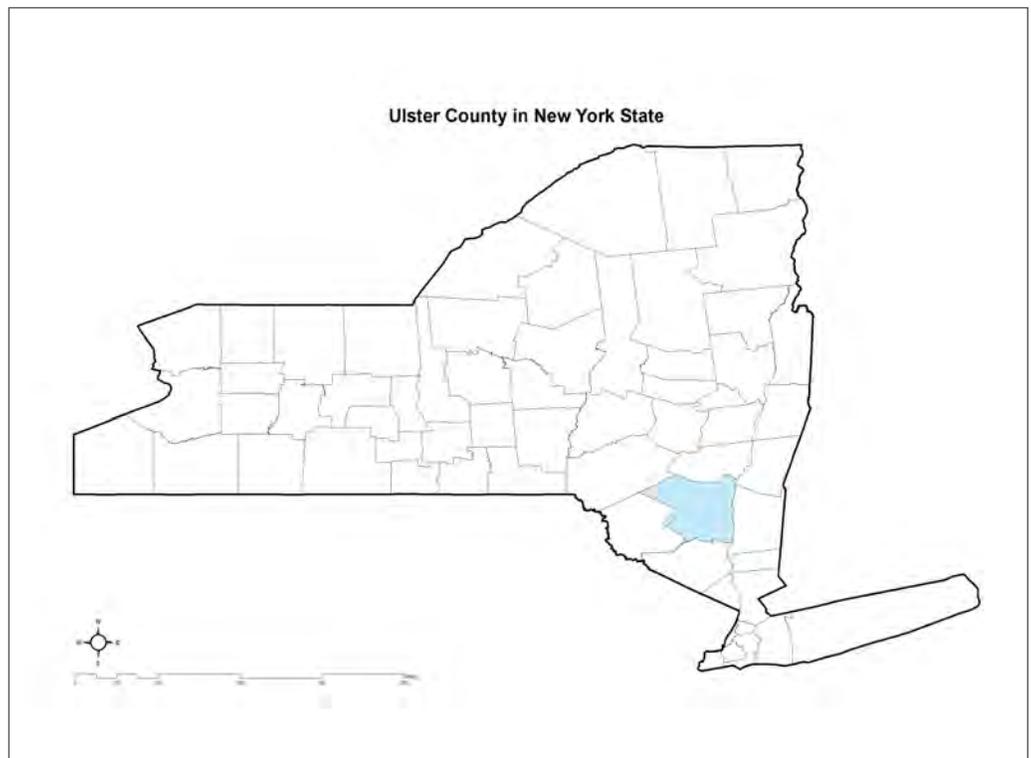
Ulster County brought together a strong coalition of county departments, agencies and key interest groups coordinated by the Ulster County Department of the Environment to provide guidance for the mapping effort.

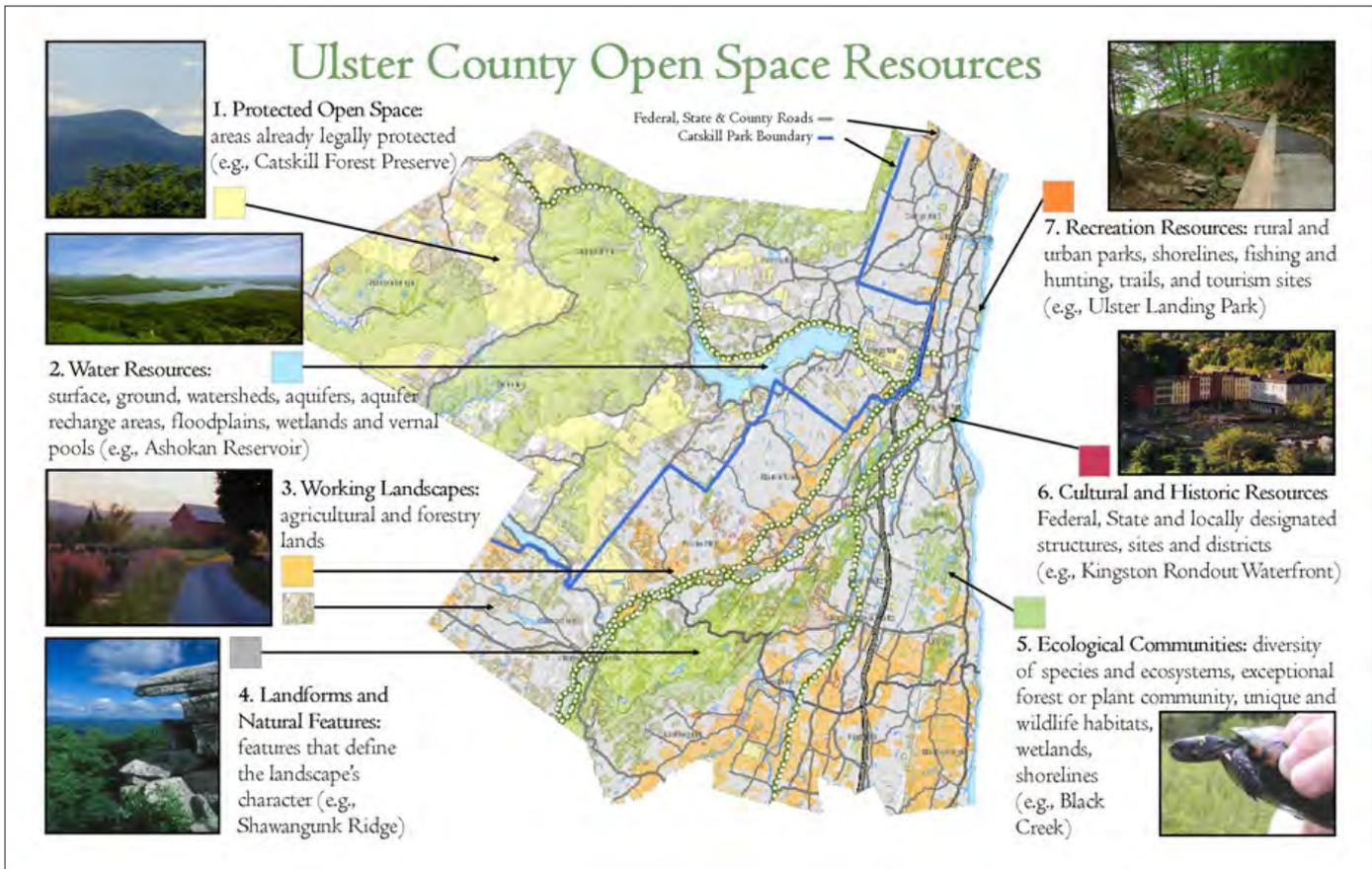
The GIC led the process for developing the mapping model, obtaining key data sources, soliciting peer review for the methods, creating the base map and themed overlay maps, and creating presentations and training for county staff and the public. Ulster County staff received technical support from the GIC to produce green infrastructure maps and showcase priorities to guide the locality's own on-going conservation and planning efforts. These efforts include comprehensive planning, open space and parkland planning, planning for future growth, watershed protection, zoning decisions and economic development.

Conference calls, a kickoff meeting and map review meetings were held to ensure opportunities for input. Ulster County also held staff meetings to develop a mission statement for the project, to review data and to discuss outreach and applications for the maps. The county also provided the mapping goals for the themed overlay maps.

Ulster County completed its Open Space Plan in 2007 as a collaborative undertaking by the Ulster County Environmental Management Council and the Ulster County Planning Board. The Open Space Plan provided an inventory of the county's protected landscapes, water resources, natural features and major landforms, recreation, cultural and historic resources and ecological communities (see Open Space Plan Graphic on the next page). While the plan provides invaluable baseline data and strategic directions to guide the county's conservation and future growth and development, it does not provide a system for identifying significant areas of forest habitat or ranking those various natural resources.

The green infrastructure landscape maps take the 2007 Open Space Plan to the next step. Rather than replacing the Open Space Plan, the green infrastructure map provides the county with a tool to evaluate its open space areas and determine the highest-quality habitats – it provides a ranking system to determine the most unique and sensitive landscapes. It also provides a tool to compare how other uses, such as historic preservation or recreation, are supported by these high-value habitats. In future updates of the plan, these newly ranked habitats can guide future priorities. In addition, the New York State Open Space Conservation Plan also can be informed by Ulster County's green infrastructure map.





The green infrastructure base map was created utilizing existing state and national data sets, as well as local data that met quality assurance requirements and which have data that are represented spatially for mapping purposes.

PROCESS DESCRIPTION

The process of identifying and prioritizing intact core habitat uses geographic information systems (GIS). Chapter Seven contains a step-by-step methodology for creating a county-scale base map of core habitats. This base map can aid in the analysis of a number of different natural resources priorities, ranging from water quality and biodiversity to recreation, culture and working landscapes.

For a description of cores and their role in a green infrastructure network please see Chapter One.

Step 1: Set Goals

Ulster County first created a vision for what it hoped to achieve with the project:

Vision Statement -

“Ulster County’s unique resources - its mountains, forests, waterways, and soils - have both been shaped by and help to shape its communities, economies and overall quality of life. In recent years, we realize more than ever the critical connections of our cultural and natural resources to our local and regional environmental and economic sustainability.

This county-scale mapping effort will draw more focused attention to critical resource protection areas, and will do so in a meaningful, visual and accessible manner. Borne of this focused attention are initial steps to address pressing concerns and potential threats to Ulster County’s critical resources as well as new recognition of great opportunities inherent in better protecting and understanding our natural assets.”

The GIC formed a mapping team with county staff coordinated by the Ulster County Department of the Environment, and determined the key focal areas to

THEMED MAPS

A themed map highlights a particular land use or resource as it relates to the green infrastructure base map of intact habitats and locational information such as towns and highways. As noted in earlier chapters, not everything can go on one map because it becomes unreadable and unusable. Selecting themes to focus on allows a map to highlight one or two key topics of interest. For example, a themed map about agricultural soils can show where there are lands containing high quality agricultural soils not currently covered by forests that may be suitable for farming.

Themed maps can also show relationships. For example, you can place a recreational activity layer that highlights key areas for birding, hunting or hiking over a map of high-quality habitats to see how large intact landscapes also support activities that depend upon a connected landscape.

overlay on the base map. The county staff reviewed and consulted key documents, such as the Open Space Plan; technical reports, such as those covering the Catskills and Shawangunk Ridges; and current on-going efforts such as the Greenways Plan. The GIC also consulted with key stakeholder groups, such as the Nature Conservancy, Hudsonia and the Federated Sportsmen's Club of Ulster County; local towns within Ulster County's borders; other county departments and agencies, such as Economic Development and Tourism; state and regional offices of the NYSDEC; and the U.S. Environmental Protection Agency.

Based on the county's review and meetings with staff and key stakeholders, several themes were determined as important to the county and were later used to group information:

- Ecological Cores for Habitat (both terrestrial and aquatic)
- Working Lands: Parcels suitable for forestry or agriculture
- Water Resources and Riparian Habitat
- Natural Resource-Based Recreation
- Heritage Resources and Rural Character

Step 2: Review Data

The GIC prepared a chart of data needed to build a habitat core model and researched the available land cover data to find the most up-to-date and consistent data sets. [The full list of data utilized is found in Chapter Seven of this guide].



Rich agricultural soils are part of Ulster County's green infrastructure.

Simple rules of thumb for what can be mapped are:

- The data must exist (or be readily obtainable).
- The data must be represented spatially.
- The data must be consistently available over the entire area.

