

SIGNIFICANT HABITATS

IN THE CITY OF POUGHKEEPSIE, DUTCHESS COUNTY, NEW YORK



Report to the Environmental Cooperative at the Vassar Barns
and the City of Poughkeepsie

By Elise Heffernan and Gretchen Stevens
Hudsonia Ltd.

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This report was prepared by
Elise Heffernan and Gretchen Stevens,
Hudsonia Ltd.

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under the direction of Jennifer Rubbo

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for the City of Poughkeepsie, New York.

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Cover photo: Ledge along Hudson River from Waryas Park Promenade in the City of Poughkeepsie, NY.
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Hudsonia Ltd.

a nonprofit institute

PO Box 5000, Annandale, NY 12529



**Department of
Environmental
Conservation**

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EXECUTIVE SUMMARY

The City of Poughkeepsie’s cultural and economic history is closely tied to the Hudson River, which remains one of the great ecological and scenic assets and a source of local identity for the city. Other significant habitat areas throughout the city contribute to local and regional biodiversity and to the well-being of Poughkeepsie residents, workers, businesses, and institutions.

The Hudson River, including the main channel, the tidal shallows, the intertidal shore, and the tidal tributary mouth of the Fall Kill, constitutes the largest contiguous habitat area in the city. The next largest is at the Vassar Farm and Ecological Preserve, which has cultivated field, upland meadow, calcareous wet meadow, upland shrubland, upland hardwood and mixed forests, hardwood swamp, intermittent woodland pool, marsh, streams, and constructed ponds in a large contiguous area that extends into the Town of Poughkeepsie. Springside and College Hill Park also have large areas of contiguous habitats. Smaller habitat areas throughout the city, on both public and private land, provide habitat for resident and transient wildlife, and hold great value for the people of Poughkeepsie by providing areas for recreation and visual relief, moderating local air temperatures, absorbing rainwater and snowmelt, and providing other ecosystem services. “Cultural habitats,” e.g., athletic fields, lawns, and other manicured areas, constitute much of the greenspace of the city.

The Hudson River tidal habitats are used by an array of shorebirds, wading birds, waterfowl, fishes, turtles, and other wildlife. Non-tidal streams, marshes, and constructed ponds are similarly used by wildlife, and are valued aesthetic components of the city landscape.

Large meadow areas at Vassar Farm support nesting eastern meadowlark, and could support bobolink and vesper sparrow, —grassland breeding birds of conservation concern. The grasses and forbs of those and other meadows in the city provide larval food and nectar sources for butterflies and moths, and nectar and pollen sources for native bees, honeybees, wasps, and other pollinators, as well as a host of other invertebrates, small mammals, and their predators such as foxes, coyotes, and raptors.

Forests, backyard forest groves, hedgerows, and even individual trees within manicured yards and parks are used by nesting and migratory songbirds, and could serve as summer roost sites for bats. The upland forests and swamp at Vassar Farm may support many kinds of wildlife, including, for example, some of the interior-forest bird species, such as scarlet tanager or ovenbird, that are unlikely to nest in smaller forest fragments in the city. The intermittent woodland pool at Vassar Farm provides springtime breeding and nursery habitat for wood frog, and could also support other pool-breeding amphibians—spotted salamander, Jefferson salamander, and marbled salamander,—that would occupy the nearby upland forest areas for the rest of the year.

Maintaining, restoring, and enhancing the ecological quality of the city's habitats would support native biological diversity, improve water management, strengthen people's connections to the land, and improve the resiliency of the landscape to the effects of climate change. Managing the shoreline zone to prepare for sea level rise and more frequent and severe storm events may be an issue of particular concern. The two shoreline parks, Kaal Rock Park and Waryas Park, offer public places for riverfront recreation and provide large areas of unpaved surfaces that can effectively absorb floodwaters. There may be opportunities for creating additional public-access greenspaces along the Hudson River that would also accommodate anticipated flooding and help to strengthen the city's place-based identity.

Creating or restoring greenspaces elsewhere in the city can benefit both people and ecosystems. Planting woody vegetation along the Fall Kill and smaller streams can improve the in-stream habitats (by providing shade and organic materials). Reducing the Fall Kill's channelization by removing crumbling walls in areas where flooding would not pose a threat to infrastructure can restore ecological connections between the stream and streamside habitats. Where possible, daylighting other streams in the city, softening the stream banks, and planting shading vegetation will improve stream habitats, biodiversity, water quality, and the aesthetic value of the streams.

Planting more street trees would add physical comfort to the urban environment and add habitat for migratory and resident birds and other wildlife. Transforming vacant lots into small greenspaces with, for example, butterfly gardens, benches, picnic tables, or public sculptures, would be especially beneficial in parts of the city where public and private greenspaces are few. This report identifies a few places where significant habitats could be expanded or improved, and where connectivity between and among existing greenspaces could be extended. It also offers ideas for enhancing the habitat values of backyards and other developed areas that can be carried out by private landowners on their own properties and by city agencies on public lands.



Sunset at the Poughkeepsie Farm Project on the Vassar Farm and Ecological Preserve.
E.Heffernan © 2018

INTRODUCTION

Background

In 2017 the Environmental Cooperative at the Vassar Barns began the preparation of a Natural Resource Inventory (NRI) for the City of Poughkeepsie, Dutchess County, New York. The NRI is a reference document for city-wide and site-specific land use planning and land management, as well as municipal policy-making and regulatory decisions. The Environmental Cooperative recruited Vassar College students to develop parts of the NRI, and Hudsonia Ltd. to identify, map, and describe ecologically significant habitats throughout the city. This report documents Hudsonia's findings and accompanies a large-format, city-wide habitat map.

Although the city's land cover is predominately structures and pavement, there are still remnant forests and meadows of the pre-urban landscape, as well as other areas that are highly disturbed but still provide islands of natural habitat in the urban matrix. Still other areas are intensively managed for recreation or aesthetics, and are of great value to Poughkeepsie residents even though they may have little habitat value for native plants and animals.

Urban greenspaces can serve as stopover habitat for migratory birds; nectar and pollen sources for butterflies and bees; summer and winter roosts for bats; hunting, foraging, and residence habitat for mesocarnivores (e.g., coyote, fox, skunk, raccoon) and other wildlife (e.g., chipmunk, squirrels); and habitat for native and non-native plants. Some rare species of plants and animals find ways to persist and even thrive in urban environments (Kiviat and Johnson 2013).

A human consequence of the intensification of urban land use is that urban populations are increasingly disconnected from the natural areas that define the region. By conserving, restoring and expanding natural habitats within the city, and creating connected corridors for people and wildlife, the City of Poughkeepsie can enhance its sense of place, maintain strong ecological connections with the larger landscape, and improve the quality of life for human residents, workers, and visitors.

Knowledge of the biological landscape will help landowners, planners, and regulatory agencies devise ways to balance economic, social, and environmental factors for a more livable and sustainable city. Although many land use decisions in the region are necessarily made on a site-by-site basis, the long-term viability of biological communities, habitats, and ecosystems requires consideration of whole landscapes. The availability of general biodiversity information for large areas such as entire towns, cities, watersheds, or counties allows landowners, developers, municipal planners, and others to better incorporate habitat protection and enhancement into day-to-day decision-making.

To address the need for comprehensive, regional planning, Hudsonia Ltd., a nonprofit institute for scientific research and education, based in Annandale, New York, has completed town-wide habitat maps and reports for twelve towns in Dutchess and Ulster counties, as well as many other large areas in Albany, Dutchess, Greene, Ulster, and Orange counties since 2001. In 2008, Hudsonia completed the habitat map for the Town of Poughkeepsie (Tabak and Stevens 2008) which borders the City of Poughkeepsie on three sides. These habitat mapping projects demonstrate how Hudsonia's *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001) can be used to identify important biological resources over large geographic areas and inform local communities about biodiversity conservation.

Biologist Elise Heffernan conducted most of the work on this project from June through November 2017, with assistance from other Hudsonia biologists. Through map analysis, aerial photograph interpretation, and field observations, we created a map of ecologically significant habitats in the City of Poughkeepsie. Some of these habitats may support plants or animals of conservation concern, many provide habitat for common wildlife or ecological stepping stones between habitat areas, and many provide important services to the human community. The emphasis of this project was on identifying and mapping general habitat types; we did not conduct species-level surveys or map the locations of rare species.

To facilitate intermunicipal planning, we strive for consistency in the ways that we define and identify habitats and present the information, but we also work to improve our methods and

products as the habitat mapping program evolves. Many passages in this report that are applicable to the region as a whole are taken directly from previous Hudsonia reports accompanying habitat maps in Dutchess County (e.g., Stevens and Broadbent 2002, Reinmann and Stevens 2007, Tabak and Stevens 2008, Graham and Stevens 2012) without specific attribution. This report, however, addresses our findings and specific recommendations for the City of Poughkeepsie. We intend for each of these projects to build on the previous ones, and believe that the expanding body of biodiversity information will be a valuable resource for site-specific, city-wide, and region-wide planning and conservation efforts.

We hope that the habitat map and this report will help landowners understand how their properties fit into the larger ecological landscape, and will inspire them to implement habitat protection and enhancement measures voluntarily. We also hope that the City of Poughkeepsie will engage in proactive land use and conservation planning to ensure that future development occurs with a view to long-term protection of its valuable biological resources and improvement of the quality of life for residents and visitors.

What is Biodiversity?

The concept of biodiversity, or biological diversity, encompasses all living organisms, their interactions and ecological processes. It includes ecosystems, biological communities, species and their genes, as well as their interactions with each other and the abiotic components of their environment, such as soil, water, air, and sunlight. Protecting native biodiversity is an important component of any effort to maintain intact, functioning ecosystems that sustain the human community and the living world around us. Healthy ecosystems make the earth habitable by moderating the climate, cycling essential gases and nutrients, purifying water and air, building soil, producing and decomposing organic matter, and providing many other essential services. Ecosystems also serve as the foundation of our natural resource-based economy.

The decline or disappearance of native species can be a symptom of environmental deterioration or collapses in other parts of the ecosystem. While we do not fully understand the roles all organisms play in an ecosystem and cannot fully predict the consequences of the loss

of any particular species, we do know that each organism, including inconspicuous ones such as fungi or insects, plays a specific role in the maintenance of biological communities. Maintaining the full complement of native species in a region better enables an ecosystem to withstand stresses and adapt to changing environmental conditions.

What are Ecologically Significant Habitats?

For purposes of this project, a “habitat” is simply the place where an organism or population lives or where a biological community occurs, and is defined according to both its biological and non-biological components. Individual species will be protected for the long term only if their habitats remain intact. The local or regional disappearance of a habitat can lead to the local or regional loss of species that depend on that habitat. Habitats that we consider to be “ecologically significant” in the City of Poughkeepsie include:

1. Habitats that are rare or declining in the region, or those that support rare species and other species of conservation concern.
2. Common habitats that meet a minimum size criterion for the habitat type.
3. Complexes of connected habitats that, by virtue of their size, composition, or configuration, appear to have significant biodiversity value.

Because most wildlife species need to travel among different habitats to satisfy their basic survival needs, landscape patterns can have a profound influence on wildlife populations. The size, connectivity, and juxtaposition of both common and uncommon habitats in the landscape all have important implications for wildlife and biodiversity as a whole.

In addition to their importance from an ecological standpoint, habitat areas also provide immeasurable services to the human community. By illustrating the locations and configurations of significant habitats throughout the City of Poughkeepsie, the habitat map provides ecological information that can be incorporated into local land use planning and decision-making.

Benefits for People

The largest contiguous habitat, and greatest defining environmental feature of the City of Poughkeepsie, is the Hudson River. The River has been critical to Poughkeepsie's economic and cultural development, connects people to the natural world, and engenders a region-wide identity.

Greenspaces and natural settings provide many benefits to city infrastructure, energy use, and the health and well-being of city residents (Hausmann et al. 2015). Trees reduce air pollution and create cooler conditions, both indoors and outdoors, moderating the urban heat island effect (Hladnik and Pirnat 2011). Greenspaces absorb rainwater and snowmelt, reducing stormwater runoff and impacts on local waterways. Parks and public-access lands with athletic fields, picnic areas, walking trails, and other recreational features can be invaluable resources to nearby residents. Viewing natural spaces reduces stress (Frumkin 2001), and having parks and undeveloped land within cities can enhance people's connections to the greater environment (Szlavec et al. 2011).



Park bench below habitat ledge in Upper Landing Park. E. Heffernan © 2018

The biological assemblages in urban habitats are often distinct from those of surrounding non-urban areas (Faeth et al. 2011). They are much influenced by past and present-day intensive horticulture and landscaping, and tend to be dominated by plants and animals that are highly adaptable to the conditions of the urban environment. Many of the plants that were brought in either for ornamental purposes or accidentally now persist in both managed and unmanaged areas, and they help to determine the kinds of animals that use these habitats.

Cities present a paradox for the relationship between people and their environment. The concentration of residences, businesses, industry, and infrastructure in urban areas reduces the footprint of human activities on the regional environment, but it also excludes many natural elements from the urban environment. Moreover, public greenspaces, and private lawns and gardens tend to concentrate in areas of higher-value business and residential real estate (Jennings et al. 2012). The expenses of land and landscaping (in time and money), short-term rent cycles, and other factors combine to reduce the feasibility of long-term investments in landscaping for residents with modest incomes (Szlavec et al. 2011). The result is a skewed city matrix in which wealthier populations have greater access to greenspace (Jennings et al. 2012). The uneven distribution of residence-based landscaping makes city planning for habitat conservation important to the health of the whole city.

Study Area

The City of Poughkeepsie (Figure 1) borders the Hudson River in western Dutchess County in southeastern New York. It encompasses approximately 5.1 mi² (13.2 km²) (excluding 0.5 mi² [1.4 km²] of the Hudson River) and has a population of roughly 30,300 residents (United States Census Bureau 2016). The city's topography is of low hills with broad plains inbetween. Elevations range from sea level along the Hudson River to 376 ft (115 m) at the top of College Hill in the northeast corner of the city. All of the land in Poughkeepsie ultimately drains into the Hudson River, largely via the Fall Kill (Winnakee Creek) and the Casperkill (or Casper Creek, Casperkill Creek), but some areas drain directly to the Hudson River. The largest expanse of contiguous undeveloped land includes the large wetlands, upland forests and meadow complexes of the Vassar Farm and Ecological Preserve in the southeastern corner of the city.

