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.

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.
Creating a Natural Resources Inventory

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.

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

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

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 carbonated 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.

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 riparian, 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.

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).

**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.
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

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.
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

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

Monarch butterfly on goldenrod plant. © I. Haeckel
Creating a Natural Resources Inventory

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.)

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.
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.

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.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Species information</th>
<th>Where to find</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York Natural Heritage Program Database</td>
<td>documented state rare plants, animals, and significant natural communities</td>
<td>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 <a href="mailto:NaturalHeritage@dec.ny.gov">NaturalHeritage@dec.ny.gov</a>.</td>
</tr>
<tr>
<td>New York Flora Atlas</td>
<td>county plant lists, search for plant species’ habitat and rarity</td>
<td>atlas.nyflora.org</td>
</tr>
<tr>
<td>Important Bird Areas</td>
<td>sites identified by Audubon New York that are significant to breeding and migrating birds</td>
<td>ny.audubon.org</td>
</tr>
<tr>
<td>Native trout streams</td>
<td>streams where trout naturally reproduce (not stocked)</td>
<td>DEC Regional Office (see Appendix A)</td>
</tr>
<tr>
<td>Invasive species</td>
<td>county records of invasive plants, insects, and animals</td>
<td>imapinvasives.org/nyimi/map</td>
</tr>
</tbody>
</table>

### 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.

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

*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

*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.

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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
Creating a Natural Resources Inventory

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.

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

Dutchess County Department of Planning and Development
Biodiversity block data

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.

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