To ensure that the same model can potentially be built in every county in New York State, the data we utilized are available at a scale that any county can obtain. So, for example, while there are some LiDAR data – high-resolution land cover imagery at 1.4 meter scale – in Ulster County, it doesn't cover all of the county, as of April 2013. Moreover, many counties in New York State don't have LiDAR data. However, land cover imagery covering larger, 30-meter area zones is available for all of New York, so that scale was applied to build the model for Ulster.

Step 3: Make Maps

To create a map of intact habitats, a digital data layer consisting of large areas of intact habitat was created using natural land cover. Next, a layer consisting of developed lands and transportation features was overlaid to determine which areas were fragmented. Edge areas were removed to determine the amount of land that makes up the interior habitat. Following that step, the habitat cores were analyzed for additional attributes relating to size, biological and habitat diversity and water quality. Finally, based on these attributes, the cores were ranked to aid in prioritization for protection or conservation actions.

The following is a description of the data that were utilized.

Natural Land Cover Layer

The natural land cover layer represents land cover for which biodiversity and ecosystem services have the greatest potential to remain most intact and of highest value. It was constructed by selecting different habitat types that were identified using recent analysis of aerial land cover imagery. This method for identifying habitat utilizes recent, free federal data that are available statewide. This ensures consistency and efficiency when creating a cores model.

The natural land cover layer consists of selections from the United States Department of Agriculture's (USDA) Cropscape Cropland Data Layer (CDL), which includes a variety of different land cover types, including crops, forests, water and urban areas. Additional wetlands data identified habitat that may have been missed by the CDL. See Appendix A for all data sources.



Farms can support agrotourism.

Development Layer

The development layer represents land cover and land use that causes the most disruption of the ecosystem. Features such as roads and highways, railroads, buildings, impervious surfaces, other developed areas and intensively used open space, such as ski slopes or golf courses, can fragment the landscape. In order to show this fragmentation with GIS, a number of shapefiles, listed in the Development Layer Appendix A, were combined. These combined datasets created a picture of where habitat does not exist. An edge area of 100 feet was removed to account for disturbance caused by development. Edge impacts are described in Chapter One. This was then paired with the natural land cover layer in order to remove patches of habitat that are too heavily fragmented to provide significant ecosystem services.

The habitat cores layer is the result of overlaying the development layer onto the natural land cover layer and removing underlying impacted habitat areas.

Data on new buildings is also important to show where cores may have been impacted since the last land cover imagery was created. For some areas, where the data may be from 2006, maps of buildings were used to determine if there were any newly impacted areas and what was the level of impact. An example of how this is done is shown at right.

The image on the top right shows a core that experienced new development. Buffers were added using GIS to indicate all the areas impacted by the new structures (middle). Finally, the image on the bottom right shows those areas that had to be excluded from this single habitat core because of the fragmenting impacts of recent development. As a result, this core had to be removed from the model, as it was clearly no longer intact and viable for most wildlife.

For more information on data sources, see the Development Layer section of Appendix A.

Geometry

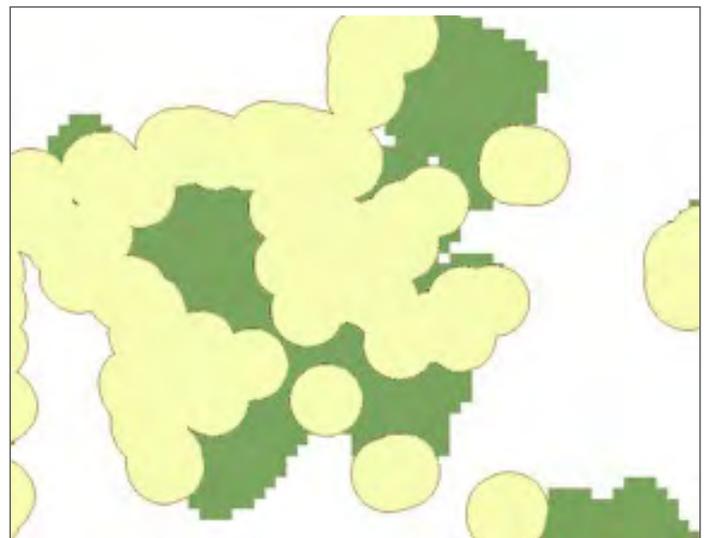
The geometry of a core can influence its diversity and its resilience, as well as the extent of ecosystem services provided by the core (Bulluck, *et al*, 2007). Simply calculating overall acreage gives an incomplete picture of the value of a habitat core's size. The more depth and more round a core is, the less edge and more interior habitat it contains.



This core has had development since the first model run.



A 100-meter buffer was added around each building to account for the area of impact (driveways, lawns, edge).



Once removed, these areas of impact show this core is no longer intact and should be deleted.

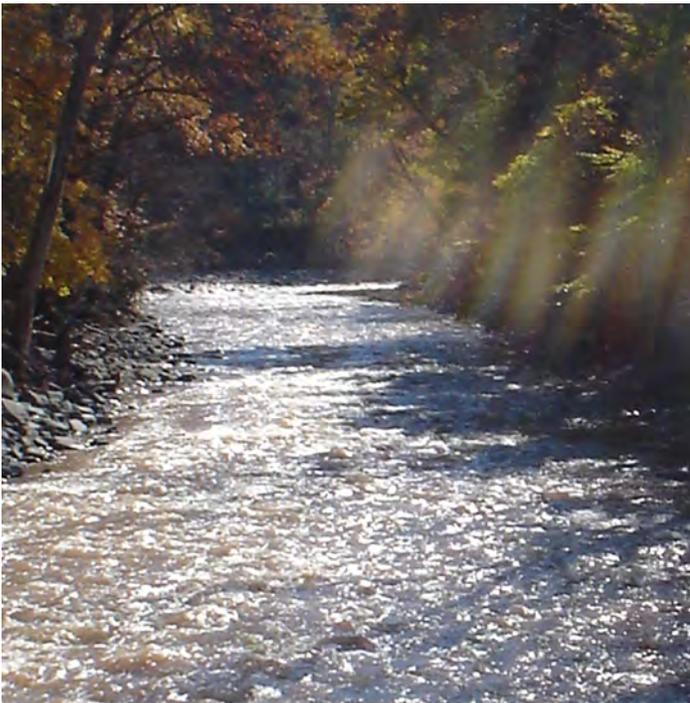
Interior habitat is fundamental for the survival of many species and ecological communities (Bulluck, et al, 2007). Therefore, a number of different spatial attribute fields were created for the cores layer in order to gain a more complete picture of a core's geometry.

For a complete list of data and methods, see the Geometry section of Appendix A.

Water Quality and Quantity

Intact natural landscapes help protect water resources. Depending upon internal land cover, cores can filter pollutants, allow for groundwater recharge, cool streams and provide habitat and food for a variety of species (Weber, 2003). The water quantity within cores adds value to the cores since it can contain habitat for aquatic species and also is a drinking water source for terrestrial creatures that call the core home. A number of fields were added to the cores layer to represent the water resources present in the core and provide analysis and prioritization for conservation, remediation or other management activities. These fields included analysis of water quantity, water use classification and predicted biodiversity.

For a complete list of data and methods, see the Water Quality and Quantity section of Appendix A.



The county's streams provide recreation, drinking water, habitat and natural beauty.

Rare Species Habitat

The NYSDEC's Natural Heritage Program (NHP) tracks and maintains data on rare species and natural communities of plants, animals and aquatic organisms throughout the state. While the NHP does not have data for the entire state, it does provide the most consistently measured and applied analysis of species and habitat conservation needs. NHP data are high resolution and comparable across areas where they have been gathered.

"The species and communities tracked by NHP are referred to as *elements of biodiversity*, and their individual locations are referred to as *element occurrences (EOs)*."

The species and communities tracked by NHP are referred to as *elements of biodiversity*, and their individual locations are referred to as *element occurrences (EOs)*. The NHP data included in the Ulster County model are rare plants and animals and significant natural communities from 1980 onward, for which there is location data. More detailed information about many of the rare and listed animals and plants in New York, and the natural community types, including biology, identification, habitat, conservation, and management, are available online in Natural Heritage's Conservation Guides at <http://www.acris.nynhp.org/>.

The NHP's data act as a surrogate for overall biodiversity value within a core. Exact locations within the habitat core are not provided, in order to protect disturbance of the many sensitive species and ecosystems. The NHP has approved the method for masking sensitive data in the green infrastructure model.

For a complete list of data and methods, see the Habitat section of Appendix A of this guide.

Also, variation in elevation can provide for a number of different environmental habitat zones (niches) where species and ecological communities can thrive. The standard deviation and range of elevation within each habitat core was calculated to help approximate the influence of changes in elevation on diversity.

For a complete list of data and methods, see the Other Attributes: Elevation section of Appendix A.

Cores Layer Ranking

Cores were ranked based on habitat geometry, species diversity, and water quality and quantity and were combined to create an overall Core Rank. Ranking is on a scale from one to five. One denotes exceptional quality and five represents habitat cores with general qualities. Lower values mean better overall water quality, geometry and diversity, which can support a wider range of ecosystem services. This methodology allows users of the model to quickly and easily assess which cores provide the best all around water quality, geometry and diversity to support a wide range of ecosystem services. Additionally, model users can compare cores based upon each of the major ranks, or even on the scores that contribute to those ranks.

The prioritization and ranking steps utilize quantitative data to reflect socially constructed values. Those who create a green infrastructure model place a high value on having large intact habitats because they support a variety of wildlife species, protect and recharge water resources and provide other beneficial ecosystem services such as sequestering carbon. And it is not just size of the habitat that is important for supporting a diversity of wildlife; differences in elevation can impact the variety of habitat niches within a core and are an important factor to consider when evaluating and prioritizing cores.

As conditions change and more data become available, social values used to rank cores may change. For example, the ability to calculate carbon sequestration more accurately in cores may lead to data that can be used to score and rank cores according to their importance for reducing climate change.

DIVERSITY RANK

The diversity rank was calculated based on combining four different factors – elevation, the acreage of interior habitat that supports rare or threatened species (also called element occurrences), the total number of rare or threatened species and the number of species in a core of different global and subnational ranks. For a complete list of data and calculation methods, see the Cores Layer Ranking: Diversity section of Appendix A.

HOW WATER QUALITY AND QUANTITY ARE SCORED

NYSDEC LENGTH CLASSIFICATION SCORE

This score gives the most direct measurement of the quality of water within a core. The NYSDEC Length Classification Score ranks habitat cores based upon the quantity of different potential uses identified. These uses include drinking water potential, waters that support swimming and fishing uses and waters that are of sufficient quality to support aquatic species. For more information, see the NYSDEC Water Classifications section in Appendix A.

INTERIOR SURFACE WATER SCORE

Interior surface waters are those inside the core. Interior surface waters were divided into five categories and given a score of one to five, with one referencing the highest acreage of surface waters to a score of five having the least. Valuing cores that have greater interior surface water acreage is important because of the aquatic habitat it provides.

INTERIOR WETLANDS SCORE

Cores can protect water quality and sensitive habitat in wetlands. The acreages of interior wetlands were divided into five categories and given a score of one to five, where one depicts cores with the most acreage of interior wetlands.

INTERIOR STREAMS SCORE

While this measurement is slightly redundant to the NYSDEC water quality classifications score, it helps capture the value of streams that either were not classified by NYSDEC because they are not monitored or were of poor or unknown quality and thus were not incorporated into the NYSDEC classification score. These non-classified waters still can provide habitat and water quantity for water supply.