City of Poughkeepsie

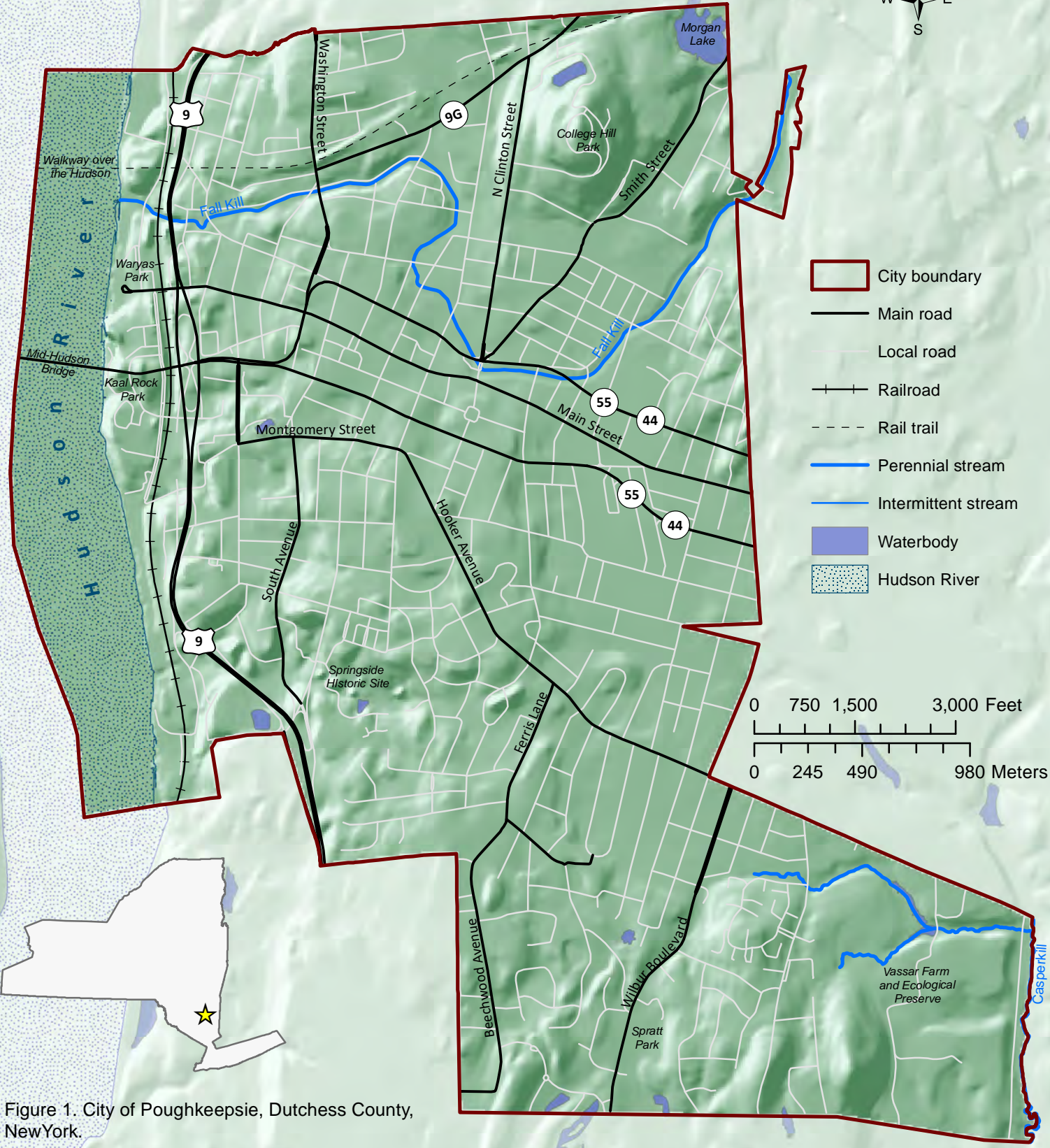


Figure 1. City of Poughkeepsie, Dutchess County, New York.

Notable topographic features are several elongate knobs (drumlins) oriented generally northeast-southwest. Smaller hills in the southeast are underlain by limestone (Fisher et al. 1970) (Figure 2). Poughkeepsie Mélange—bedrock composed of various rock fragments cemented together—is in a zone along the shoreline, often as an inclusion in shale formations. The surficial material in the city is primarily glacial till, but Cadwell et al. (1989) showed lacustrine deposits of sand, silt, and clay in the east and southeast, and large areas in the northeast and northwest where bedrock is at or near the ground surface (Figure 3). Although there may once have been a band of alluvium along the Hudson River shoreline, as mapped by Cadwell et al., today most of the shoreline zone is occupied by fill and/or pavement (Faber 2002) (Figure 3).

Land uses in the City of Poughkeepsie are dominated by residential and commercial development, but also include recreational, industrial and institutional facilities, and preserved open space. The great majority (96%) of land parcels in the city are small (1 acre [0.4 hectare] or less) and privately owned. Of the four parcels larger than 30 ac (12 ha), two are city-owned property (College Hill Park and Spratt Park), and the largest is the Vassar Farm and Ecological Preserve. All four are greenspaces open to the public.

The Stockbridge-Munsee Mohican tribe traces its roots to the Hudson Valley and Poughkeepsie region; the name Mohican derives from their name for the Hudson River, the Mohicannittuck, roughly “waters that are never still,” a tribute to the tidal flows of the river. Before European colonization, land was managed for agriculture and subsistence hunting and fishing, and fruit, nuts, edible plants and medicinal herbs were collected from forests and meadows (Bonney Hartley, personal communication). The Hudson River and local streams were critical to human survival, and settlements were often located along waterways.

The Hudson River was a key source for food, transport, and trade. The Hudson River and other waterways also provide habitat for turtles and bald eagles, species of significance to the Stockbridge-Munsee Mohican tribe (Bonney Hartley, personal communication). Having been relocated from the Hudson Valley, the Stockbridge-Munsee Mohican tribe is based in Bowler,

Wisconsin, but maintains an interest in their cultural and heritage lands. The Delaware Tribe and Delaware Nation also cite Dutchess County within their cultural areas of interest (Brooks 2018).



Cattails growing next to rail trail. E. Heffernan © 2018

Bedrock

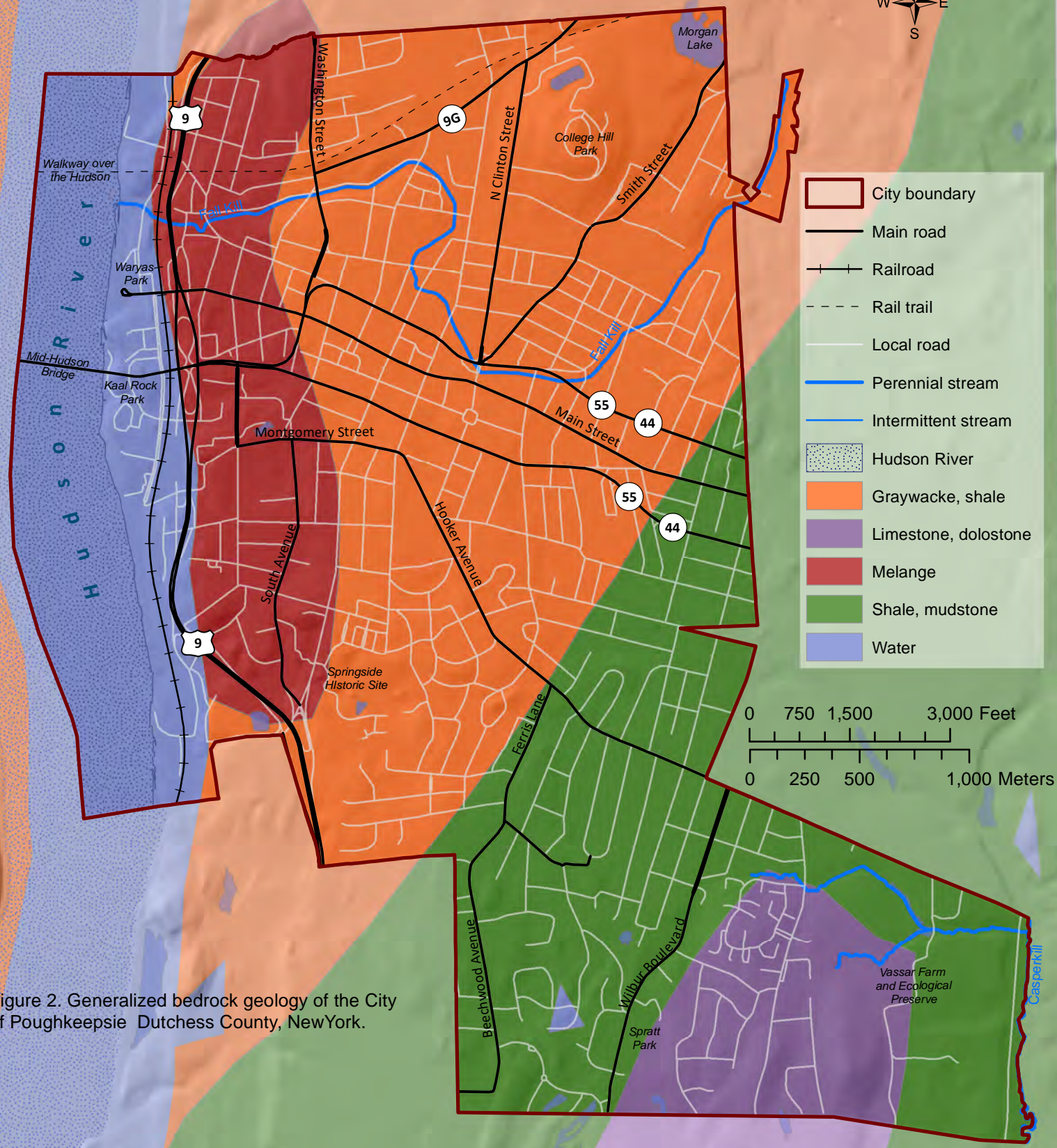


Figure 2. Generalized bedrock geology of the City of Poughkeepsie Dutchess County, New York.

Surficial Geology

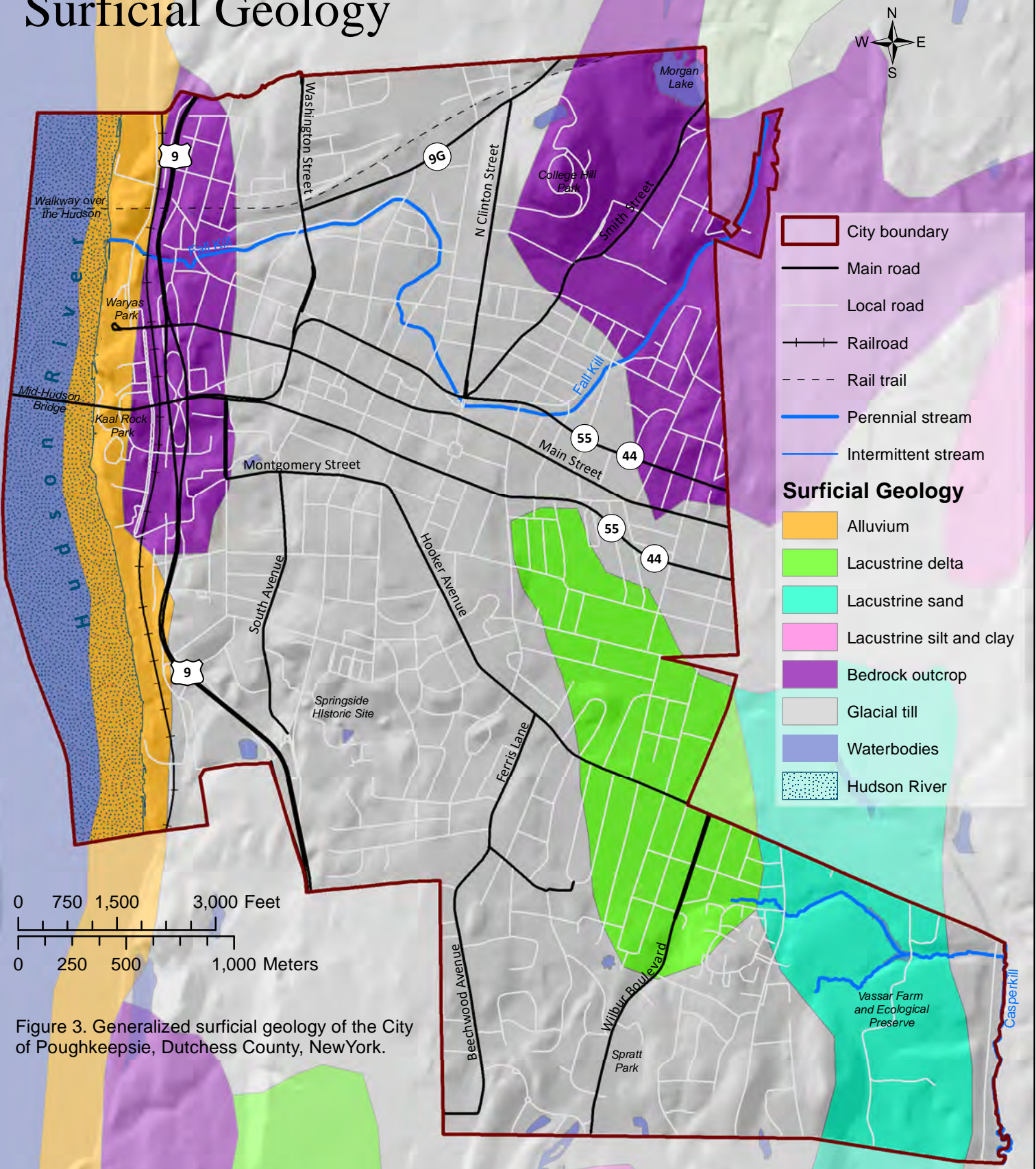


Figure 3. Generalized surficial geology of the City of Poughkeepsie, Dutchess County, New York.

Data Sources:
 Surficial geology from Cadwell et al. (1986). GIS data modified in 2000; obtained from New York State Museum (<http://www.nysm.nysed.gov/gis/>).
 For road, stream, waterbody and hillshade data sources, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.



View of the city from the Walkway Over the Hudson. E. Heffernan © 2018

METHODS

Hudsonia employs a combination of laboratory and field methods to identify habitats. Below we describe each phase in the Poughkeepsie habitat mapping project.

Gathering Information and Predicting Habitats

We use combinations of map features (e.g., topography, bedrock chemistry, and soil texture, depth, and drainage) and features visible on aerial photographs (e.g., exposed bedrock, streams, vegetation cover types) to predict the location and extent of ecologically significant habitats. In addition to previous studies conducted by Hudsonia biologists in Poughkeepsie and biological data provided by the New York Natural Heritage Program, we used the following resources for this project:

- *1:40,000 scale color infrared aerial photograph prints* from the National Aerial Photography Program series taken in spring 1995, obtained from the U.S. Geological Survey. Viewed in pairs with a stereoscope, these prints (“stereo pairs”) provide a three-dimensional view of the landscape and are extremely useful for identifying vegetation cover types, wetlands, streams, and cultural landscape features.
- *High-resolution (1 pixel = 1 ft [30 cm]) color infrared digital orthophotos* taken in spring 2013, obtained from the New York State GIS Clearinghouse website (<http://www.nysgis.state.ny.us>; accessed June 2017). These digital aerial photos were used for on-screen digitizing of habitat boundaries.
- *U.S. Geological Survey topographic maps* (Poughkeepsie 7.5 minute quadrangle). Topographic maps contain extensive information about landscape features, such as elevation contours, surface water features, and significant cultural features. The contour lines can be used to predict the occurrence of habitats such as cliffs, intermittent woodland pools and other wetlands, intermittent streams, and seeps.
- *Bedrock and surficial geology maps* (Lower Hudson Sheets) produced by the New York Geological Survey (Fisher et al. 1970, Cadwell et al. 1989). Along with topography,

surficial and bedrock geology strongly influence the development of particular soil properties and aspects of groundwater and surface water chemistry, and thus have important implications for the biological communities that become established at any site.

- *Soil Survey of Dutchess County, New York* (Faber 2002). Specific attributes of soils, such as depth, drainage, texture, and pH, strongly influence the types of habitats that are likely to occur in an area. Shallow soils, for example, may indicate the location of exposed ledges. Poorly and very poorly drained soils usually indicate wetland habitats such as swamps, marshes, and wet meadows.
- *GIS data*. A Geographic Information System enables us to overlay multiple data layers on a computer screen, greatly enhancing the efficiency and accuracy with which we can predict the diverse habitats that are closely linked to local topography, geology, hydrology, and soil conditions. GIS also enables us to create detailed, spatially accurate maps. We obtained most of our GIS data layers from the New York State GIS Clearinghouse, including roads, soils, bedrock geology, surficial geology, and wetlands. National Wetlands Inventory data prepared by the US Fish and Wildlife Service was obtained from the USFWS website. We also obtained 10 ft (3 m) contour data from the Dutchess Land Conservancy, and 2017 tax parcel data from the Dutchess County Office of Real Property Tax.

