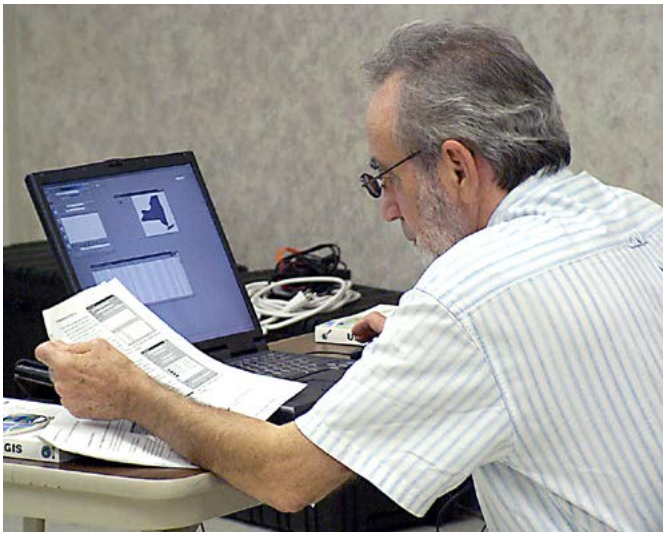
CHAPTER: 3

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



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

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

What is a geographic information system?

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

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

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

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

Online mapping tools

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

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

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

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

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

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

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

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

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

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

GIS workshop. © L. Heady

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

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

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

Limitations of GIS Data

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

What map scale should be used?

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

Map Scale

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

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

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

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

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

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

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

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

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

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

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

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

How recent are the GIS data?

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