PREDICTED MUSSEL RICHNESS SCORE

Freshwater mussels are the most globally threatened freshwater organism (NSF, 2012). They require large quantities of high-quality freshwater. Due to their sensitivity, they can act as a surrogate for water quality. Predicted mussel richness, which is a measure taken from the New York Natural Heritage Program's Freshwater Blueprint, models the predicted number of mussel species for a particular reach of stream.

WATER QUALITY AND QUANTITY RANK

All five scores were combined to create an overall Water Quality and Quantity Rank. Lower ranks represent better interior water quality.

HOW SPECIES DIVERSITY ARE SCORED

COMMUNITY ELEMENT OCCURRENCE RANK SCORE

A community element occurrence is a unique plant community. The various ranks that the New York Natural Heritage Program assigns to element occurrences (EO ranks) are based upon rigorous field analysis. The ranks assigned provide insight into the overall ecological health of a core. The more highly ranked element occurrences within a core, the more potential resilience the core has to disturbance. This score gives the most direct measurement of the quality of significant natural communities within a core. A lower score represents a core with more acres of better-quality element occurrences.

ELEMENT OCCURRENCE SPECIES COUNT SCORE

The overall number of rare species and natural community types (elements) within a core provides insight into the diversity and quality of habitats within a core. The more rare species and significant natural community types a core can support, the better likelihood of higher quality and diversity of interior habitat.

G AND S RANK SPECIES COUNT SCORE

This rank represents the globally (G rank) and state

(S rank) rare species within a core. The cores were scored based on the number of species that received a rank of G1, G2 or G3 and S1, S2 or S3. All tracked species have both a G and an S rank. The S Rank is the primary ranking factor and the G rank is used to provide additional weight to the score.

PREDICTED BIOLOGICAL ASSESSMENT PROFILE (BAP) SCORE

This score illustrates the predicted aquatic biodiversity of a core. Intact cores can provide for better water quality by filtering pollutants and providing a riparian cooling effect that can support a diversity of species within a stream.

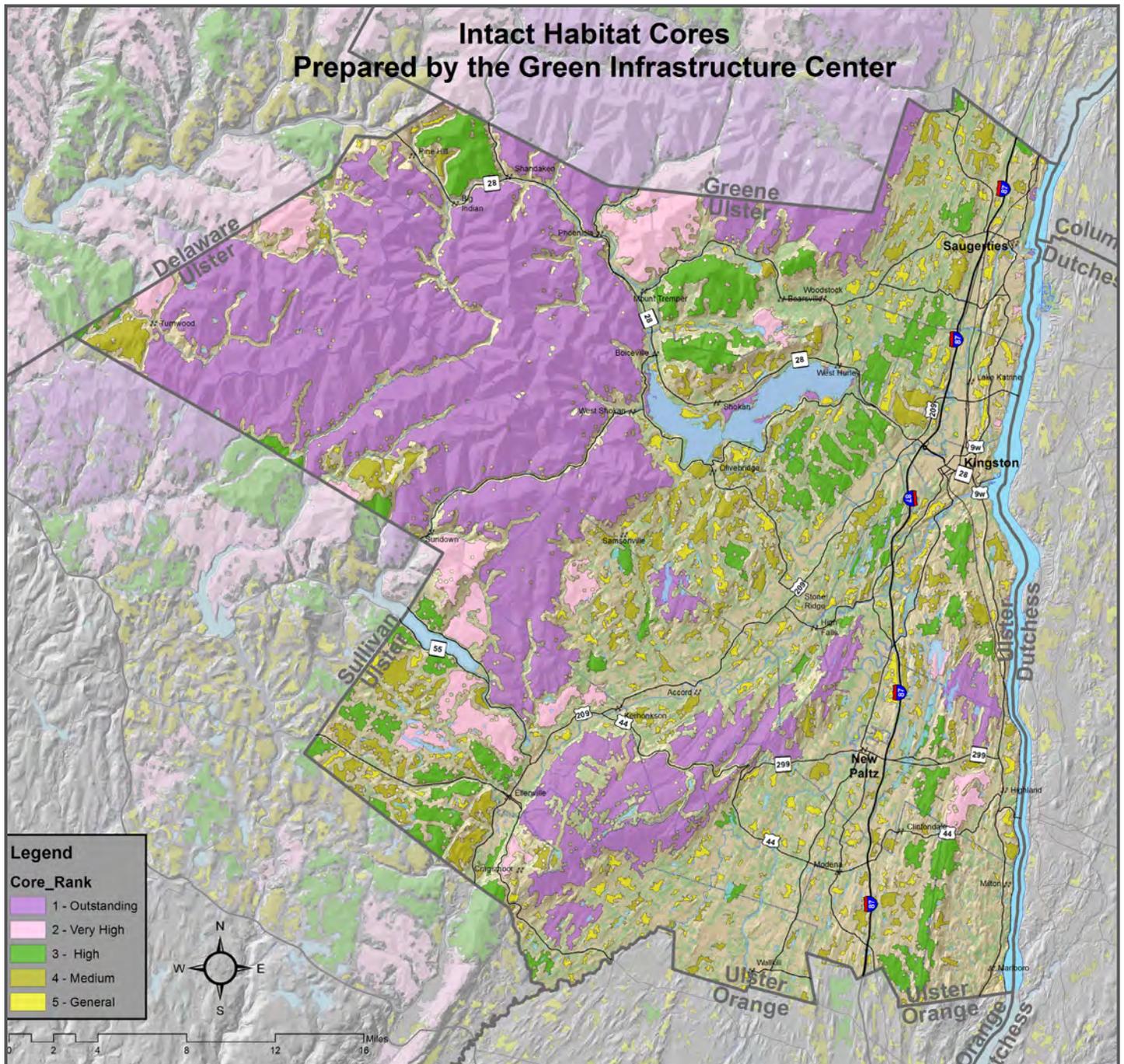
The length of streams and rivers of Natural Heritage Programs Predicted BAP ranks inside of each core were weighted and added together. A lower score represents a core with more streams and rivers of better quality.

DIVERSITY RANK

All five scores were combined to create an overall Diversity Rank. Lower ranks represent better potential interior biological diversity.

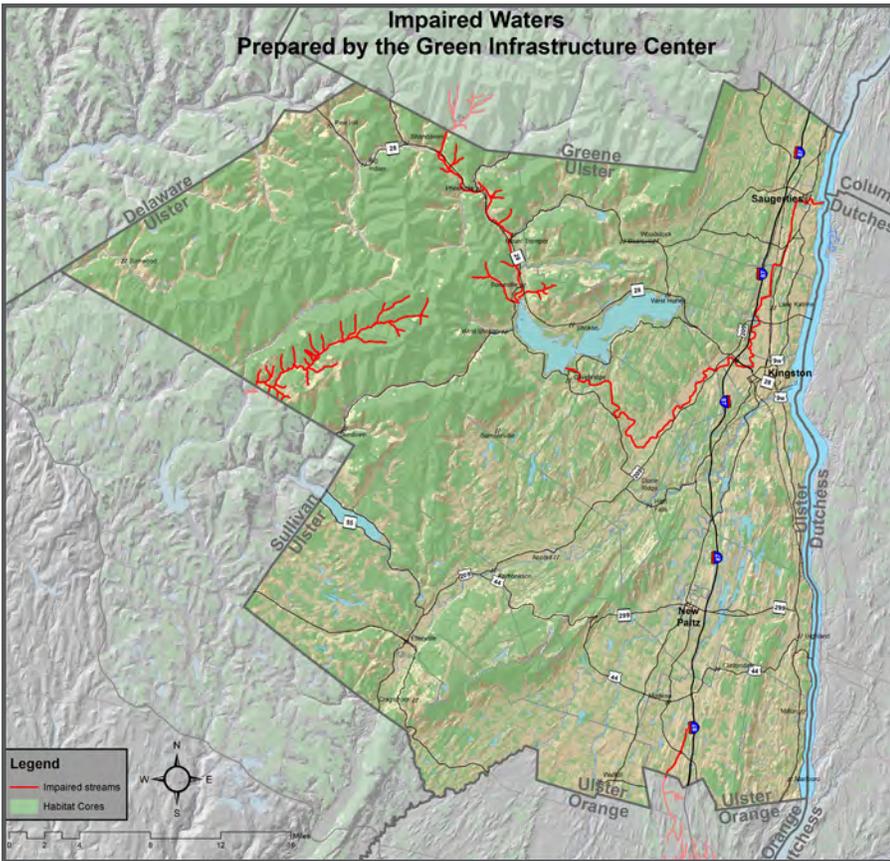


Located in Ulster County, the Ashokan Reservoir is a source of drinking water for New York City.



Base Map

The final map shows the habitat cores with their final ranks. The data used to map these cores can be updated over time to reflect habitat that is restored or lost. Habitat core ranks may change in the future as additional rare or threatened species are found or new human values emerge that inform the final rank.



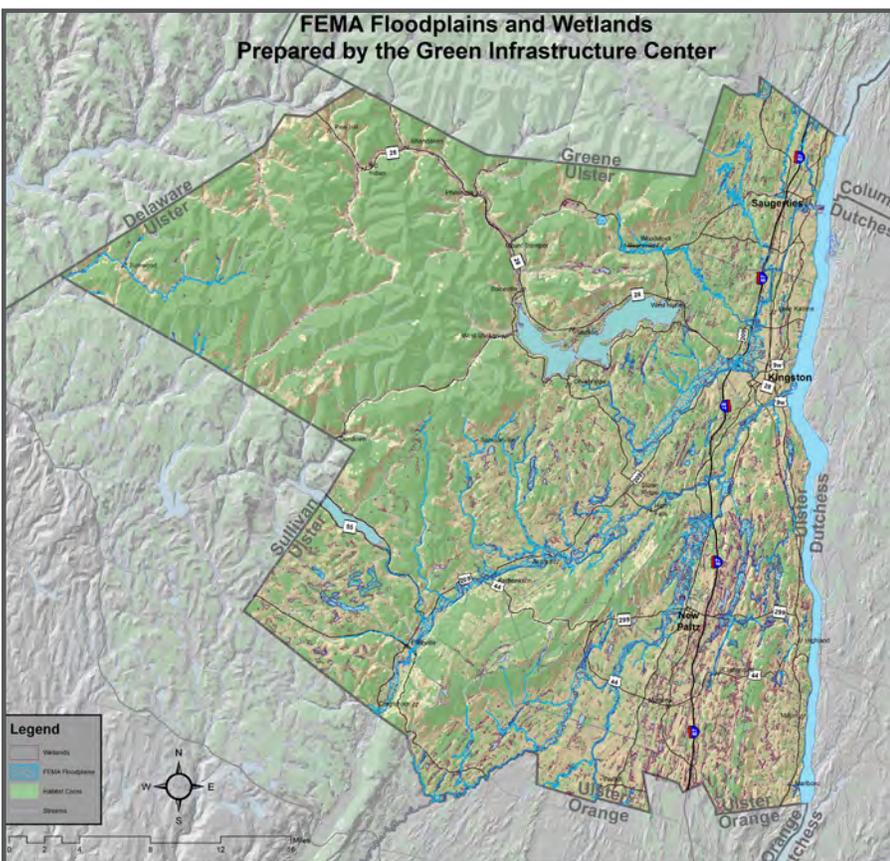
Step 4: Assess Risk

Once green infrastructure assets are mapped, they should be analyzed for risk. For example, impaired waters can pose a risk to downstream waters. In this case, the Esopus Creek is impaired from turbid water from the upstream reservoir. This problem will need to be rectified to ensure the long term health of the waterway and downstream waters. Consider whether improving streamside forested buffers or improved reservoir management practices could help restore the health of this waterway.