Preliminary Habitat Mapping and Field Verification

We prepared a preliminary map of predicted habitats based on map analysis and stereo interpretation of aerial photographs. We digitized the predicted habitats onscreen over the orthophoto images using ArcMap 10.6 (Environmental Systems Research Institute 2017) software. With these draft maps in hand we conducted field visits to as many of the mapped habitat units as possible to verify their presence and extent, and to assess their quality.

We identified landowners using tax parcel data, and before visiting field sites, contacted landowners for permission to walk on their land. We prioritized sites for field visits based both on opportunity (i.e., willing landowners) and our need to answer habitat questions that could

not be answered remotely. In addition to conducting fieldwork on public and private land, we viewed habitats from adjacent properties, public roads, and other public access areas. Because the schedule of this project (and non-participating landowners) prevented us from conducting field visits to every parcel in the city, this strategy increased our efficiency while maintaining a high standard of accuracy.

Ultimately, we field-checked approximately 46% of the undeveloped area in Poughkeepsie (325 acres [132 ha]). Areas that could not be field-checked were nonetheless mapped remotely, but we assume that areas of the habitat map that were field checked are generally more accurate than areas we did not visit.

Defining Habitat Types

Habitats are useful for categorizing places according to apparent ecological function, and are manageable units for scientific inquiry and land use planning. We have classified broad habitat types that are identifiable largely by their vegetation and visible physical properties. Habitats exist, however, as part of a continuum of intergrading resources and conditions, and it is often difficult to draw a line to separate two habitat types. Also, some habitats are intermediates between two defined habitat types, and some habitat categories can be considered complexes of several habitats. In order to maintain consistency within and among habitat mapping projects, we adhere to certain mapping conventions for delineating habitat boundaries. Some of these are described in Appendix A. Because some parts of Poughkeepsie were only mapped remotely, and all mapped habitat boundaries are drawn without survey or GPS equipment, all of the mapped features should be considered approximations.

Each habitat profile in the Results section describes the general ecological attributes of places that are included in that habitat type. Developed areas and other areas that we consider to be non-significant habitats (e.g., structures, paved roads and driveways, other impervious surfaces, and small lawns, small meadows, and hedgerows) are shown as white (no symbol or color) on the habitat map. Areas that have been developed since 2013 (the orthophoto date) were identified as such only if we observed them in the field. For this reason, it is likely that we have underestimated the extent of developed land in the city.

Final Mapping

We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map. We printed the final large-format habitat map at a scale of 1:6,000 using a Hewlett Packard DesignJet 800PS plotter. The GIS database that accompanies the map includes additional information about many of the mapped habitat units, such as the dates of field visits (including observations from adjacent properties and roads) and some of the plant and animal species observed in the field. The habitat map, GIS database, and this report have been given to the Environmental Cooperative for use in the Natural Resource Inventory and to the City of Poughkeepsie to inform land use planning and decision-making.

We request that any maps printed from this database for public viewing be printed at scales no larger than 1:6000, and that the habitat map data be attributed to Hudsonia Ltd. Although the habitat map was carefully prepared and extensively field-checked, there are inevitable inaccuracies in the final map. Because of this, we request that the following caveat be printed prominently on all maps:

“This map is suitable for general land-use planning, but is not suitable for detailed planning and site design, or for jurisdictional determinations (e.g., for wetlands). Boundaries of wetlands and other habitats depicted here are only approximate.”



Morgan Lake from the College Hill Golf Course. E. Heffernan © 2018

Significant Habitats

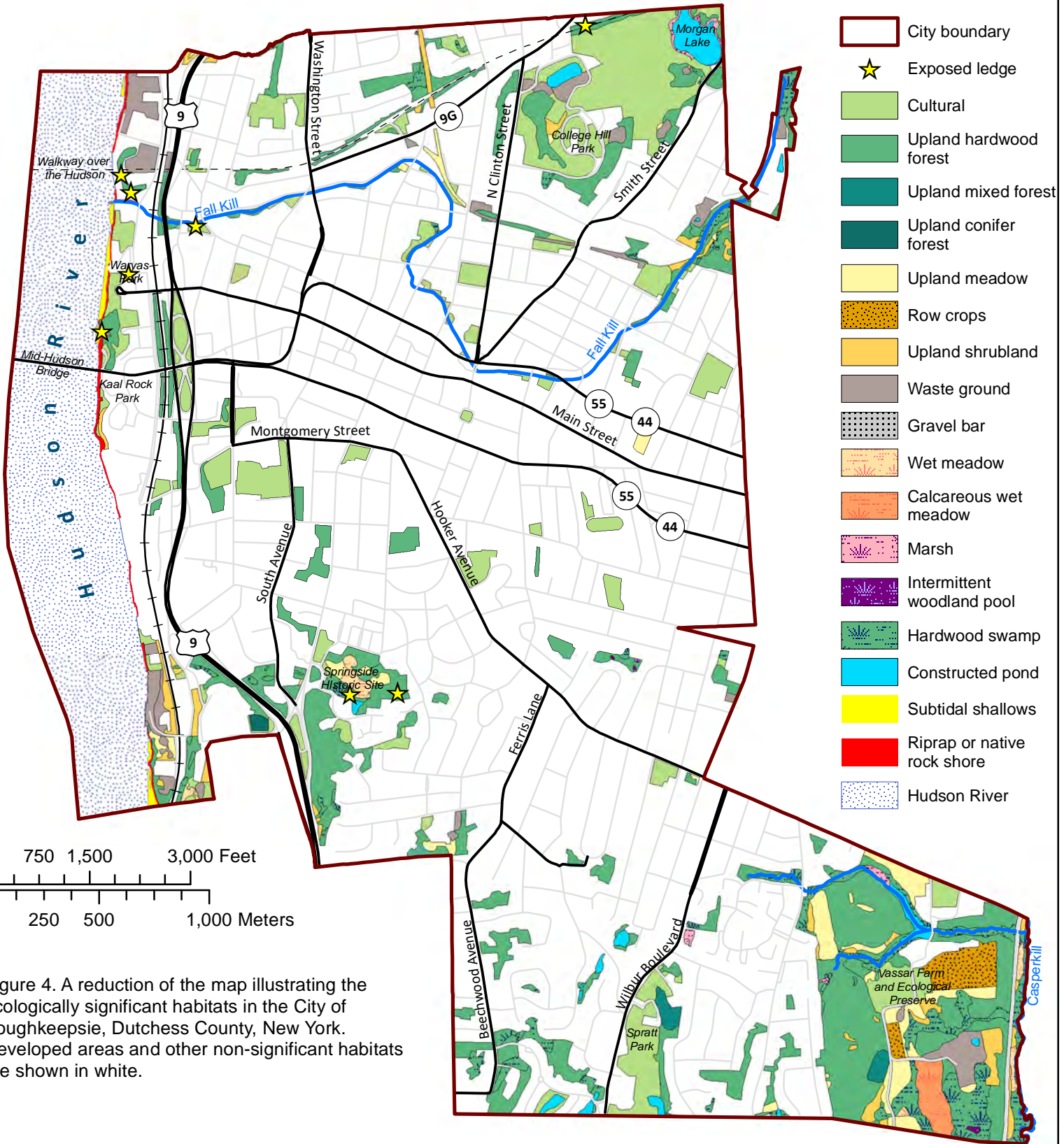


Figure 4. A reduction of the map illustrating the ecologically significant habitats in the City of Poughkeepsie, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white.

RESULTS

Overview

The large-format City of Poughkeepsie habitat map illustrates the ecologically significant habitats in the city and their configurations in the landscape. Figure 4 is a reduction of the completed habitat map. Of the total 5.1 mi² (13.8 km²) terrestrial area of the city, approximately 19.4% was mapped as significant habitat. Including the Hudson River portion of the city brings the total area of significant habitats to 1.7 mi² (4.4 km²), or 29.0 % of the city. Most of the undeveloped land is in disjunct patches. Figure 5 shows blocks of contiguous undeveloped habitat areas within the city, color-coded by size. Several types of common habitats cover extensive areas within these blocks. For example, upland forests, open meadows (managed and unmanaged) and swamps each occupy nearly 3% of the land in the city. “Cultural” areas, which are defined as highly managed habitats without pavement or structures (e.g., large lawns, golf courses, cemeteries), account for over 5% of the land in the city. Some of the smaller, more unusual habitats we documented include habitats associated with the Hudson River, such as the rocky shore and tidal tributary mouth. In total, we identified 20 general habitat types in the City of Poughkeepsie that we consider to be of potential ecological importance (Table 1).

Although the mapped areas represent ecologically significant habitats, each has been much altered by past and present-day human activities. Most or all areas of the upland forests, for example, have been cut repeatedly in the past 300 years, and many forested areas lack the structural complexity of long-undisturbed forests. Many of the wetlands in the city have been extensively altered by dams, filling, draining, pollution, and construction of railroads and roads. Non-native, invasive plants species (e.g., purple loosestrife, common reed, Bell’s honeysuckle, Norway maple, multiflora rose, garlic-mustard, water-chestnut) are widespread in upland and wetland habitats in the city.

We have documented the locations and extent of important habitats in Poughkeepsie (Figure 4), but only in some cases have we provided information on the quality and condition of these habitats. Notes in the GIS database provide some of these assessments.

Table 1. Ecologically significant habitats identified by Hudsonia in the City of Poughkeepsie, Dutchess County, New York, 2018.

Upland Habitats	Non-Tidal Wetland Habitats	Hudson River Habitats
Upland hardwood forest Upland conifer forest Upland mixed forest Crest/ledge Upland shrubland Upland meadow Cultural Waste ground	Hardwood & shrub swamp Intermittent woodland pool Marsh Wet meadow Spring/seep Constructed pond Open water Stream	Riprap and native rocky shore Tidal tributary mouth

Habitat Descriptions

Below we describe some of the ecological attributes of the habitats identified in the City of Poughkeepsie, and discuss some conservation measures that can help to protect these habitats and the species of conservation concern they may support. We have indicated species of conservation concern (those that are listed by state or federal agencies or considered rare or vulnerable by non-government organizations) that are generally associated with these habitats by placing an asterisk (*) after the species name. The conservation status of animal species mentioned in this report is given in Appendix C. Appendix D gives the common and scientific names of all plants mentioned in this report.

Large Habitat Patches

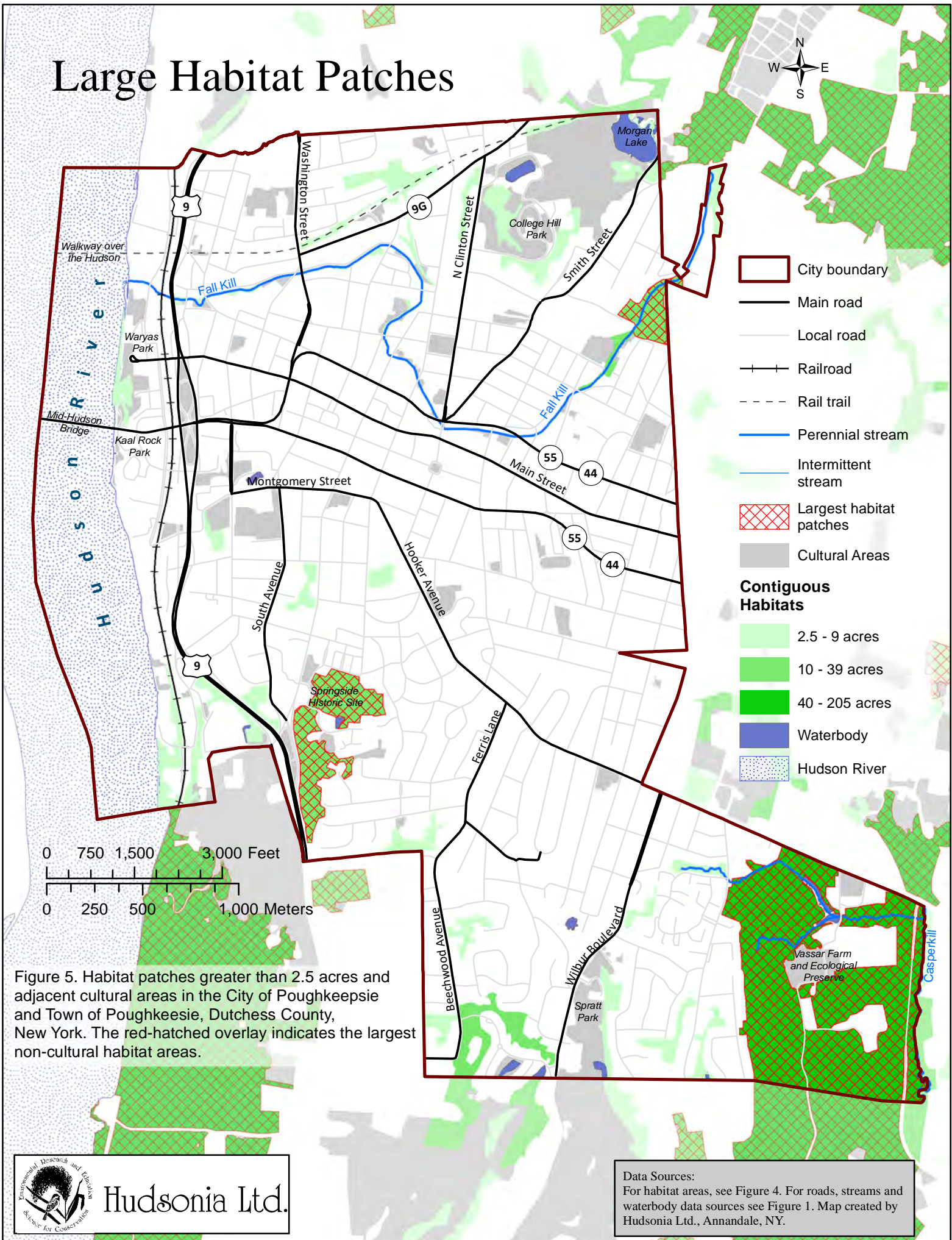


Figure 5. Habitat patches greater than 2.5 acres and adjacent cultural areas in the City of Poughkeepsie and Town of Poughkeepsie, Dutchess County, New York. The red-hatched overlay indicates the largest non-cultural habitat areas.

Upland Habitats

Upland forests

Ecological Attributes

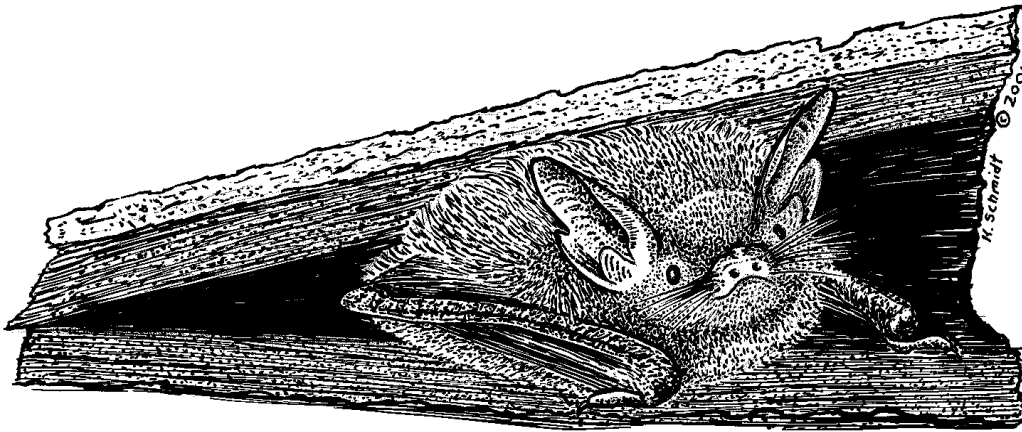
We classified upland forests into three general types for this project: hardwood forest, conifer forest, and mixed forest. We recognize that upland forests are in fact much more variable, with each of these three types encompassing many distinct biological communities. However, our broad forest types are useful for general planning purposes, and are also the most practical for our remote mapping methods.