While not done for this project, towns can also overlay their zoning and ask questions such as: “Are these cores likely to be conserved or more likely to be developed?”; “Should zoning be changed to a less intensive use to protect the cores?”; “Should they be removed from the map?”; and “Can these landowners develop their land using conservation approaches that leave cores connected and reduce their development footprint?”

Other types of risk can include areas subject to flooding. For example, floodplains can be evaluated to determine if their location threatens existing development and to avoid building there in the future.

Another type of risk to consider is human health. New research shows that smaller habitat fragments can lead to increased risk for Lyme’s disease carried by ticks. For more see text box.



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A study by the Cary Institute of Ecosystem Studies in Millbrook, NY, found that fragmentation of forests into less than five acre patches should be avoided to help reduce the risk of Lyme disease (Allan, *et al*, 2003). The reason is related to decreased mammalian biodiversity in smaller forested patches – there are fewer small mammal competitors and fewer mammalian predators to control the populations of white-footed mice, considered the principal natural reservoir for the bacterium that carries Lyme disease.

The small forest patches were linked with higher densities of white-footed mice and higher densities of infected nymphal blacklegged ticks. Research in a highly urbanized area in Connecticut had slightly different results, but also agreed that the relationship between landscape structure and

disease risk can inform residential planning and development (Brownstein, *et al*, 2005). They concluded, “Residential configurations that preserve remnant forests in such a way that reduces adjacency of households to forest fragments would also serve to reduce human exposure to infected ticks.”

Works referenced:

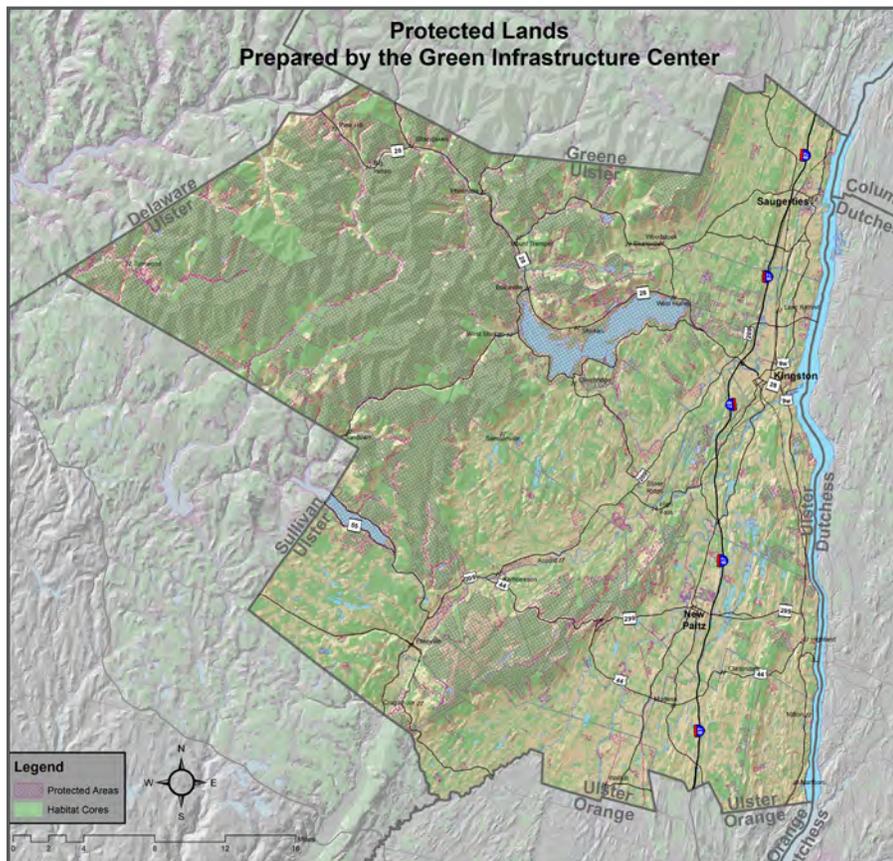
Allan, B.F., F. Keesing, R.S. Ostfeld. 2003. Effect of forest fragmentation on Lyme disease risk. *Conservation Biology* 17:267–272 (http://www.ecostudies.org/reprints/Allan_et_al_2003_Cons_Bio_17_267-272.pdf)

Brownstein, J.S., D.K. Skelly, T.R. Holford, and D. Fish. 2005. Forest fragmentation predicts local scale heterogeneity of Lyme disease risk. *Oecologia* 146(3): 469-75

Step 5: Determine Opportunities

The level of protection can help to inform what is at risk and also where there may be opportunities. By calculating lands in a permanent protected conservation or resource

management use, analysis can show how protected a core is from fragmentation and degradation. Areas that are high-value habitat and are not under any protection can also be evaluated and consider for protection.



Once large habitat cores have been selected, key corridors can be identified to help connect additional areas. Streams and rivers with an adequate buffer often provide valuable connectors across the landscape.

Riparian corridors can be established by identifying those areas that have 300 meters of habitat cover on either side of a riparian feature. A corridor of 300 meter width is ideal for wildlife movement across a landscape.

For a complete list of data and methods, see the Corridors: Riparian and Waterbody Corridors section of Appendix A.

The Natural Heritage Program created *PATHWAYS: Wildlife Habitat Connectivity in the Changing Climate of*

the Hudson Valley as a way to track important lands for a variety of species over the next century. This project identifies suitable habitat for 26 species of greatest conservation need and aggregates the results into a single analysis. The data identifies parcels that will be important for these species over the next century as climate change starts to alter the natural ecosystems that these species rely upon. Since one of the goals of PATHWAYS was to identify a connected landscape, it lends itself readily as a corridor model for this analysis. Unfortunately, it is currently only available for the Hudson River Valley.

A locality can examine which parcels are currently important and which ones will be important in the future as our climate changes. It is recommended that any locality interested in using PATHWAYS to represent corridors download the report and examine which attributes make the most sense considering local goals and priorities. To do so, please contact the Natural Heritage Program at NYSDEC.

Step 6: Implement Opportunities

Once you have created your natural asset maps, include them in daily and long-range planning, such as park planning, comprehensive planning, zoning, tourism and economic development. These maps can also be adopted into the comprehensive plan to help guide future growth and development decisions.

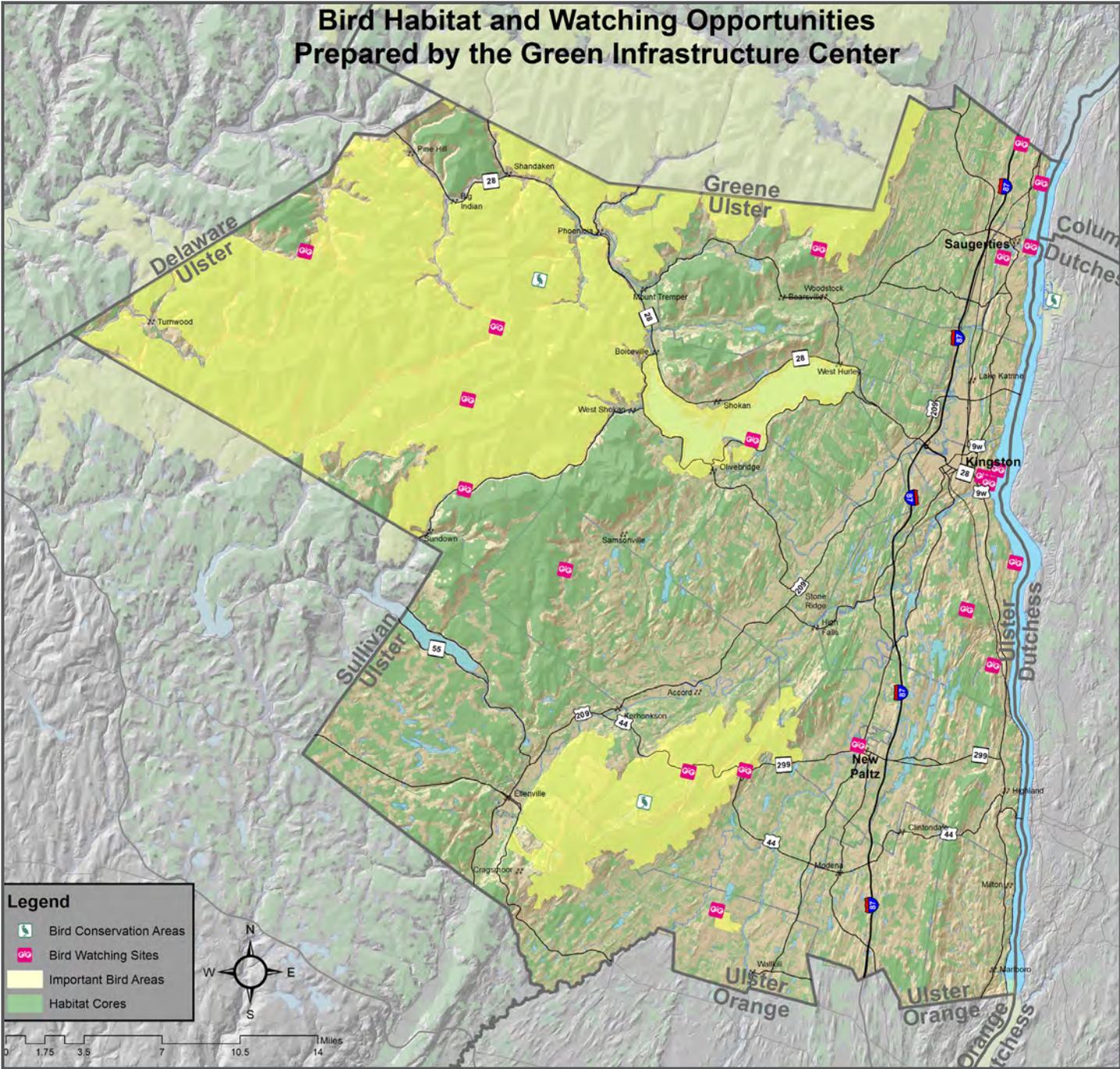
Themed Overlay Maps

Themed maps can be used to show other natural assets of importance and to determine how the natural asset network supports other cultural values. In the Working Landscapes Map, agricultural soils were added to the map to show where soils are most productive for farming. Similarly, data showing areas important for forestry were mapped (see Working Landscapes - Forestry). Areas greater than 25 acres are better able to support sustained silviculture than smaller parcels. These maps can be used by county extension agents, foresters and staff to help zone areas appropriately and allow these 'working land uses' to continue, if desired.

Each themed map is overlain on the Intact Habitat Core area map which depicts the large intact forested or wetland areas. Habitat cores provide pathways for wildlife, protect water and air quality, and support natural resources industries such as farming, forestry and recreation. Each county determines what themes are important to them. So for example, outdoor recreation such as hunting, fishing and birding are very important to Ulster County residents and visitors. Agriculture is also a key economic and cultural activity that depends on the landscape and the location of the best quality agricultural soils. Ulster County requested and supported the development of these themed maps to inform their land planning.