Upland Hardwood Forest

Upland hardwood forest is the most extensive habitat type in the region and the city, and includes many different types of deciduous forest communities. Upland hardwood forests are used by a wide range of common and rare species of plants and animals. Common trees of upland hardwood forests in Poughkeepsie include maples (sugar, red, Norway), oaks (black, red, white), hickories (shagbark, pignut), white ash, and black locust. Conifers such as eastern hemlock and white pine occur occasionally in hardwood forests. Common understory species include Bell's honeysuckle, spicebush, hop hornbeam, and a variety of wildflowers, sedges, ferns, and mosses.

Eastern box turtle* spends most of its time in upland forests and meadows, finding shelter under logs and organic litter. Spotted turtle* may spend several weeks resting in upland forests during the warm months of the year. Many snake species forage widely in upland forests and other habitats. Upland hardwood forests provide nesting habitat for raptors, including red-shouldered hawk,* Cooper's hawk,* sharp-shinned hawk,* broad-winged hawk,* and barred owl,* and many species of songbirds including warblers, vireos, thrushes, woodpeckers, and flycatchers. American woodcock* forages and nests in young hardwood forests. Pileated woodpecker uses large trees (live or standing dead) for foraging, roosting, and nesting (Bull and Jackson 1995). Wood thrush* and scarlet tanager* may require large forest-interior areas to maintain viable populations. Large mammals such as black bear,*

bobcat*, and fisher* also seem to require large expanses of forest even though they will use many other parts of the landscape. Many small mammals are associated with upland hardwood forests, including eastern chipmunk, southern flying squirrel, and white-footed mouse. Hardwood trees greater than 5 inches (12.5 cm) in diameter (especially those with loose platy bark such as shagbark hickory or deeply furrowed bark such as black locust) can be used by Indiana bat* and other bat species for summer roosting and nursery colonies. Upland hardwood forests are extremely variable in their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other habitat factors. Other habitats, such as intermittent woodland pools, crest, and ledge, are sometimes embedded within areas of upland hardwood forest.



Indiana bat may use Poughkeepsie trees for summer roosts.. Kathleen A. Schmidt © 2001

Upland Conifer Forest

This habitat includes pole-sized (approximately 5-10 in [12-25 cm] diameter at breast height) to mature conifers in naturally occurring upland forests with conifers representing more than 75% of the canopy. In Poughkeepsie there are a few instances of planted conifers—native and non-native—that are managed as forest. Because these forests were planted, they are more uniform in size and age of overstory trees, structure, and overall species composition than natural conifer stands.

Conifer stands are used by many species of owls (e.g., barred owl,* great horned owl, long-eared owl*) and other raptors (e.g., Cooper's hawk* and sharp-shinned hawk*) for roosting

and sometimes nesting. Pine siskin,* red-breasted nuthatch,* black-throated green warbler,* evening grosbeak,* and purple finch* nest in conifer stands. American woodcock* sometimes use conifer stands for nesting and foraging. Conifer stands also provide important habitat for a variety of mammals, including eastern cottontail, red squirrel, and eastern chipmunk (Bailey and Alexander 1960). Some conifer stands provide winter shelter for white-tailed deer and can be especially important for them during periods of deep snow cover.

Upland Mixed Forest

The term “upland mixed forest” refers to non-wetland forested areas with both hardwood and conifer species, where conifer cover is 25-75% of the canopy. These areas are less densely shaded at ground level and support a higher diversity and greater abundance of understory species than conifer-dominated stands. There is an area of planted native and non-native conifers at the Vassar Farm and Ecological Preserve that are now interspersed with hardwoods.

Occurrence in the City of Poughkeepsie

Forested areas in the City of Poughkeepsie, including both forested wetlands and uplands, are shown in Figure 5. The two largest contiguous forests in the city occupy approximately 77 ac (31 ha) and 55 ac (22 ha) on the Vassar Farm and Ecological Preserve, and are part of a larger forest extending south into the Town of Poughkeepsie. Although large, these patches have a high ratio of edge (perimeter) to forest core (area). Forest edges tend to be warmer, brighter, drier, and windier than forest interiors (Vanwallegem 2009) and are often occupied, in part, by non-native invasive plants, which are less likely to infest the undisturbed interior (Harper et al. 2005). A forest with more edge and less core habitat will have less of the cooler, moister, and shadier habitats of the deep forest, and hence less area for the plants and animals of conservation concern that benefit from those conditions. Less core will also expose some vulnerable animals—such as forest-interior songbirds—to the predators and nest parasites that frequent forest edges.

Elsewhere in the city are many small patches of forest—the amalgamation of backyard forests—that could serve as stepping stones for wildlife movement. Few of the forested areas in

the city are large enough to support the forest dwelling animals of conservation concern mentioned in the habitat descriptions above, but many are still likely to host species adapted to smaller and more-disturbed forests and forest edge habitats.

Upland hardwood forest was the most widespread of the mapped habitat types in the city. All forests in the city have been cleared or logged in the past, but many large trees are present, most of them at College Hill Park or the Vassar Farm and Ecological Preserve. Upland hardwood forests were common in the floodplains of the Casperkill and its tributaries. The understories of these floodplain forests were often dominated by non-native shrubs such as Bell's honeysuckle and multiflora rose (a common condition in post-logging and post-agricultural forests in the Hudson Valley), and non-native vines such as oriental bittersweet and porcelain berry were often present in moist areas.



Upland hardwood forest at the Vassar Farm and Ecological Preserve. E. Heffernan © 2018

Upland mixed and conifer forests covered relatively small total areas (5.6 ac [2.3 ha] and 1.3 ac [0.5 ha], respectively); the largest were on the Vassar Farm and Ecological Preserve. Most of the mixed and conifer forests were plantations of Norway spruce, Scotch pine, white pine, or eastern red cedar.

Sensitivities/Impacts

Forests of all kinds can be important habitats for wildlife. Large forests that are unfragmented by roads, meadows, trails, utility corridors, or developed lots are especially important for certain organisms, but are increasingly rare in the region. Both paved and unpaved roads act as barriers that many species either do not cross or cannot safely cross, and many animals avoid breeding near traffic noise (Forman and Deblinger 2000, Trombulak and Frissell 2000).

In addition to fragmentation, forest habitats can be degraded in several other ways. Clearing the forest understory destroys habitat for birds such as wood thrush* which nests in dense understory vegetation, and black-and white warbler* which nests on the forest floor. Soil compaction and removal of dead and downed wood and debris have many negative impacts, including the elimination of habitat for mosses, lichens, fungi, cavity-using animals,



Canopy gap in forest at Vassar Farm and Ecological Preserve. E. Heffernan © 2018

amphibians, reptiles, small mammals, and invertebrates. Where dirt roads or trails cut through forest, vehicle and pedestrian traffic can harm tree roots and cause soil erosion. The roadway itself can provide nest predators (such as raccoon and opossum) and the brown-headed cowbird (a nest parasite) access to interior forest areas. Roads and trails can provide entry for non-native invasive weeds such as garlic-mustard and multiflora rose, and human activity along roads and trails can inhibit nesting of certain songbirds. Runoff from roads can pollute nearby areas with road salt, heavy metals, and sediments (Trombulak and Frissell 2000), and mortality from vehicles can significantly reduce the population densities of amphibians (Fahrig et al. 1995).

Norway maple, tree-of-heaven and Amur corktree were common non-native invasive trees found at the Vassar Farm and Ecological Preserve. Norway maples were common throughout the city as both planted street trees and dominant canopy trees in forest patches. Forests are also susceptible to invasion by shade-tolerant, non-native herbs and shrubs, and this susceptibility is increased by development-related disturbances. Gaps created by storms and disease can provide habitat for fast-growing, shade-intolerant, non-native species such as tree-of-heaven, Japanese barberry, and Bell's honeysuckle. Once established, many of these species are difficult to eliminate. Due to the highly fragmented nature of the city's forests and the ongoing human disturbance, most have some non-native species, and non-natives reach high densities in many places. Oriental bittersweet and porcelain berry, two non-native woody vines, are rampant in some parts of the city where they overtake forest and shrub canopies, and may suppress native species and alter forest composition (Ladwig and Meiners 2009). The forest at College Hill Park had small patches of wisteria, another non-native that can also be invasive.

Whatever the condition of their native plant communities, however, urban forests have special value for the human community. Forests, wooded hedgerows, and street trees improve the livability of cities by reducing pollution, moderating air temperatures, absorbing stormwater, providing visual relief, and connecting people to the natural environment (Greene et al. 2011). Forests and other habitat patches in the city can act as stepping stones for wildlife, and serve a similar function for human residents to connect them with the natural landscapes of the Hudson Valley. While the Poughkeepsie habitat map depicts forest patches of 0.2 ac (900 m²) or larger, street trees and backyard forests are also important habitat features both for urban wildlife and

for people. Figure 8 outlines some hypothetical stepping stones and corridors between and among habitat patches.

Introduced forest pests are also threatening forest health in the city and other parts of the Hudson Valley. Of note is the hemlock woolly adelgid (HWA), an insect that has infested many eastern hemlock stands from Georgia to New England. The adelgid typically kills trees within 10-15 years and has the potential to eliminate most or all eastern hemlock trees in the region. In Poughkeepsie many hemlock stands are in some stage of decline due to the HWA, but there are still several areas with hemlocks exhibiting few if any signs of infestation.

The emerald ash borer (EAB) is a non-native tree borer (a jewel beetle) that infests ash species from New Hampshire to Georgia and west to Colorado, and is now found in 30 of New York's 62 counties (NYSDEC 2017). While the adults do little damage to the tree, the larvae feed on the inner bark of the trees; a heavy infestation will effectively girdle a tree, killing it within 2-4 years. Early detection of the emerald ash borer is difficult, and outbreaks are almost impossible to contain once identified. White and green ashes are common trees throughout the City of Poughkeepsie. White ash is frequent in upland forests and as a street tree, and green ash is common in floodplains and hardwood swamps. A 2017 ash survey conducted by Vassar College students found that over half of the 387 ash trees assessed in the city showed signs of stress, and approximately 9% had recognizable symptoms of EAB activity.



Woodpecker damage to ash tree due to emerald ash borer infestation.
E. Heffernan © 2018

(See the Conservation Priorities and Planning section for recommendations on preserving the habitat values and other values of large and small forests in Poughkeepsie.)

Crest and ledge

Ecological Attributes

Rocky crest and ledge habitats often occur together, so they are described and mapped together for this project. Crest and ledge habitats occur where soils are very shallow and bedrock is partially exposed at the ground surface, at the summit or shoulder of a hill or knoll (crest) or as a steep-sided rock outcrop (ledge). These habitats can occur at any elevation and are usually embedded within other habitat types, most commonly upland forest. Some crest and ledge habitats support well-developed forests, while others have sparse, patchy, and stunted vegetation.

Crest and ledge habitats often appear to be harsh and inhospitable, but they can support an extraordinary array of uncommon or rare plants and animals. Some species, such as wall-rue, smooth cliffbrake,* purple cliffbrake, and northern slimy salamander* are found only in and near such habitats elsewhere in the region. The communities and species that occur at any particular location are determined by many factors, including bedrock type, outcrop size, aspect, exposure, slope, elevation, biotic influences, and kinds and intensity of human disturbance.



Ebony spleenwort on ledge habitat.
E. Heffernan © 2018

Northern oak hairstreak* (butterfly) occurs with oak species which are host plants for its larvae, and olive hairstreak* occurs on crests with its host eastern red cedar. Rocky habitats with larger fissures, cavities, and exposed ledges may provide shelter, den, and basking habitat for eastern racer,* eastern ratsnake,* and northern copperhead.* Southern redback vole is found in some rocky areas in the region.

Occurrence in the City of Poughkeepsie

Crest and ledge habitats were small and scattered in Poughkeepsie. The largest areas with exposed rock were along the Hudson River shoreline and vicinity and along active and abandoned railroad beds. While most ledges were in forests, there were several areas of exposed Poughkeepsie Mélange bedrock along the river that supported no trees and only patchy herbaceous vegetation. The only crest area that we identified was the highly-disturbed opening above the ledge at Kaal Rock Park.



Ledge habitat along rail trail. E. Heffernan © 2018

Sensitivities/Impacts

Crest and ledge habitats often occur in locations that are valued by humans for recreational uses, scenic vistas, and house sites. Construction of trails, roads, and houses destroys or degrades crest and ledge habitats directly, and causes fragmentation of these habitats and the forested areas of which they are often a part. Rare plants of rocky habitats are vulnerable to trampling and collecting; and snakes that use these habitats are susceptible to road mortality,

intentional killing or harassing, and collecting. The shallow soils of these habitats are susceptible to erosion from construction and logging activities, and from foot and ATV traffic. The only ledge feature along the shoreline is located between Kaal Rock Park and Waryas Park. The ledge could benefit from directed management of visitors to encourage responsible use of the habitat and discourage destructive social trails.

Upland shrubland

Ecological Attributes

We use the term “upland shrubland” to describe non-forested uplands with significant ($\geq 20\%$) shrub cover. In most cases these are lands in transition between meadow and young forest, but they also occur in recently cleared areas, or are maintained along utility corridors by cutting or applying herbicides. Recently cleared or disturbed sites often contain dense thickets of shrubs and vines, including the non-native Japanese barberry, Bell’s honeysuckle, multiflora rose and oriental bittersweet. Abandoned agricultural fields and pastures often support diverse plant communities, including a variety of meadow grasses and forbs, shrubs such as meadowsweet, gray dogwood, northern blackberry, raspberries, and scattered seedling- and sapling-size eastern red cedar, hawthorns, white pine, gray birch, red maple, white ash, black cherry, quaking aspen, and oaks. Occasional large, open-grown trees (e.g., sugar maple, white oak, sycamore) left as shade for livestock may be present.

Rare butterflies such as Aphrodite fritillary,* dusted skipper,* and Leonard’s skipper* may occur in shrublands where their host plants are present (violets for the fritillary and native grasses such as little bluestem for the skippers). Upland shrublands and other non-forested upland habitats may be used by turtles (e.g., painted turtle, wood turtle,* spotted turtle,* Blanding’s turtle,* and eastern box turtle*) for nesting. Many bird species of conservation concern nest in upland shrublands and adjacent upland meadow habitats, including brown thrasher,* blue-winged warbler,* golden-winged warbler,* prairie warbler,* yellow-breasted chat,* clay-colored sparrow,* field sparrow,* eastern towhee,* American woodcock,* and northern harrier.* Extensive upland shrublands and those that form large complexes with meadow habitats may be particularly important for these breeding birds. Several species of

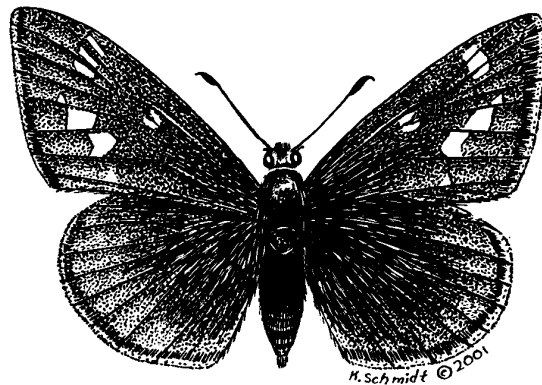
hawks and falcons use upland shrublands and adjacent meadows for hunting small mammals such as meadow vole, white-footed mouse, and eastern cottontail.

Occurrence in the City of Poughkeepsie

Most of the upland shrublands of the city were in former agricultural areas, forest gaps, and utility corridors, and ranged from 0.01 to 4.1 ac (>0.01-1.7 ha), for a total of 25.7 ac (10.4 ha). The largest shrublands were those occupying former agricultural fields on the Vassar Farm and Ecological Preserve.

Sensitivities/Impacts

Shrublands and meadows (see below) have closely-related plant communities and share many of the same ecological values. Having a diversity of ages and structures in these habitats may promote overall biological diversity, and can be achieved by rotational mowing and/or brush-hogging. To reduce the impacts of these management activities on birds, mowing should be timed to coincide with the post-fledging season for most birds (e.g., September and later) and only take place every few years, if possible. To reduce impacts on turtle nests and hatchlings, mowing should be delayed until after September. Delaying mowing until even later will help preserve the late-season wildflowers that are an important food source for native bees, butterflies, and other pollinating insects. As in upland meadows, soil compaction and erosion caused by ATVs and other vehicles and equipment can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. If shrublands are left undisturbed, most will eventually become forests, which are also valuable habitats.



Dusted skipper caterpillars feed on little bluestem in shrublands. Kathleen A. Schmidt © 2001

Upland meadow

Ecological Attributes

This broad category includes active cropland and oldfields in Poughkeepsie. Upland meadows are typically dominated by grasses and forbs, and have less than 20% shrub cover. The ecological values of these habitats can differ widely according to the types of vegetation present and varied disturbance histories (e.g., tilling, mowing, grazing, pesticide applications). Undisturbed meadows develop diverse plant communities of grasses, forbs, and shrubs and support an array of wildlife, including invertebrates, reptiles, mammals, and birds. It is for both present and potential future ecological values that we consider all types of meadow habitat to be ecologically significant.

Several species of rare butterflies use upland meadows that support their particular host plants. Upland meadows can be used for nesting by wood turtle,* spotted turtle,* Blanding's turtle,* eastern box turtle,* painted turtle, and snapping turtle. Grassland-breeding birds such as savannah sparrow,* eastern meadowlark,* and bobolink* use extensive meadow habitats for nesting and foraging. Upland meadows often have large populations of small mammals (e.g., meadow vole) and can be important hunting grounds for raptors, foxes, and eastern coyote.

Occurrence in the City of Poughkeepsie

Upland meadow was a common habitat type in the City of Poughkeepsie, but accounted for only 4% of the total land area. Figure 4 illustrates the location and distribution of contiguous meadow habitat in the city (including both upland and wet meadows). Upland meadows were relatively small, ranging from smaller than 0.1 ac (0.04 ha) to nearly 6 ac (2.4 ha). The largest upland meadows were concentrated in the south part of the city, and consisted mostly of mowed fields rather than crop fields or pasture. A subset of upland meadow (15.6 ac, 6.3 ha) was the vegetable farm and community garden, classified as "row crops," at the Poughkeepsie Farm Project. Other community and school gardens throughout the city, while important, were too small (<900 m²) to be mapped for this project.

Sensitivities/Impacts

The dramatic decline of grassland-breeding birds in the Northeast has been attributed to the loss of large areas of suitable meadow habitat; many of these birds need large meadows that are not divided by fences or hedgerows, which can harbor predators (Wiens 1969). Another threat to upland meadow habitats is the soil compaction and erosion caused by ATVs and other vehicles and equipment, which can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. Destruction of vegetation can affect rare plant populations and reduce viable habitat for butterflies, dragonflies, damselflies, and bees, and mowing of upland meadows during the bird nesting season can cause extensive mortality of eggs, nestlings, and fledglings. (See the Conservation Priorities and Planning section for recommendations for maintaining large meadow habitats.)

Cultural

We use the term “cultural” habitats for areas that are significantly altered and intensively managed (e.g., mowed), but are not otherwise developed with pavement or structures. These include large mowed lawns, athletic fields, golf courses, and similar areas. We identified this as an ecologically significant habitat type due to its benefits to people rather than its current habitat values, which are limited by frequent mowing, application of pesticides, or other types of management, and intensive human uses. Nonetheless, eastern screech-owl* and barn owl* are known to nest and roost in cultural areas. American kestrel,* spring migrating songbirds, and bats may forage in these habitats, and wood duck* may nest in such places. Individual ornamental trees can provide habitat for cavity-nesting birds, roosting bats (including Indiana bat* and small-footed bat*), and other animals.

Some cultural areas buffer less disturbed habitats from human activities, and link patches of undeveloped habitat together. Because cultural habitats are already significantly altered, their current habitat value for native wildlife is greatly diminished compared to relatively undisturbed habitats.

But many cultural areas have tremendous “open space” values for the human community, and are all the more precious in an urban setting. In Poughkeepsie, many of the cultural areas are athletic fields and manicured parks, which are important neighborhood resources. Many of these cultural resources are isolated within the city and could benefit from increased human connectivity by means of signage, bike lanes, or pedestrian walkways. Some ways to improve the habitat values for wildlife while retaining the utility of cultural areas as common outdoor space for public uses are explained below. (See the Conservation Priorities and Planning section for recommendations for maintaining cultural areas.)

Occurrence in the City of Poughkeepsie

Cultural areas were the second most common habitat type that we identified in the City of Poughkeepsie, and included golf courses, playing fields, and large lawns. The College Hill golf course covered 51 ac (20.6 ha) and is part of a larger habitat area of 114 ac (46.1 ha). The second largest cultural area was Spratt Park, which is part of a larger habitat complex extending



View of Waryas Park and Walkway Over the Hudson. E. Heffernan © 2018

into the Town of Poughkeepsie (Figure 4). At present however, many of the public-access parks and habitat areas are small (≤ 2.5 ac [1 ha]), and are so widely spaced (≥ 1500 ft, 500 m, or about a 10 minute walk) throughout the city that they are not easily accessible by all residents (Thompson and Aspinall 2011) (Figure 6). Residences and business on Main Street and Cannon Street in particular are isolated or on the peripheral limit of reasonable distance from parks for most of their length, and this access is further limited by the high traffic arterials (Route 44/55) that border these two roads (we did not consider traffic patterns when mapping reasonable distance areas in Figure 6). The south-central portion of the city is also bereft of public-access land, but does benefit from scattered habitat patches on private land, and houses that are more widely spaced. While most residences of the city are within walking distance of a public greenspace, single-use spaces such as baseball fields may not serve all the residents within walking distance. Additionally, the “pleasantness” of the area around a park will encourage or discourage use of the park (Thompson and Aspinall 2011).

Waste ground

“Waste ground” is a botanists’ term for land that has been severely altered by previous or current human activity, but lacks pavement or structures. Most waste ground areas have been stripped of vegetation and topsoil, or filled with soil or debris but remain substantially unvegetated. This category encompasses a variety of highly impacted areas such as active and abandoned gravel mines, rock quarries, mine tailings, dumps, unvegetated wetland fill, unvegetated landfill cover, construction sites, and abandoned lots. The term “waste ground” does not necessarily imply dumpsites for refuse.

Although waste ground often has low habitat value, there are notable exceptions. Several rare plant species are known to inhabit waste ground environments, including rattlebox,* slender pinweed,* field dodder,* and slender knotweed.* Rare lichens and mosses may potentially occur in some waste ground habitats. Several snake and turtle species of conservation concern, including eastern hognose snake* Blanding’s turtle,* spotted turtle,* and wood turtle,* may use the open, gravelly areas of waste grounds for burrowing, foraging, or nesting habitat. Bank swallow* and belted kingfisher typically nest on bare vertical banks of soil, such as high,

Public-Access Greenspaces

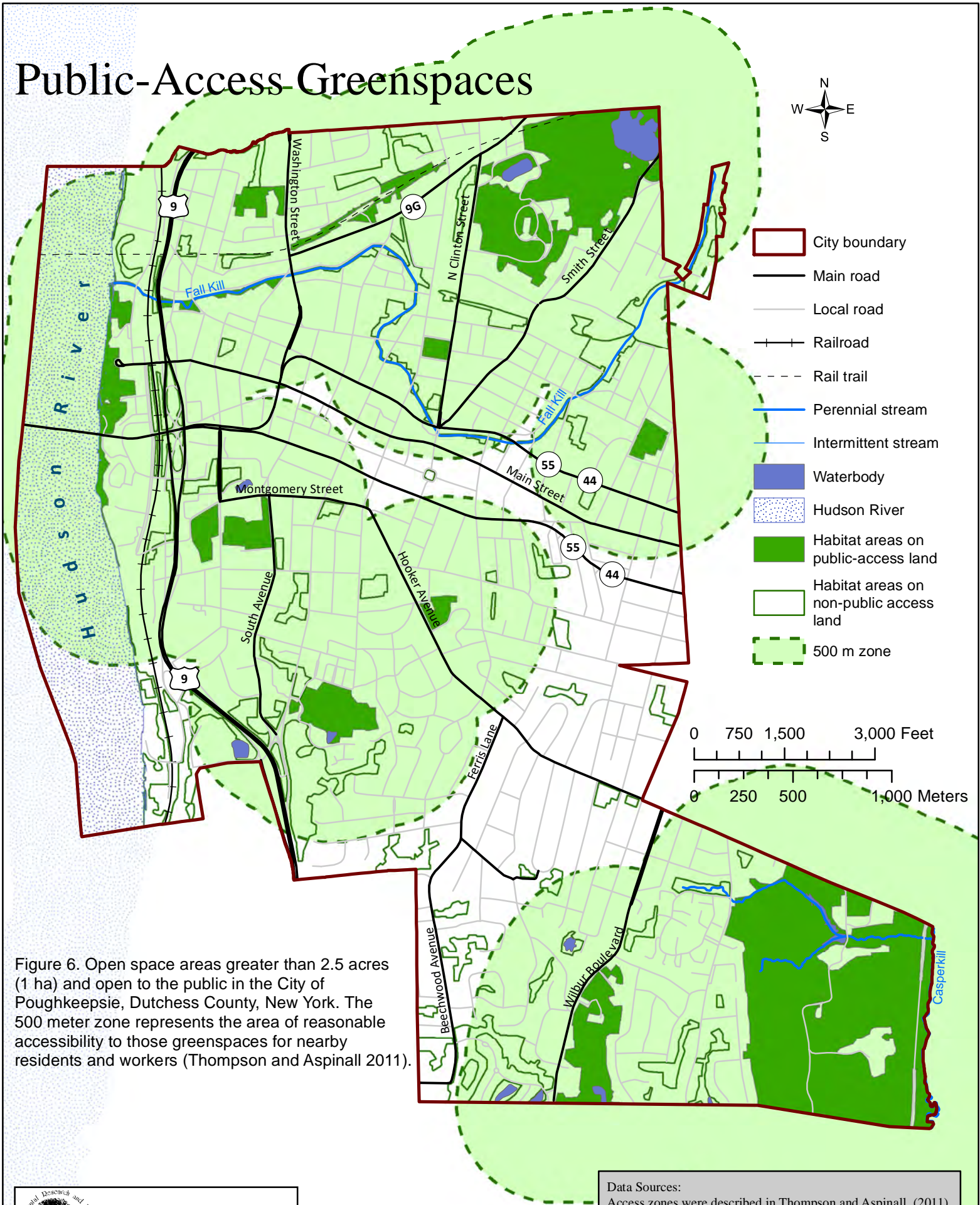


Figure 6. Open space areas greater than 2.5 acres (1 ha) and open to the public in the City of Poughkeepsie, Dutchess County, New York. The 500 meter zone represents the area of reasonable accessibility to those greenspaces for nearby residents and workers (Thompson and Aspinall 2011).

eroding stream banks or the stable walls of soil mines, but sometimes they nest in piles of soil or sawdust. Bare, gravelly, or otherwise open areas provide nesting habitats for spotted sandpiper, killdeer, and possibly common nighthawk.*

The biodiversity values of waste ground depend on site-specific conditions, which change over time as vegetation slowly becomes established, and the habitat becomes more similar to surrounding and nearby areas. Some of the rare species of these habitats depend on the early stages of habitat development, when soils are poor and vegetation is sparse. The City of Poughkeepsie has an extensive, post-industrial, waste-ground complex along the Hudson, with potential to be restored to a mixed-use area that would accommodate sea level rise and enhance the riverfront as a public asset (Figure 7).



Waste ground site below Walkway Over the Hudson. E. Heffernan © 2018

Wetland Habitats

Hardwood swamp

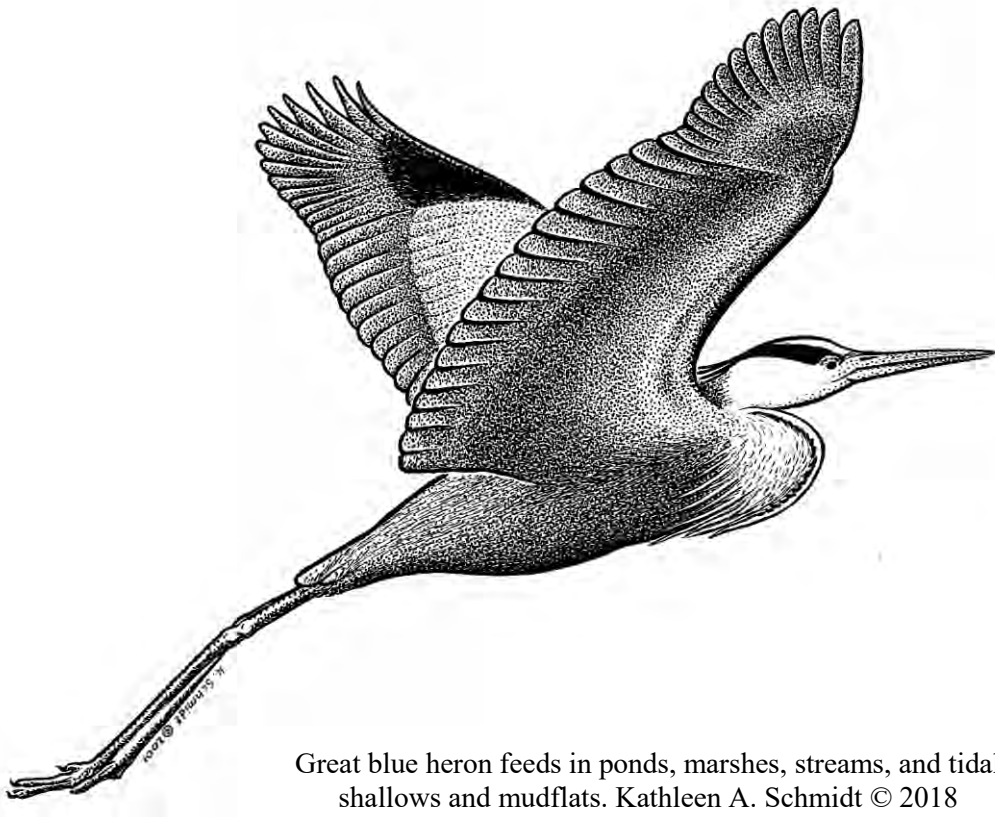
Ecological Attributes

A swamp is a wetland dominated by woody vegetation (trees and/or shrubs). We combined forested and shrub swamps into a single habitat type because the two often occur together and can be difficult to separate using remote sensing techniques. Red maple, green ash, American elm, slippery elm, pin oak, and swamp white oak are common trees of hardwood swamps in the region. Typical shrubs include silky dogwood, swamp azalea, spicebush, winterberry holly, and highbush blueberry; a few common herbaceous species are tussock sedge, sensitive fern, and skunk-cabbage.