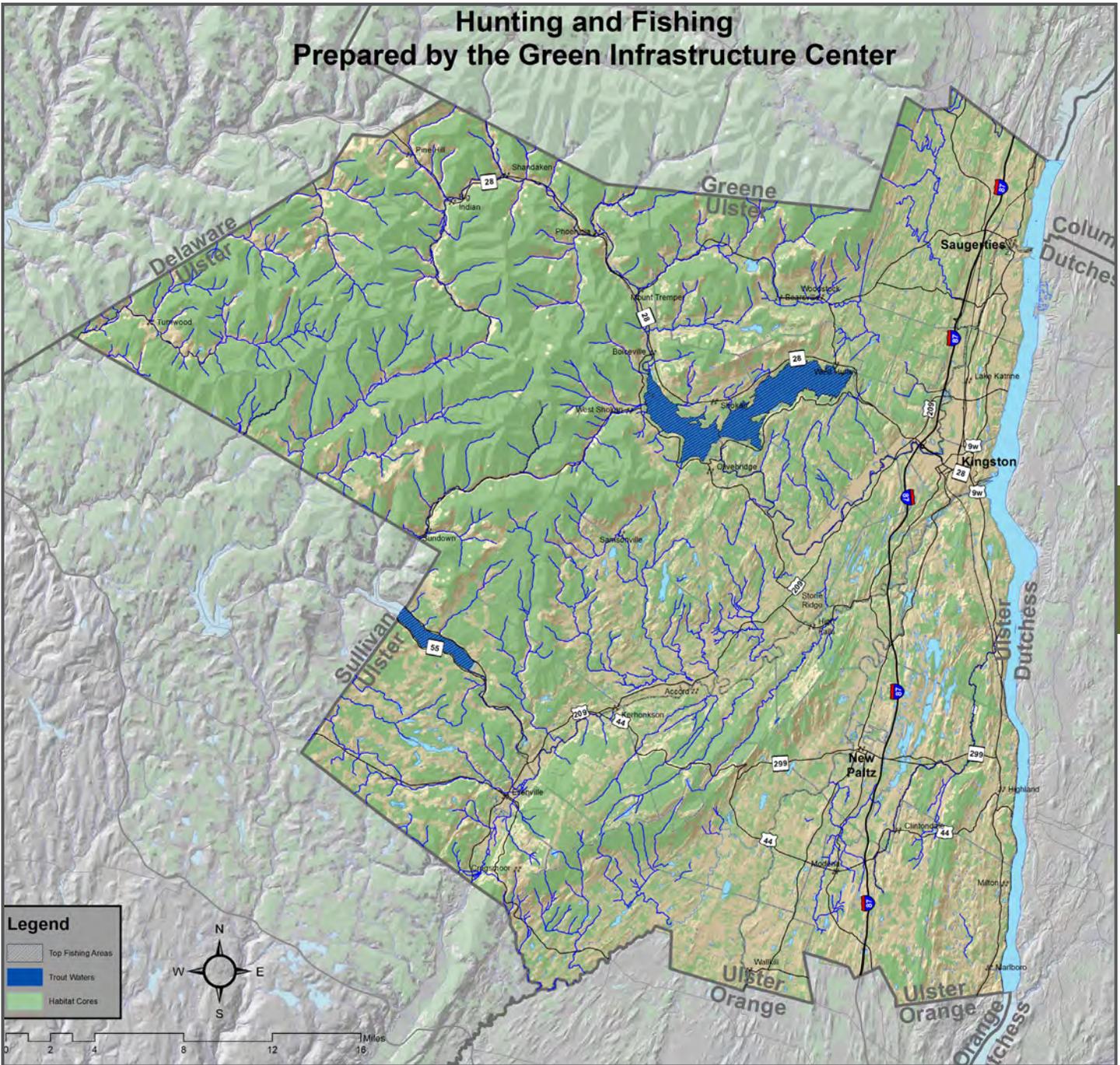


The dramatic Hudson River cliffs offer wonderful views.



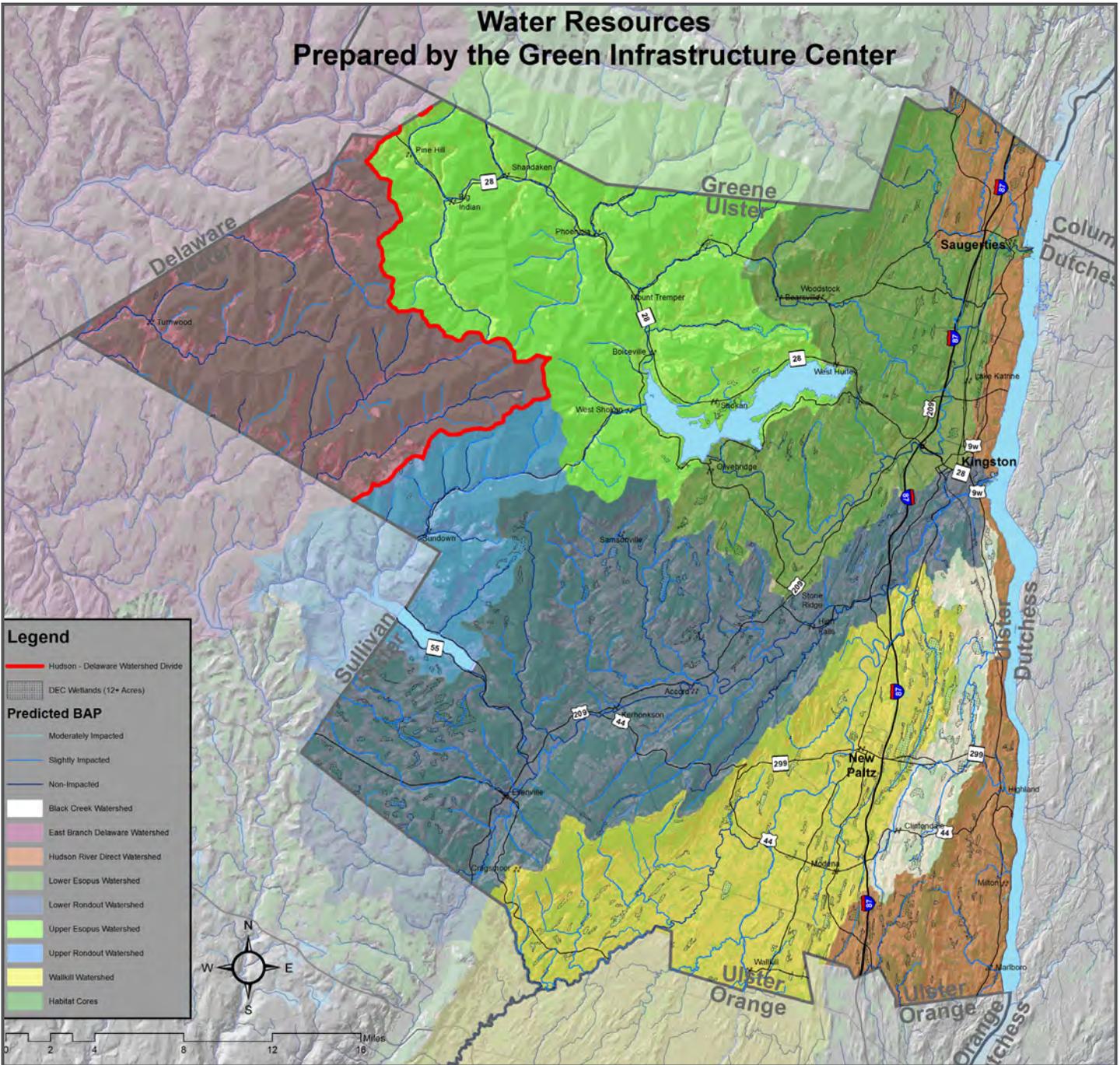
Bird Map

This map shows habitat cores that support important birding areas in Ulster County. Habitat cores consist of large areas of intact forests and wetlands that are potential habitat for birds. Bird watching is not only a fun way to spend time in the great outdoors; it is also a significant tourism driver. People who watch birds take advantage of a range of other services such as restaurants, bed and breakfast establishments, hotels, general stores, and guided tours.



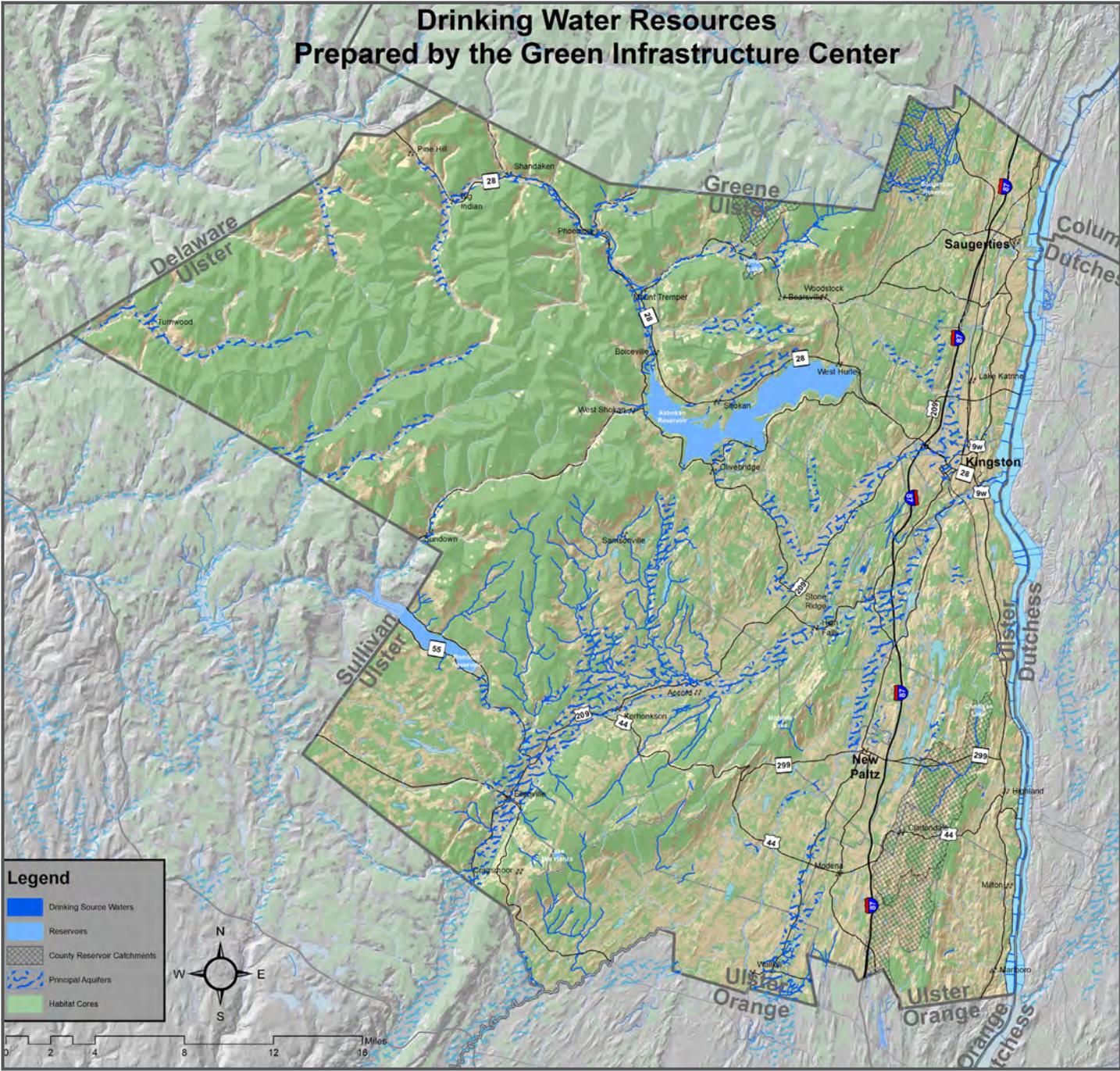
Hunting and Fishing Map

Habitat cores provide intact habitat for game animals and protect water quality for fishing. Ulster County has many opportunities for hunting and fishing. High quality natural areas are required to support these activities. Game animals require large ranges of varied habitat to provide for all of their needs. The better the habitat, the healthier the animal and more rewarding the hunting experience. Many animals, such as black bears, need a large area for their range and depend upon a connected landscape for cover as they travel in search of food. Some species of fish, such as brook trout, need high quality waters in order to survive and flourish. This map shows how current hunting lands and fishing opportunities relate to those habitat cores. Hunting and fishing require proper permits on all lands and access to private hunting clubs and gamelands require additional approval of the property owner.



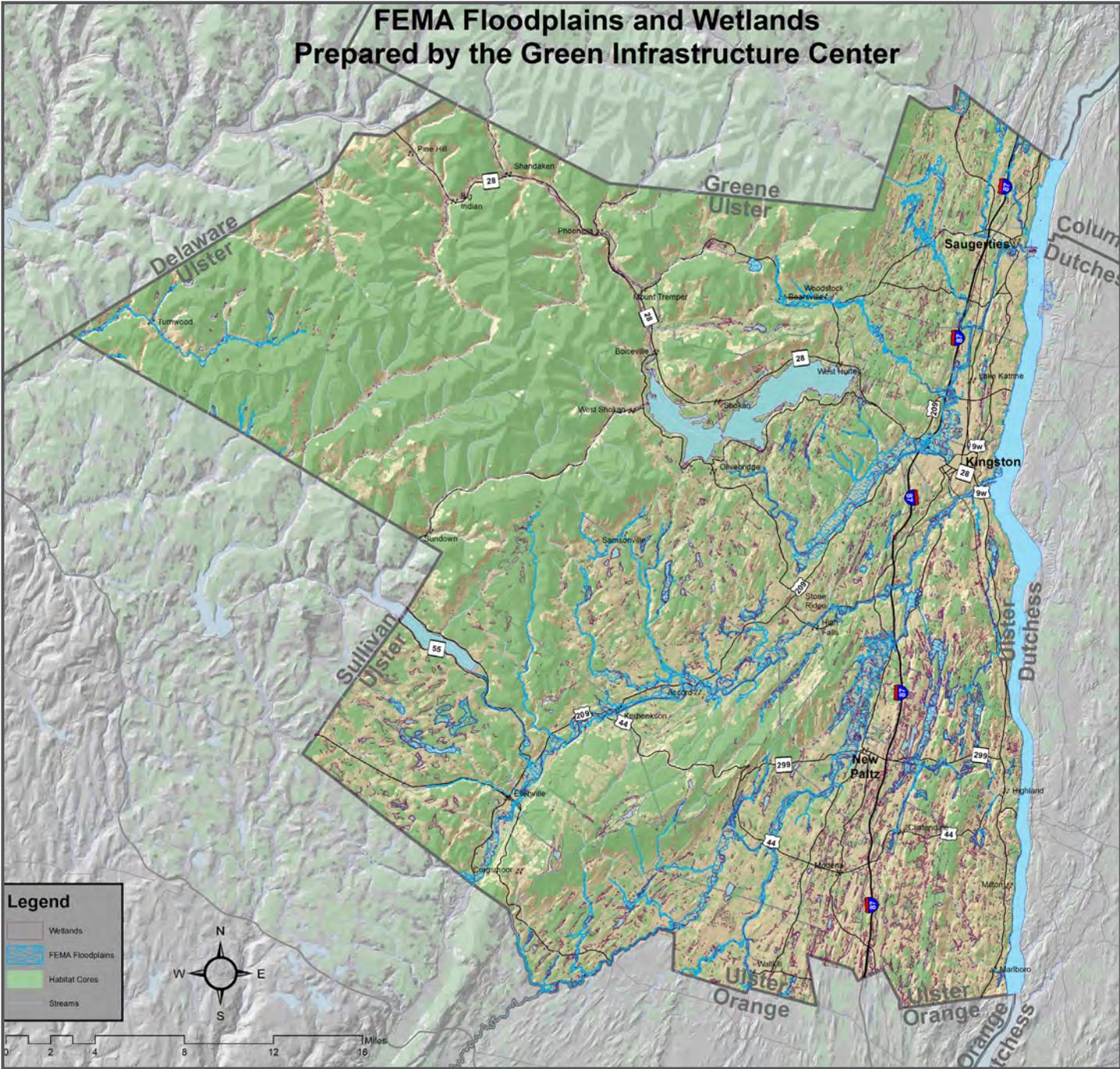
Water Resources

This map shows Ulster County’s water resources. These provide clean and abundant water for people and industry, opportunities for recreation and habitat for fish and wildlife. The landscape around water resources has a great influence on their quantity and quality. Habitat cores are extremely important for maintaining good water quality. They filter pollutants, reduce erosion, increase water storage capacity and provide shade that cools waters and maintains oxygen levels.



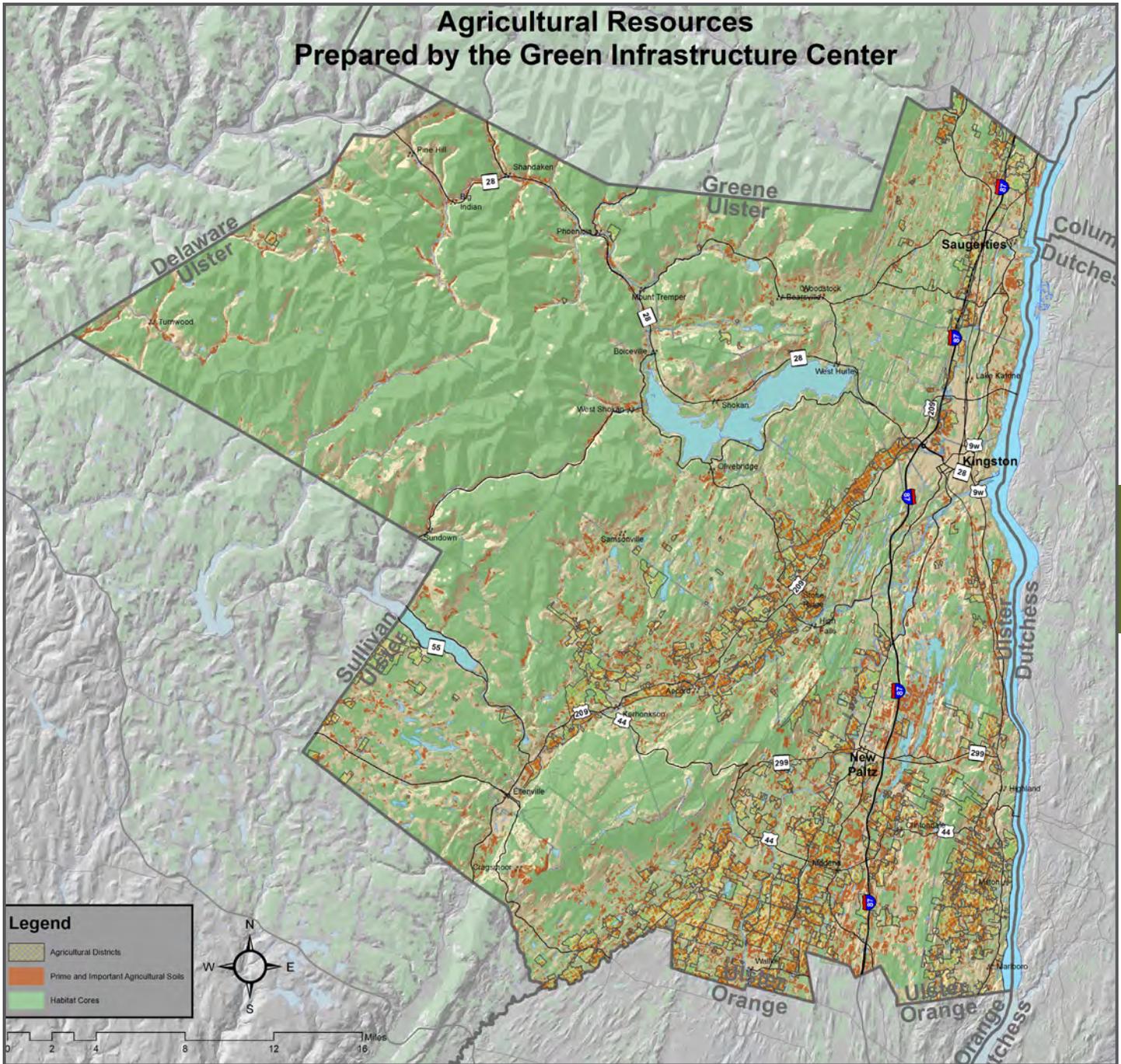
Drinking Water

This map shows Ulster County’s drinking water resources and the reservoirs that supply New York City -- the Ashokan and Rondout Reservoirs. These resources support clean and abundant drinking water. The landscape around them has a great influence on water quantity and quality. Habitat cores with native land cover are extremely important for water resources. They filter pollutants, reduce erosion by slowing runoff, increase water storage capacity and provide shade to cool the water. All these services are a far cheaper alternative to expensive water treatment facilities and processes. The protection afforded to the water supply for New York City saved the city billions of dollars in construction costs for additional water filtration. The watersheds that supply New York City’s drinking water cover 231,018 acres and 31 percent of Ulster County.