Swamps are important to a wide variety of birds, mammals, amphibians, reptiles, and invertebrates, especially when swamp habitats are contiguous with other wetland habitats or embedded within large areas of upland forest. Hardwood and shrub swamps along the floodplains of clear, low-gradient streams can be an important component of wood turtle* habitat. Other turtles such as spotted turtle* and eastern box turtle* frequently use swamps for summer foraging, drought refuge, overwintering, and travel corridors. Pools within swamps are used for breeding by several amphibian species, and are the primary breeding habitat of blue-spotted salamander.* Four-toed salamanders* use swamps with rocks or abundant moss-covered downed wood or woody hummocks. Red-shouldered hawk,* barred owl,* great blue heron,* wood duck,* Canada warbler,* Virginia rail,* and white-eyed vireo* may nest in hardwood swamps.

Occurrence in the City of Poughkeepsie

Hardwood swamp covered a total of 73.1 ac (29.6 ha) in the City of Poughkeepsie (Figure 4). Swamps ranged from <0.1 to 12.2 ac (<0.04-5 ha), but most were small, averaging 1.16 ac (0.5 ha). Most swamps were in the floodplains of streams in the less-developed areas and many were contiguous with other wetland habitats such as marsh and wet meadow (Figure 4). The largest contiguous swamp was on the Vassar Farm and Ecological Preserve, and had predominantly forest cover.



Great blue heron feeds in ponds, marshes, streams, and tidal shallows and mudflats. Kathleen A. Schmidt © 2018

Some swamps were shrub-dominated (native or exotic), while others had a full canopy of trees. The typical overstory trees were red maple, green ash, and eastern sycamore. Water depth varied greatly, with some swamps drying completely in the summer months while others retained relatively deep pools. Swamps that were isolated from streams and other wetlands may have ecological roles similar to those of intermittent woodland pools, providing a seasonal source of water, fish-free breeding habitat for pool-breeding amphibians, and refuge for turtles (see below).

Sensitivities/Impacts

Some swamps (like other wetlands) are partially protected by federal or state laws, but most are still threatened by a variety of land uses. Some of the wetlands shown in Figure 4 are not delineated on the USFWS National Wetlands Inventory or NYS DEC Freshwater Wetlands maps and do not have protected status. Small swamps embedded in upland forest are often overlooked in wetland protection, but can have high biodiversity values, similar to those of intermittent woodland pools (see below). Swamps can easily be damaged by alterations to the quality, quantity, or timing of surface water runoff, or by disruptions of the groundwater sources feeding them. Swamps adjacent to agricultural land are subjected to runoff contaminated with agricultural chemicals, and those near roads and other developed areas often receive runoff high in nutrients, sediment, de-icing salts, and toxins. Polluted runoff and groundwater degrade the swamp's water quality, affecting the ecological condition (and thus habitat value) of the swamp and its associated streams. Maintaining flow patterns and water volumes in swamps is important to the plants and animals of these habitats. Connectivity between swamp habitats and nearby upland and wetland habitats is essential for amphibians that breed in swamps and for other resident and transient wildlife of swamps. Direct disturbance, such as logging, can damage soil structure, plant communities, and microhabitats, and provide access for invasive plants. Ponds for ornamental or other purposes are sometimes excavated in swamps, but the loss of habitat values of the pre-existing swamp usually far outweighs any habitat value gained in the new, artificial pond environment.

Intermittent woodland pool*Ecological Attributes*

An intermittent woodland pool is a small wetland partially or entirely surrounded by forest, typically with no surface water inlet or outlet (or an ephemeral one), and with standing water during winter and spring that dries up by mid- to late summer during a normal year. This habitat is a forested subset of the widely recognized "vernal pool" habitat. Seasonal drying and lack of a stream connection ensure that these pools do not support fish, which are major predators on amphibian eggs and larvae. For this reason, these pools are the critical breeding and nursery habitat for a special group of pool-breeding amphibians that are especially

vulnerable to fish predation. The surrounding forest supplies the pool with organic litter, the base of the pool's food web; the forest is also essential habitat for adult amphibians during the non-breeding seasons.

Intermittent woodland pools with suitable hydroperiods can support breeding wood frog, Jefferson salamander,* marbled salamander,* and spotted salamander.* These pool-breeding amphibians are especially vulnerable to upland habitat fragmentation. Each year adults migrate from upland forests to the intermittent woodland pools to breed, and then adults and (later) juveniles disperse from the pool back to upland forest habitats. The salamanders are known to migrate seasonally up to 2,050 ft (625 m) from their breeding pools into surrounding forests (Semlitsch 1998). A wood frog adult may travel as far as 3,835 ft (1,169 m) from a breeding pool (Calhoun and Klemens 2002). Both salamanders and frogs are susceptible to vehicle mortality where roads or driveways cross their travel routes; roads, especially networks of roads or heavily-traveled roads, have been associated with reduced amphibian populations (Fahrig et al. 1995, Lehtinen et al. 1999, Findlay and Bourdages 2000). Open fields and clearcuts are also barriers to forest-dwelling amphibians. Juveniles have trouble crossing open fields due to a high risk of desiccation and predation in that exposed environment (Rothermel and Semlitsch 2002). For these reasons, maintaining large intact areas of upland forest around woodland pools is key to maintaining local populations of these animals.

Despite the small size, pools that hold water through early summer can support amphibian diversity equal to or higher than that of much larger wetlands (Semlitsch and Bodie 1998, Semlitsch 2000). Reptiles such as spotted turtle* and Blanding's turtle* use intermittent woodland pools for foraging, rehydrating, and resting. Wood duck,* mallard, and American black duck* use intermittent woodland pools for foraging, nesting, and brood-rearing, and a variety of other waterfowl and wading birds use these pools for foraging. The invertebrate communities of these pools can be rich, providing abundant food for songbirds such as yellow warbler, common yellowthroat, and northern waterthrush.* Springtime physa* is a regionally rare snail associated with intermittent woodland pools. Large and small mammals use these pools for foraging and as water sources. Featherfoil* and swamp cottonwood* are two NYS Threatened plants that occur in intermittent woodland pools elsewhere in the Hudson Valley.

The intermittent woodland pool at Vassar Farm is within a large 313 (127 ha) habitat complex extending south into the Town of Poughkeepsie. Although no other woodland pools are in the portion of the farm within the city limits, there are other pools in the habitat complex in the town which may also have suitable habitat for pool-breeding amphibians.

Occurrence in the City of Poughkeepsie

We mapped four small intermittent woodland pools in the City of Poughkeepsie (Figure 4). Three of the pools were smaller than 0.1 ac (0.04 ha) and embedded in a small forest area surrounded by residences. The fourth was 0.34 ac (0.14 ha) in a large forested area at Vassar Farm and Ecological Preserve.



Wood frog lives in upland forests, but requires woodland pools for breeding in the spring.
L. Heady © 2018

Sensitivities/Impacts

We consider intermittent woodland pools to be one of the most imperiled habitats in the region. Although they are widely distributed, most pools are small and their ecological importance is often undervalued. They are frequently drained or filled by landowners and developers, used as dumping grounds, treated for mosquito control, and sometimes converted into ornamental ponds. They are often overlooked in environmental reviews of proposed developments. Even when the pools themselves are spared in a development plan, the surrounding forest so essential to the ecological function of the pools is frequently destroyed (Calhoun and Klemens 2002).

Intermittent woodland pools are often excluded from federal and state wetland protection due to their small size and their isolation from other wetland and stream habitats. It is these very characteristics of size, isolation, and intermittency, however, that make woodland pools uniquely suited to species that do not reproduce or compete as successfully in larger wetland systems.

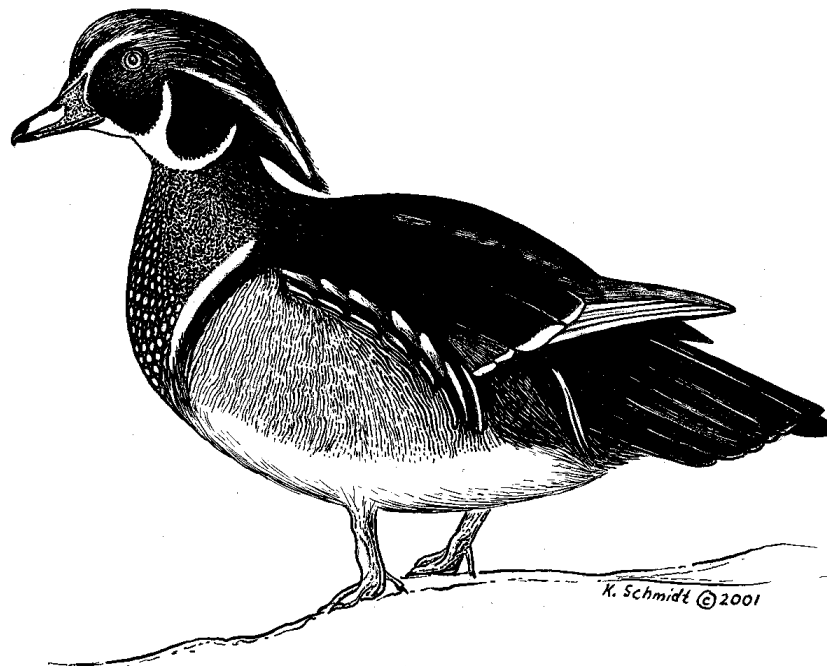
Three of the pools that we identified are surrounded by a small forest that is probably inadequate to support significant populations of pool-breeding amphibians during the non-breeding season. The pools could be used by others, however, such as spring peeper and green frog, and may certainly have habitat values for aquatic invertebrates, transient mammals, and other wildlife. The pool at Vassar Farm, however, seems to have adequate breeding and non-breeding habitat for pool-breeding amphibians, such as the wood frog; it is surrounded by a large area of hardwood swamp and adjacent upland hardwood forest and is part of a larger network of intermittent woodland pools and forest extending into the Town of Poughkeepsie. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of intermittent woodland pools.)

Marsh

Ecological Attributes

A marsh is a wetland that typically has standing water for much or all of the growing season, and is dominated by herbaceous (non-woody) vegetation. Marshes often occur at the fringes of deeper water bodies (e.g., lakes and ponds), or in close association with other wetland habitats such as wet meadows or swamps. The edges of marshes, where standing water is less permanent, often grade into wet meadows. Cattail, tussock sedge, arrow arum, broad-leaved arrowhead, water-plantain, common reed, and purple loosestrife are some typical emergent marsh plants in this region. Deeper water may support rooted, floating-leaved plants such as pond-lilies, or submergent aquatic plants such as pondweeds, bladderworts, and watermilfoils.

Several rare plant species are known from marshes in the region, including buttonbush dodder.* Marshes are important habitats for reptiles and amphibians, including painted turtle, snapping turtle, spotted turtle,* Blanding's turtle,* green frog, pickerel frog, Atlantic Coast leopard frog,* and spring peeper. Numerous bird species, including marsh wren,* common



Wood duck nests in tree cavities in and near swamps, marshes, woodland pools and even constructed ponds. Kathleen A. Schmidt © 2001

gallinule,* American bittern,* least bittern,* great blue heron,* Virginia rail,* king rail,* sora,* American black duck,* and wood duck* use marshes for nesting, nursery, or foraging habitat. Many raptor, wading bird, and mammal species use marshes for foraging.

Occurrence in the City of Poughkeepsie

We mapped five marsh areas in the City of Poughkeepsie, covering a total of 3.7 ac (1.5 ha) (Figure 4). Most were along the margins of or embedded in hardwood and shrub swamps, wet meadows, or constructed ponds. Because it was sometimes difficult to distinguish marsh from shrub swamp or wet meadow on aerial photographs, all mapped marsh boundaries should be considered approximate. Common reed, purple loosestrife, cattail, and common duckweed were abundant in many of the marshes of Poughkeepsie. Most of the mapped marshes were small (<1 ac [0.4 ha]); the largest (approximately 2 ac [0.8 ha]) occupied the perimeter of Morgan Lake in College Hill and Morgan Lake Parks.

Sensitivities/Impacts

In addition to direct disturbances such as filling or draining, marshes are subject to stresses from up-gradient sources. Alteration of surface water runoff patterns or groundwater flows can lead to dramatic changes in the plant and animal communities of marshes. Polluted stormwater runoff from roads, parking lots, lawns, and other surfaces in developed landscapes carries sediments, nutrients, de-icing salts, toxins, and other contaminants into the wetland. Alteration of water levels by humans or beaver can also alter the plant community and, as with elevated nutrient and sediment inputs, can invite invasion by non-native plants such as purple loosestrife and common reed. Purple loosestrife and common reed have displaced many of the native wetland plants in recent decades and are now common in many of the marshes in the City of Poughkeepsie. Noise and direct disturbance from human activities can discourage breeding activities of marsh birds. Because many animal species of marshes depend equally on surrounding upland habitats to meet various needs throughout the year, protection of the ecological functions of marshes must go hand-in-hand with protection of surrounding habitats. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of marshes within larger wetland complexes.)

Wet meadow

Ecological Attributes

A wet meadow is a wetland dominated by herbaceous (non-woody) vegetation and lacking standing water for most of the year. Its period of inundation is longer than that of an upland meadow, but shorter than that of a marsh. Some wet meadows are dominated by purple loosestrife, common reed, reed canary-grass, or tussock sedge, while others have a diverse mixture of wetland grasses, sedges, forbs, and scattered shrubs. Bluejoint, mannagrasses, woolgrass, soft rush, blue flag, sensitive fern, and marsh fern are some typical plants of wet meadows.

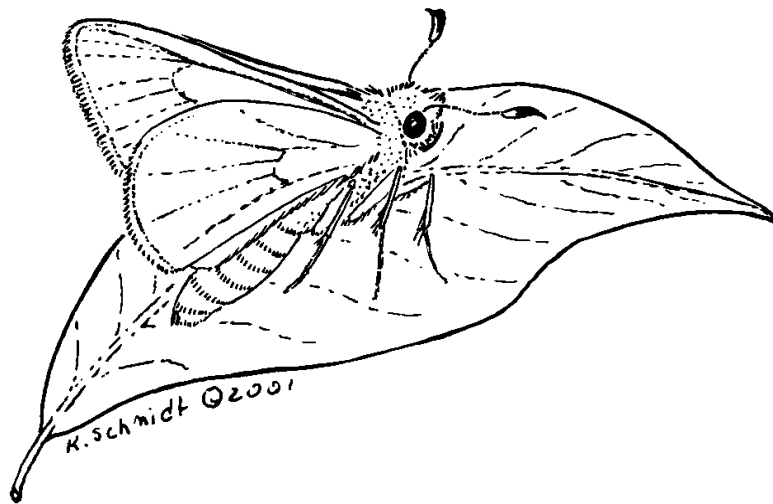
Wet meadows with diverse plant communities may have rich invertebrate faunas. Blue flag and certain sedges and grasses of wet meadows are larval food plants for several regionally-rare butterflies. Wet meadows provide nesting and foraging habitat for songbirds such as sedge wren,* wading birds such as American bittern,* and raptors such as northern harrier.* Wet meadows that are part of extensive meadow areas (both upland and wetland) may be especially important to species of grassland-breeding birds. Large and small mammals use wet meadows and other meadow habitats for foraging.

Occurrence in the City of Poughkeepsie

Many of the wet meadows of the City of Poughkeepsie were associated with swamps and streams. We mapped 11 wet meadows, covering 16.6 ac (6.7 ha) in the city. Most were smaller than 1 ac (0.4 ha). Many were dominated by non-native species such as purple loosestrife, and non-native genotypes of common reed and reed canary grass. The largest wet meadow was on the Vassar Farm and Ecological Preserve. It covered approximately 9.7 ac (3.9 ha), but was part of a larger meadow complex to the west and extending south into the Town of Poughkeepsie. The meadow is apparently calcareous, and supported native forbs such as wild bergamot and Joe-Pye weed, among many other plants.

Sensitivities/Impacts

Some wet meadows are able to withstand occasional mowing without significant harm, but frequent mowing or other disturbance can degrade the soil structure, eliminate sensitive plant species, and invite non-native weeds. Mowing in late summer or fall when the soils are drier is less damaging to the soils and plant community. Wet meadows that are part of larger complexes of meadow and shrubland habitats are prime sites for development or agricultural use, and are often drained or excavated. Because many wet meadows are omitted from state, federal, and site-specific wetland maps, they are frequently overlooked in environmental reviews of development proposals. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of wet meadows within larger wetland complexes, and general recommendations on mowing practices.)



Butterflies, moths and many other pollinators rely on meadows for nectar.
Kathleen A. Schmidt © 2001

Constructed pond*Ecological Attributes*

“Constructed ponds” include those waterbodies that have been excavated or dammed by humans, either in existing wetlands or stream beds, or in upland terrain. Most of these ponds are deliberately created for such purposes as fishing, watering livestock, irrigation, swimming,

boating, or aesthetics. Some ponds are constructed near houses or other structures to serve as sources of water in the event of a fire. If constructed ponds are not intensively managed by humans, they can be important habitats for many of the common and rare species that are associated with natural open water habitats. Undisturbed, shallower ponds can develop into marshes or swamps over time.

Occurrence in the City of Poughkeepsie

We classified all of the open waterbodies in the City of Poughkeepsie as constructed ponds. Most were maintained for ornamental or water retention purposes (and located in industrial, commercial, or landscaped areas). Because of the potential value of constructed ponds as drought refuge and foraging areas for turtles and other wildlife, we mapped constructed ponds within developed areas as well as those surrounded by intact habitats.



Mute swan viewed through marsh at edge of Morgan Lake. E. Heffernan © 2018

Only nine of the 16 constructed ponds that we mapped were smaller than 1.0 ac (0.4 ha). Morgan Lake in College Hill Park was the largest, (measuring 10.5 ac [4.3 ha] including the marsh along its perimeter).

Sensitivities/Impacts

The habitat values of constructed ponds vary depending on factors such as the landscape context, extent of human disturbance, water quality, and degree of invasion by non-native species. In general, the habitat value is higher when the ponds have undeveloped shorelines, are relatively undisturbed by human activities, have more native vascular plant vegetation, and are embedded within an area of intact habitat. Because many constructed ponds are not buffered by sufficient natural vegetation and soil, they are vulnerable to the adverse impacts of septic leachate, and pesticide or fertilizer runoff from lawns and gardens. We expect that many of those maintained as ornamental ponds are treated with herbicides and perhaps other toxins, or contain introduced fish such as grass carp and various non-native game and forage fishes. Since constructed ponds serve as potential habitat for a variety of common and rare species, care should be taken to minimize these impacts.

The habitat values of constructed ponds (and especially intensively managed ornamental ponds) do not ordinarily justify altering streams or destroying natural wetland or upland habitats to create them. In most cases, the loss of ecological functions of natural habitats far outweighs any habitat value in the new artificially created environments.

Springs & seeps

Ecological Attributes

Springs and seeps are places where groundwater discharges to the ground surface, either at a single point (a spring) or diffusely (a seep). Springs often discharge into ponds, streams, or wetlands, but are most noticeable when these discharge conspicuously into upland locations. Springs and seeps originating from deep groundwater sources flow more or less continuously, while those from shallower sources flow intermittently. The habitats created at springs and seeps are determined in part by the hydroperiod and the chemistry of the soils and bedrock

through which the groundwater flows before emerging. Springs and seeps are significant water sources for many streams, ponds, and wetlands, and they help to maintain the cool temperature of those habitats. Springs also serve as water sources for animals during droughts and during cold winters when other water sources freeze over.

Very little is known of the ecology of springs and seeps in the Northeast. Golden saxifrage is a plant more-or-less restricted to springs and groundwater-fed wetlands and streams. Northern dusky salamander* uses springs and cold streams. A few rare invertebrates are restricted to springs in the region. The Piedmont groundwater amphipod* could occur here (Smith 1988), as well as other groundwater-associated invertebrates, and gray petaltail* and tiger spiketail* are two rare dragonflies of seeps and coldwater streams. Springs emanating from calcareous bedrock or calcium-rich surficial deposits sometimes support an abundant and diverse snail fauna.

Occurrence in the City of Poughkeepsie

Because occurrences of springs and seeps are difficult to predict by remote sensing, we mapped only the one we saw—at the Springside National Historic Landmark; we expect there are others in the city. More detailed inventories of seeps and springs should be conducted as needed on a site-by-site basis.

Sensitivities/Impacts

Springs are easily disrupted by disturbance to up-gradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltrating waters. In many areas, groundwater has been polluted or drawn-down by pumping for human uses, affecting the quality or quantity of water issuing from seeps and springs.

Streams & riparian corridors

Ecological Attributes

“Perennial streams” are those that flow continuously throughout years with normal precipitation, but some may dry up during droughts. They provide an essential water source for wildlife throughout the year, and are critical habitat for many plant, vertebrate, and invertebrate species. We loosely define “riparian corridor” as the zone along a perennial stream that includes the stream banks, the floodplain, and adjacent steep slopes. We did not map riparian corridors.

Intact riparian areas tend to have high species diversity and high biological productivity, and many species of animals depend on riparian habitats in some way for their survival (Hubbard 1977, McCormick 1978). They can support a variety of wetland and non-wetland forests, meadows, and shrublands. Typical floodplain forests have trees such as eastern sycamore and eastern cottonwood, and a mixture of other upland and wetland plant species.

One area of the Fall Kill, just south of the transfer station, has not been heavily channelized. Both this portion of the Fall Kill and the Casperkill corridor in the southeastern corner, which is in a less developed area, hosted a similar complement of plant species. Trees such as eastern sycamore, eastern cottonwood, and red maple were common in floodplain forests (mapped as upland hardwood forest or hardwood swamp), and their understories had cinnamon fern or Japanese stiltgrass.

We know of many rare plants of streams and floodplains in the region, such as cattail sedge,* Davis’ sedge,* goldenseal,* and false-mermaid. The fish and aquatic invertebrate communities of perennial streams may be diverse, especially in clean-water streams with unsilted bottoms. The Fall Kill is an important stream for American eel* (Bowser 2017), which moves from the tidal Hudson into non-tidal streams as a glass eel (juvenile stage), and remains in freshwater until maturity; eels migrate back to the Sargasso Sea as adults to spawn. A modest population persists in the stream reach below the dam at Fall Kill Lake (Stalzer et al. 2016). Brook trout* and slimy sculpin* are two native fish species that require clear, cool streams for successful

spawning, and are unlikely to occur in the urban and suburban reaches of Poughkeepsie streams. Wood turtle* uses perennial streams with pools and recumbent logs, undercut banks, or muskrat or beaver burrows. Perennial streams and their riparian zones, including gravel bars, can provide nesting or foraging habitat for many species of birds, such as spotted sandpiper, belted kingfisher, tree swallow, bank swallow, winter wren, Louisiana waterthrush, great blue heron,* and green heron. Red-shouldered hawk* and cerulean warbler* nest in areas with riparian forests, especially those with extensive stands of mature trees. Bats, including Indiana bat,* use perennial stream corridors for foraging (US Fish and Wildlife Service 2007). Muskrat, beaver, mink, and river otter* are some of the mammals that use riparian corridors regularly. Riparian forests are particularly effective at removing dissolved nutrients from stream water, and produce high quality detritus (dead plant matter) important to the aquatic food web and habitat structure.

“Intermittent streams” flow only during certain times of the year or after rains, but some may flow throughout the growing season in wet years. They are the headwaters of most perennial streams, and are significant water sources for lakes, ponds, and many kinds of wetlands. The condition of these streams therefore directly influences the water quantity and quality of those water bodies and wetlands. Intermittent streams can be important local water sources for wildlife. Plants such as winged monkey-flower,* may-apple, and small-flowered agrimony* are associated with intermittent streams (and other habitats). Although intermittent streams have been little studied by biologists, they have been found to support rich aquatic invertebrate communities, including regionally rare mollusks (Gremaud 1977) and dragonflies. Both perennial and intermittent streams provide breeding, larval, and adult habitat for northern dusky salamander* and northern two-lined salamander. The forests and sometimes meadows adjacent to streams provide foraging habitats for adults and juveniles of these species.

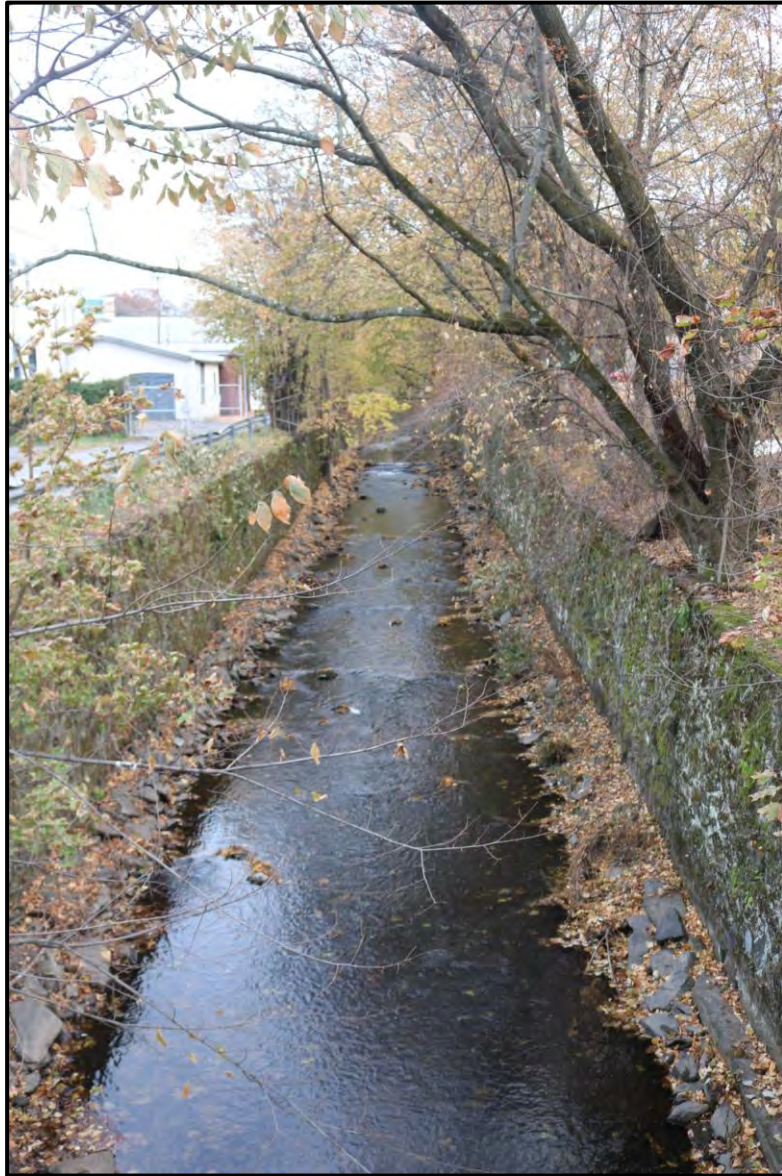
Occurrence in the City of Poughkeepsie

Though much altered by the surrounding development, perennial streams are prominent features in the City of

Poughkeepsie. The Fall Kill, the largest perennial stream in the city, runs east-to-west for 3.0 miles (4.9 km) through the northern part of the city, and empties into the Hudson River at the Poughkeepsie Landing Park. Much of the Fall Kill was channelized during the Great Depression with steep concrete or stone riprap banks, many of which are now crumbling (Bean et al. 2006), and some areas are piped and buried. The Casperkill flows north-to-south for approximately 0.8 miles (1.3 km) along the southeastern border of the city and ultimately meets the Hudson just south of the Tilcon Plant at Clinton Point.

Intermittent streams were common in the southern part of the city (Figure 4).

The many stream fragments mapped throughout the city are portions of streams that are partially piped or buried so their complete paths were not detectable.



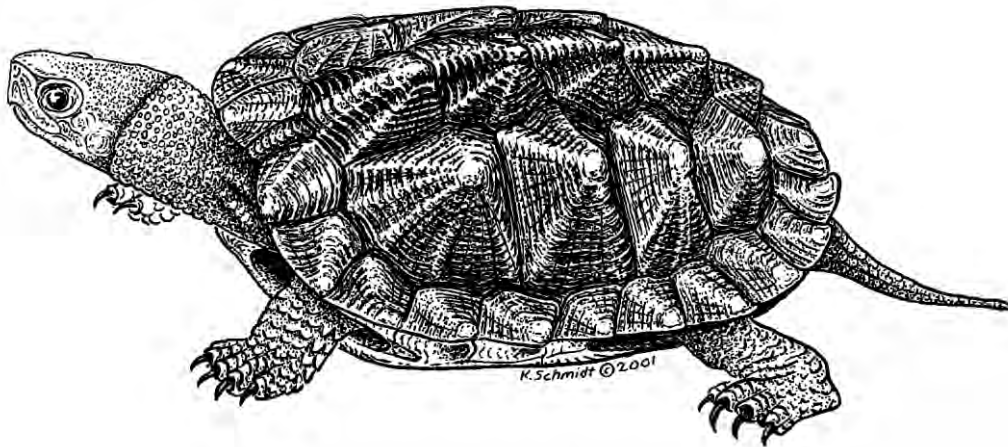
A channelized section of the Fall Kill.
E. Heffernan © 2018

Sensitivities/Impacts

Removal of trees or other shade-providing vegetation along a stream can lead to elevated water temperatures that adversely affect aquatic invertebrate and fish communities. Clearing of floodplain vegetation can reduce the important exchange of nutrients and organic materials between the stream and the floodplain. It can also diminish the floodplain's capacity for flood attenuation, leading to increased flooding downstream, scouring and bank erosion, and siltation of downstream reaches. Any alteration of flooding regimes, stream water volumes, runoff timing, and water quality can profoundly affect the habitat characteristics and species of streams and riparian zones. Hardening of the stream banks with concrete, riprap, gabions, or other materials reduces the biological and physical interactions between the stream and floodplain, and tends to degrade both stream and floodplain habitats. Channelized streams have higher velocities, which can be destructive during snow melt and rain events. Removal of snags and other woody debris from the streambed degrades habitat for fishes, turtles, snakes, birds, muskrats, and their food organisms. Stream corridors are prone to invasion by non-native weeds, including Japanese knotweed, an introduced plant that is spreading in the region (Talmage and Kiviat 2004). Stream burial, a common practice in developed areas, fragments the stream habitat, alters nutrient cycling and reduces drainage capacity (Beaulieu et al. 2015).