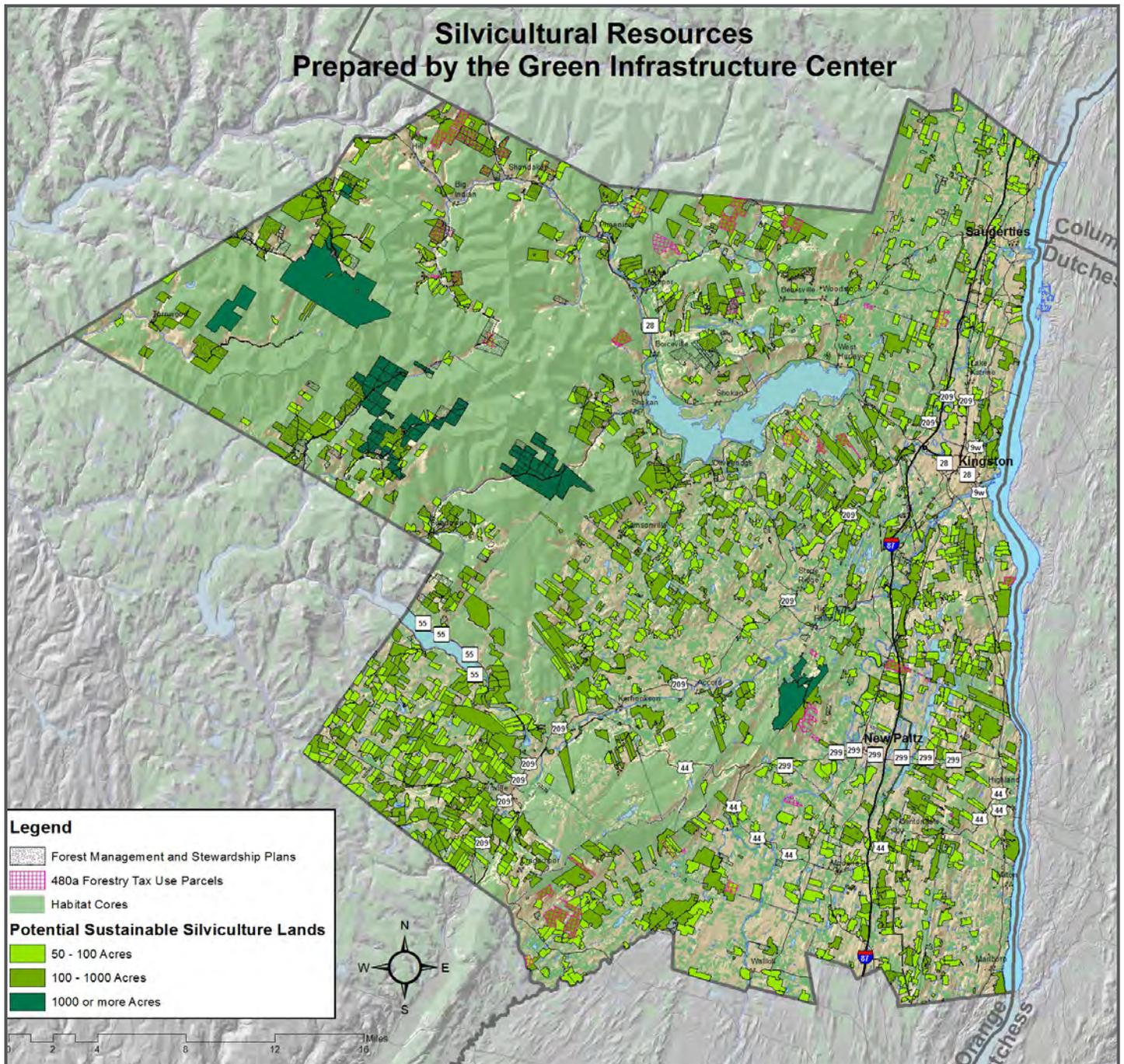
Floodplains and Wetlands

This map shows Ulster County’s floodplains and wetlands. The landscape around water resources has great influence on its quantity and quality. Habitat cores are extremely important for water recharge as they slow down water, capture and store it and filter out pollutants. Those watersheds that have large intact core areas are better able to store and filter water.



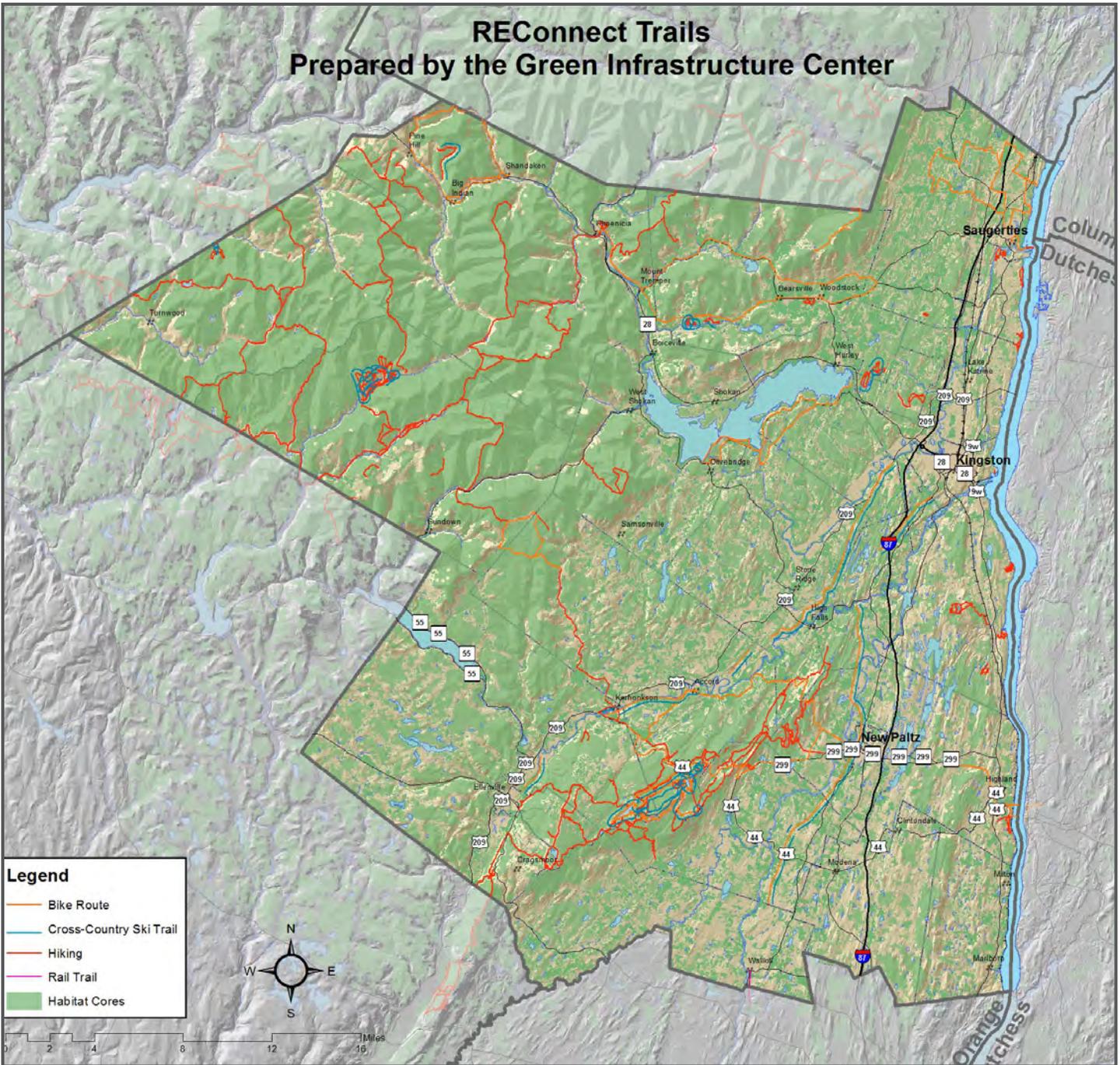
Agriculture

This map shows high quality agricultural soils in Ulster County and their relationship to habitat cores. Agriculture is a significant industry that provides jobs, food and other products. It is an integral part of Ulster’s identity and is a source of cultural pride. Agriculture relies on the surrounding landscape for a number of services. For example, habitat cores create additional food sources for pollinators and provide habitat for a number of species that are predators of invasive pests that can harm crops. Farms also provide scenic views that attract customers to Ulster’s booming agri-tourism industry. Farms can be managed to create connections between cores, protect streams and other waters, and keep land in viable rural economic use while providing a source of local food.



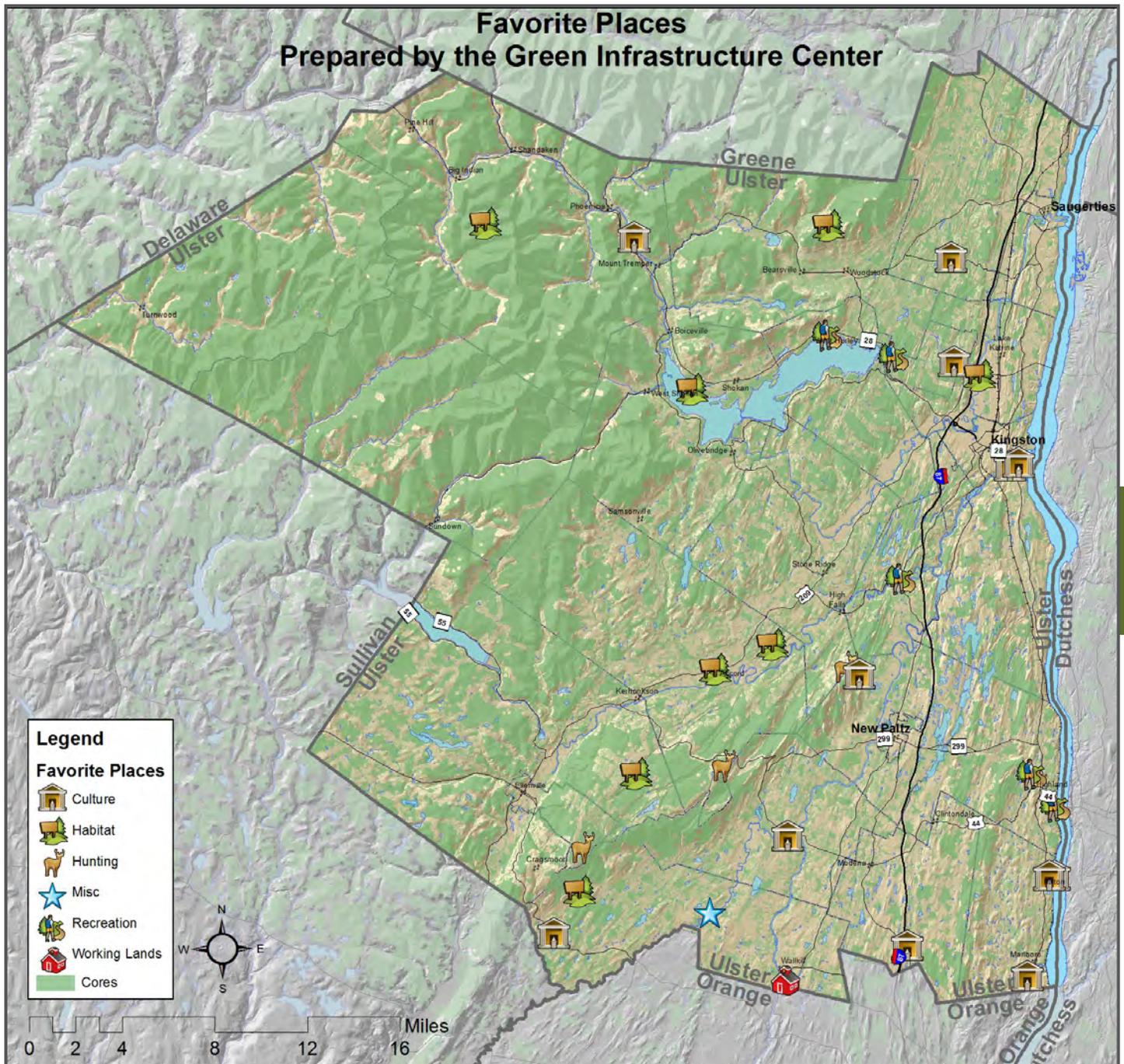
Forestry

This map shows current and potential forestry resources in Ulster County. Parcels included on the map are those that are large enough to support sustained forest management over time and are not located on steep slopes. Forestry can be an important economic activity that allows property owners to keep land in forest cover instead of converting it to other uses. Forested lands also can be managed for a variety of other services as well, such as water quality and quantity, wildlife habitat, recreational uses and aesthetic values.



REConnect Trails

This map shows major recreational trails for skiing, biking, hiking and rail trails. Many of the county’s hiking trails depend on a connected landscape and the views from those trails which are provided by the habitat cores. Ulster County has an on-line tool which allows users to make their own maps of recreational areas. Visit REConnect at <http://co.ulster.ny.us/recreation/>



Favorite Places

This map of ‘favorite places’ was made with input from the community during a workshop on March 28, 2013. Attendees were asked to note places that they believed are significant or important. This map helps planners identify areas of a green infrastructure network that hold intrinsic values for local residents.

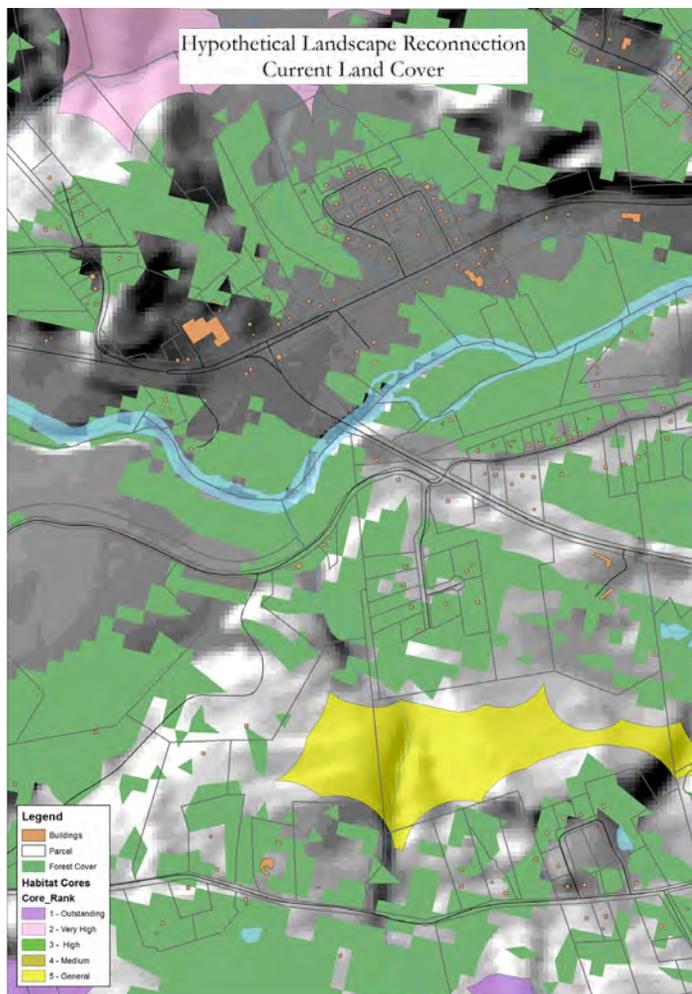
In summary, these core habitat maps and themed overlays can be used to guide growth and development by planning staff, inform developers about conservation priorities and options, help land trusts seek out those parcels of greatest importance that are also at greatest risk, and inform other key decisions about what to protect and where and how to grow.

Identifying Corridors To Restore

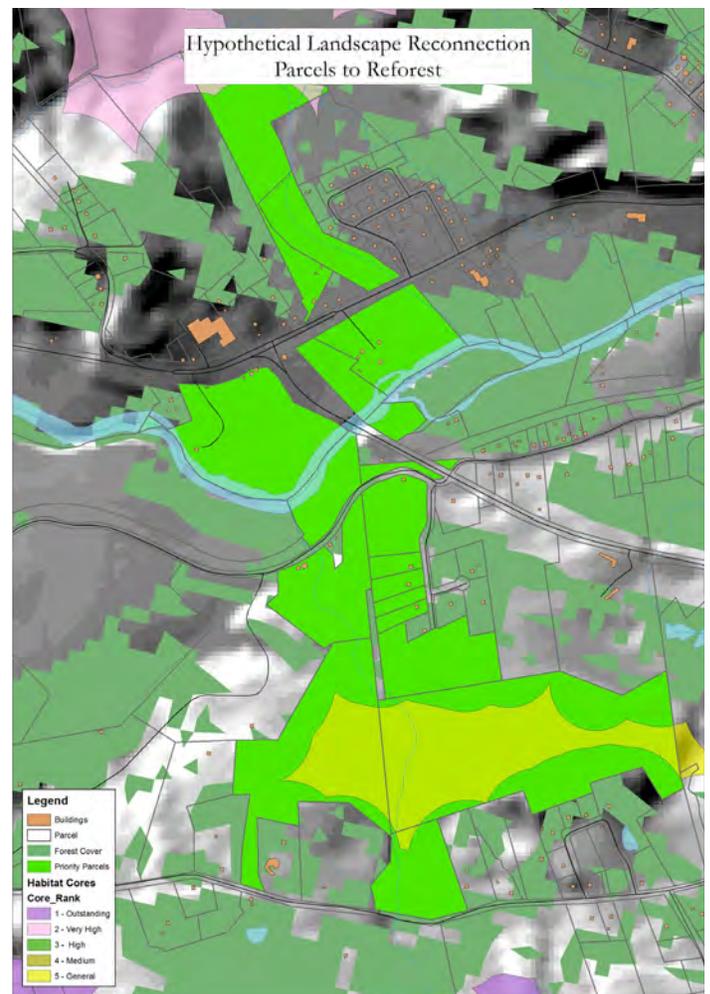
The green infrastructure maps and natural asset overlays can be utilized to prioritize areas for greenway development. The Hudson River Valley Greenway Act describes “Greenway criteria” as “the basis for attaining the goal of a Hudson River Valley Greenway.” The criteria – natural and cultural resource protection, regional planning, economic development, public access, and heritage and environmental education – provide the overall vision for voluntary local Greenway programs and projects. The general nature of the Greenway criteria allows communities to develop locally-based projects that address community

concerns while contributing to the overall framework of the Hudson River Valley Greenway.

A greenway network can also serve as corridors between habitat cores. Parcels can be identified that might provide the best opportunities to connect the landscape. In vignette example 1, there are several open parcels between two higher value habitat cores that can be reconnected. In vignette example 2, those parcels that can serve a role in reconnecting the landscape are highlighted. Note that re-greening the landscape around the general core to the south actually causes it to become higher ranked from ‘general’ or yellow to ‘high quality’ dark green because it increases in size. Ulster County can use its green infrastructure map to identify these opportunities and partner with interested towns and landowners who wish to participate in reconnecting and restoring the landscape. The landowner may still live on or farm the parcel but they might also provide a several hundred foot wide corridor to provide wildlife passage and natural beauty.



Vignette 1



Vignette 2

by Simon Gruber

AGROFORESTRY

Agroforestry describes strategies that integrate trees and forest management with agriculture. It refers to a wide array of methods, many of them not new.

Throughout history, agricultural methods in many parts of the world have mixed trees with crops and livestock. But more modern, large-scale techniques have displaced agroforestry in many parts of the world and the intimate connection between agriculture and trees has largely been lost.

Agroforestry has recently re-gained attention as an important concept and set of methods for optimizing environmental quality and economic potential in working landscapes. In some regions, it has focused on re-planting trees on agricultural lands that presently have none. But in much of the northeastern U.S., including Ulster County, NY, and surrounding areas, an opposite trend has emerged – applying agricultural management practices to existing woodland in order to enable new production options. Maple syrup is a well-known example. Ginseng is another: It is a high-value crop grown in forests. And shitake and other edible mushrooms are also valuable and in high demand in large markets in the region.

SILVOPASTURING

Silvopasturing integrates livestock production with managed forests in various ways. Many farms in the Ulster County region have some wooded land, but it's not often used as part of the grazing area. Opening these areas to livestock using a controlled, rotational grazing system offers many benefits. For one, it increases the acreage available for production without acquiring more land.

Silvopasturing fits well with a growing market demand for free-range poultry and pork, grass-fed beef, and goat products such as meat, milk and cheese. While animal health and comfort can also be improved, through free-range grazing, careful attention must be given to ensure parasite exposure is not a problem as this exposure can increase when cattle are grazed under tree cover. Also, just as pastures should not be overgrazed, forests must be carefully monitored to ensure that animals are not overgrazing and disturbing the forest ecosystem by removing key understory vegetation. Lastly, livestock should be fenced out of key riparian, bog or wetland areas to avoid damages to sensitive aquatic habitats.

Selective timber harvesting may be necessary on heavily wooded sites to establish silvopasture areas and can be integrated with their ongoing management. Many woodlands have grown up after

clear-cutting, leaving even-aged tree stands that have not been managed for optimal forest health, diversity and resilience. Logging by 'high-grading,' which takes out just the best trees, has left poorer genetic stock on many sites, resulting in an overall decline in the quality of tree species in some areas. Careful thinning, re-planting using better stock and improved woodlot management can enhance the health of area forests over time. This can be integrated with agroforestry, and this can benefit water resources, habitat, ecosystem services, and the regional economy.

From a planning and policy perspective, agroforestry offers an important set of opportunities to increase both economic activity and resilience to climate impacts and other changes. It can also support growing markets for local food and energy sources (such as woody biomass). Furthermore, finding economic and subsistence benefits from agroforestry can help landowners who need an economic return from their forested lands or otherwise would be forced to sell them, potentially leading to conversion to other uses.

ENVIRONMENTAL BENEFITS

Maintaining trees in agricultural areas can help control nutrient runoff and protect water quality, which is especially important in stream buffers and on steeper slopes. They can also reduce runoff and slow down water flowing over the landscape during larger storms, both of which ameliorate flood and erosion risks.

Other environmental benefits relevant to the local economy include improved habitat for certain birds and other wildlife, which helps support a vibrant tourism economy while also sustaining biodiversity.

Furthermore, agroforestry is closely related to permaculture, and many of these strategies are relevant to very small farms and even urban gardens, yards and parks, providing environmental benefits for our cities and towns.

BUILDING CAPACITY

Training to build capacity for implementation can be provided through the Cornell Cooperative Extension, community colleges and other educational programs. This will support businesses and provide job opportunities ranging from value-added wood products manufacturing and fine woodworking to the production of artisanal meats and cheeses, shitake exports and biomass development for energy. In addition, agroforestry may well become a tourism attraction for people interested in seeing these practices in action.

In addition to large scale landscape planning, individuals can use these maps to inform their own conservation activities. Landowners who notice that their land contains a large area of high value habitat can engage with their regional forester to develop a plan to better manage their parcel for wildlife values, or if they plan to develop their land, they may seek to keep a wooded corridor through their land to ensure that connections to other high value habitat areas are not lost. Even at the backyard scale, landowners can improve the habitat for birds and other wildlife. The book “The Woods in Your Backyard; Learning to Create and Enhance Natural Areas Around Your Home” is available for free download from

http://host31.spidergraphics.com/nra/doc/Fair%20Use%20Web%20PDFs/NRAES-184_Web.pdf and provides specific steps and actions that landowners can take to enhance wildlife habitat or other values.

MAP USES SUMMARY

Map uses:

- To identify lands for PDR or TDR programs and give more points to lands in the network.
- To create new ordinances to zone land and development appropriately.
- To protect key species at risk and promote abundant wildlife.
- To attract new heritage tourism and identify and protect viewsheds.
- To protect existing and select new agriculture and forestal districts.
- To review all transportation planning to avoid sensitive areas.
- To select future trails and utilize corridors.
- To identify hazardous areas and avoid developing in those locations.

This case study described how the green infrastructure network was created by selecting the highest-value habitats; showed how the network was updated to reflect new development; and described how other green infrastructure services for working lands, such as farming and forestry, were analyzed.

These maps serve as a resource for landowners by providing information to inform decision making for what areas are most critical to conserve or to develop with some areas left as open space. They also show areas that may benefit from being reconnected through a tree planting or voluntary conservation project. They are living maps that will be updated and changed over time as new data are collected or to reflect new or different priorities for the county.

In Chapter Six, we provide options for making the case to decision makers and building community support for this work. Chapter Seven provides the technical instructions for building a model for any New York county or region.



All ages enjoy the Hudson's viewshed.