The habitat quality of a stream is affected not only by direct disturbance to the stream, its banks, or its floodplain, but also by land uses throughout the watershed. (A watershed is the entire land area that drains to a given water body.) Urbanization (including roads and residential, commercial, and industrial development) is linked to deterioration in stream water quality in the region (Parsons and Lovett 1993). Activities in the watershed that cause soil erosion, changes in surface water runoff, reduced groundwater infiltration, or contamination of surface water or groundwater are likely to affect stream habitats adversely. For example, impervious surfaces (roads, driveways, parking lots, and roofs) without well-designed stormwater management infrastructure tends to increase surface runoff, leading to erosion of stream banks and siltation of stream bottoms, and a consequent degradation of the habitat for invertebrates, fish, and other animals. Road runoff often carries contaminants such as petroleum hydrocarbons, heavy metals, road salt, sand, and silt into streams. Applications of fertilizers and pesticides to golf courses, lawns, and gardens in or near the riparian zone can

degrade the water quality and alter the biological communities of streams. The Fall Kill is known to have experienced bacterial contamination throughout its course, likely due to sewage leaks and illegal drainage (Bean et al. 2006). For these reasons, stream habitats in urban areas are highly stressed. Many of these problems are intractable, and restoration of intact stream banks and riparian zones is often impossible due to the built environment. However, there are areas along the Fall Kill where restoration of the streambank and riparian corridor may be possible. For example, the stone revetments along the Fall Kill banks, built in the 1930s, are beginning to deteriorate in places. Allowing these walls to crumble where adjacent structures are not endangered would help to restore opportunities for some of the ecological interactions between the stream channel, banks, and riparian zone (Kim et al. 2012). (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of streams and riparian corridors.)



Wood turtles use streams with pools for hiding and logs for basking.
Kathleen A. Schmidt © 2018

Hudson River Habitats

Rock riprap and native rocky shore

Ecological Attributes

This habitat type includes artificially-placed riprap along the Hudson River shore, and the rock ledges in and above the intertidal zone of the Hudson River. Rocky shores along the Hudson are subject to regular tidal inundation or wetting by wave splash and wind spray. These habitats also experience rapid heating and cooling, ice scouring in winter, and intermittent wind and wave disturbance. The plant community is usually sparse in the intertidal zone, but may be moderately dense in the splash zone above the high water mark. Rare plants of the upper intertidal zone of freshwater reaches of the Hudson River include estuary beggar-ticks,* heartleaf plantain,* and terrestrial starwort.* Eastern prickly-pear has been found on a rocky shore in Rockland County, and river birch* on a rocky peninsula in Dutchess County. The faunal diversity supported by this habitat is poorly known. Ledge- and rock-nesting birds such as eastern phoebe, mallard, and American black duck* may nest above mean high water. Trees within or above the rocky bank provide hunting perches for bald eagle and nesting sites for fish crow. Map turtle* may bask and nest on rocky shores and harbor seal* may haul-out on isolated segments (Kiviat and Hartwig 1994). Mollusks, including the introduced zebra mussel, are prominent inhabitants at some locations.

Occurrence in the City of Poughkeepsie

Rock riprap and native rocky shore made up 70% of the city's Hudson River shoreline. The rest was vertical bulkheads of concrete or concrete and timber (Figure 7a), concentrated along the southern part of the shoreline an industrial site and a possible development site. The only area of native rock was a sparsely vegetated ledge north of Kaal Rock Park.

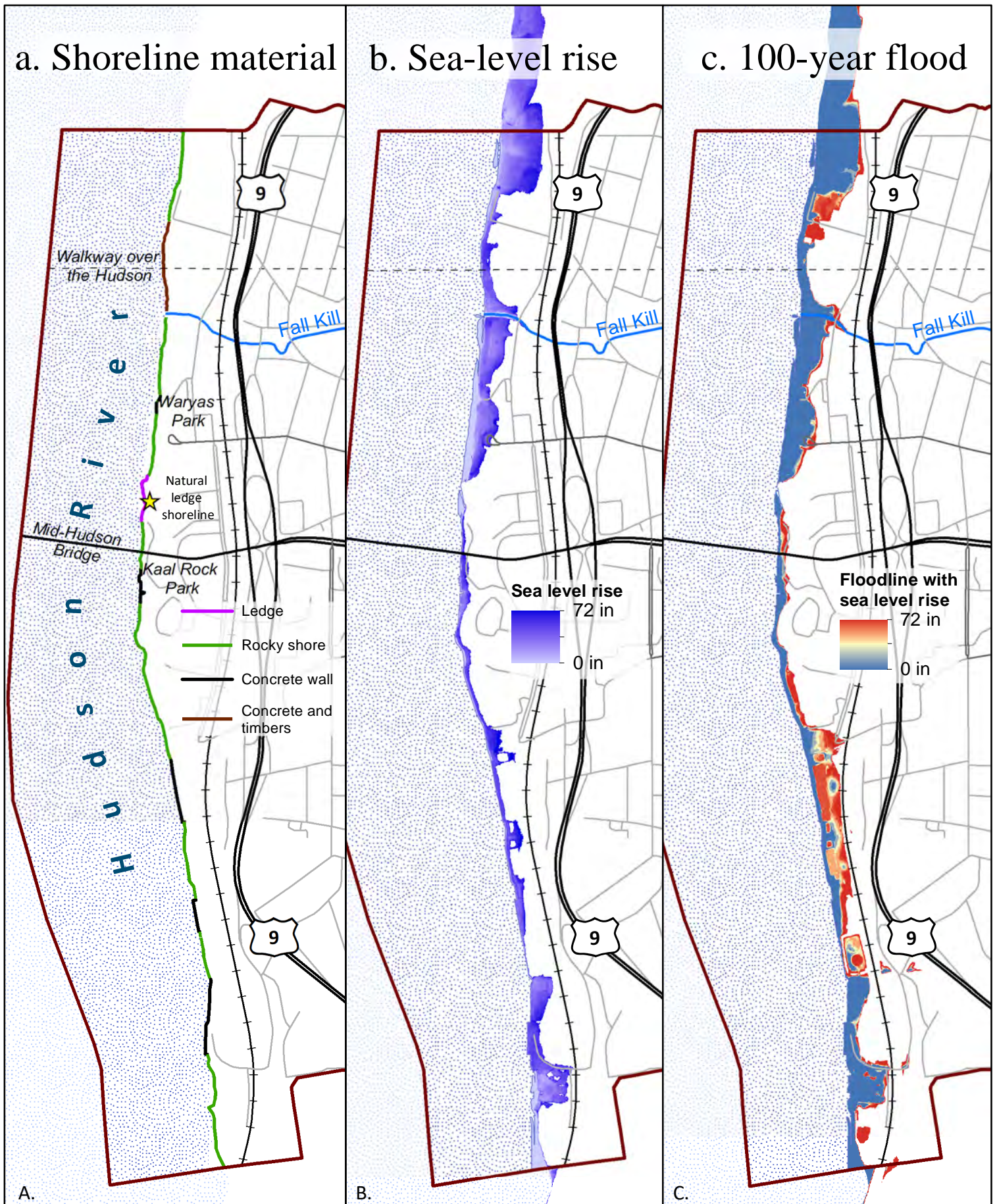
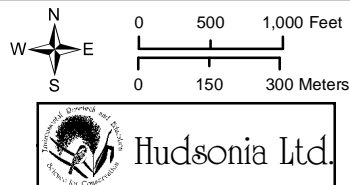


Figure 7. Shoreline material and models of sea level rise and floodlines through 2100 in the City of Poughkeepsie, Dutchess County, New York. "0 in" indicates present day sea levels and 100-year flood predictions.



Data Sources:
 Sea level rise and flood model data from Scenic Hudson 2013 (<https://www.scenic Hudson.org/slr/mapper>). Shoreline material from Hudsonia field observations and 2013 orthoimagery. For road and stream data sources, see Figure 1. Map created by Hudsonia Ltd., Annandale, NY.

Sensitivities/Impacts

Human uses such as mining, railroads, and urban development have displaced large areas of natural shoreline up and down the Hudson River, and replaced it with constructed bulkheads, railroad ballast, and riprap. The habitats of remaining natural rocky shores are vulnerable to erosion and compaction of the shallow soils, loss of soil and vegetation from trampling, and disturbance of sensitive wildlife. Colonization by aggressive, non-native plants may displace native species from these rocky habitats.



Riprap on Hudson River shoreline. E. Heffernan © 2018

Sea level is projected to rise along the tidal Hudson by 1–5 inches in the 2020s, 5–12 inches in the 2050s, and 8–23 inches in the 2080s. Based on conservative projections of sea level rise (assuming low worldwide carbon emissions), the Hudson River flood levels of the magnitude that currently has a 10% chance of occurring in any given year (i.e., the “10-year flood”) could be an annual flood event by the end of this century. The flood magnitude that may now have a 1% chance of occurring in any given year (the “100-year flood”) may have 4% chance of

occurring in any given year (a “25-year flood”) by the end of the century. Furthermore, by 2020, the flood heights of the 1% probability flood are projected to be 4-8 inches higher than today’s 1% flood, and 18-40 inches higher by 2100. These predictions are based on sea level rise projections alone, and do not take into account the increased frequency and severity of large storm events in this region. Also, if global carbon emissions are higher, and the melting of Greenland and Antarctic ice sheets continues to accelerate, then sea level rise could be as much as 37-55 inches by the 2080s, and the large floods could be considerably more frequent than outlined above (Horton et al. 2011).

Sea level rise threatens much of the developed areas along the Hudson River corridor. Scenic Hudson’s Sea Level Rise mapper (<http://scenichudson.org/slr/mapper>) predicts that much of the Poughkeepsie Landing is at risk of inundation with a relatively small sea level increase (Figure 7b), and that most or all of the low-lying shore would be inundated by a 100-year flood at the current mean higher-high water (Figure 7c) (Scenic Hudson 2013). As some of the areas in this zone (24.5 ac, 70%) are largely undeveloped or at least have no buildings, the city may have opportunities to develop a more sustainable shoreline corridor that could serve many cultural, educational, and ecological purposes. These areas could also provide a pedestrian connection between the northern and southern parts of the city. The Hudson River is one of the great cultural and scenic assets in the City of Poughkeepsie, and enhancing the quality of the shoreline would present a rare opportunity to foster the city’s place-based identity. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of rocky shores and tidal wetlands.)

Tidal tributary mouth

Ecological Attributes

The term “tidal tributary mouth” refers to the tidal reach of a Hudson River tributary stream. This habitat occurs no farther upstream than the first topographic contour line (10 ft [3 m] elevation) or the first dam, whichever is lower. This portion of the stream is strongly influenced by the mixing of non-tidal and tidal waters. The substrate and water chemistry of these habitats are often very different from those of the non-tidal reaches of the tributary or the Hudson River.

In winter there is often intense ice scouring of the stream bed and shoreline. The plant and animal communities of these habitats are composed of freshwater species able to tolerate tidal fluctuations as well as stream flooding. (The Hudson River is typically freshwater at the City of Poughkeepsie, but may become slightly brackish during droughts when reduced freshwater input from the watershed allows the salt front to extend farther upriver than usual.)

Tidal tributary mouths tend to be sites of concentrated biological activity. Macroinvertebrates may be abundant and diverse in these habitats, which also serve as spawning sites for fish, and foraging sites for birds including osprey* and American bittern.* Several rare or uncommon plants such as lizard's tail, estuary beggar-ticks,* smooth bur-marigold,* and goldenclub,* and at least one rare snail (*Pomatiopsis lapidaria*) have been found in freshwater tidal tributary mouths of the Hudson.



Tidal mouth of Fall Kill. E. Heffernan © 2018

Occurrence in the City of Poughkeepsie

The mouth of the Fall Kill is tidal for approximately 105 ft (32 m). The edges of the tributary mouth were planted with woody vegetation and developed for recreation in the Poughkeepsie Landing Park. A gravel bar that extends out into the river serves as a foraging site for wading birds. The tidal reach of the Fall Kill is relatively short due to the steep nature of the shoreline, and the habitat values may be diminished due to the intensively-developed adjacent area.

Sensitivities/Impacts

Noise, water pollution, and mechanical disturbance from boat traffic can cause extreme disturbance to the plant and animal communities of tidal tributary mouths. Foot traffic on tributary banks can damage vegetation and increase susceptibility to bank erosion. Poor water quality in the tributary stream reduces the habitat quality of the tidal stream mouth. Unlike many other Hudson River tributaries, the Fall Kill has no dams near its mouth, but has two natural falls within 1400 ft (425 m) of the head of tide that pose significant barriers to upstream fish migration (Schmidt and Cooper 1996). For most fish species the falls are insurmountable, but American eel* passes them in small numbers (Stalzer et al. 2016). (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of tidal wetlands.)

Subtidal shallows

The subtidal shallows is the zone between the mean low water (MLW) elevation and approximately 6.5 ft (2 m) below mean low water. This zone supports beds of submerged aquatic vegetation, which are well-known for their importance to water quality, fish, and waterfowl. Large areas of subtidal bottom are bare of vascular vegetation or nearly so. Such areas may have been denuded by storms or ice and not yet recolonized, or may be unsuitable due to unstable substrate, adverse materials (e.g., cinder or organic matter), pollution, chronic ice scouring or wave and current stress, or animal activities. The shallows are nearly always flooded, although spring low tides and other exceptionally low tides may expose extensive areas just below mean low water.

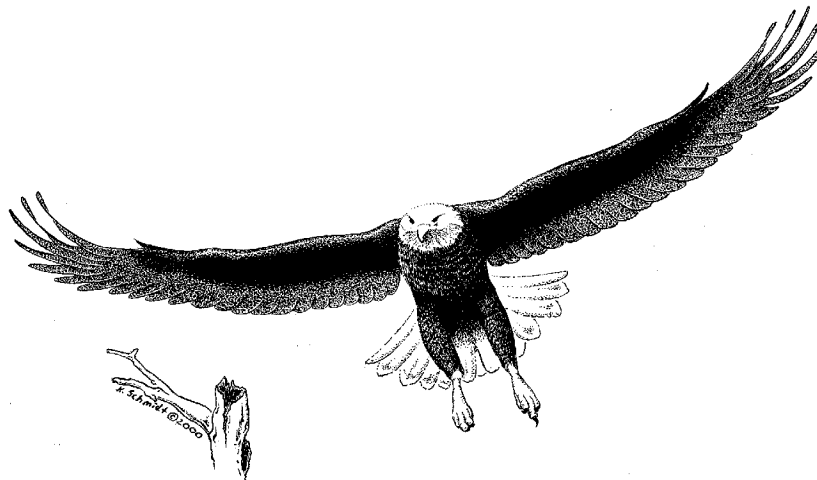
Many fish reside in or enter subtidal habitats either as adults or at immature stages. Turtles use subtidal areas more than other tidal habitats, and these areas are important feeding areas for waterfowl (ducks, geese, and swans) and several species of gulls. Double-crested cormorant, great blue heron, American coot, common gallinule, and a few other water birds also use this habitat. Hudson River water-nymph* is an aquatic plant of subtidal shallows, tidal marshes, and intertidal zone endemic to the Hudson River estuary. Bald eagle and osprey forage in the shallows, and American bittern and least bittern forage in the edges of shallows at low tide. Regionally-rare species include map turtle, and several poorly-known fishes such as the northern hog sucker.

Occurrence in the City of Poughkeepsie

We mapped three areas of subtidal shallows in the City of Poughkeepsie, covering 3.5 ac (1.4 ha). The largest area runs parallel to the Victor C. Waryas Park Promenade (1.5 [0.6 ha]), a mixed-use park and business area. The habitat quality of the subtidal shallows here and elsewhere may be diminished due to their proximity to intensive human uses.

Sensitivities/Impacts

Subtidal shallows are especially sensitive to impacts from motorized boats and accumulated pollution. The boat launch at Waryas Park poses a potential hazard to the stability of the vegetation and substrate of the shallows. Restricting the launching of motorized boats or zone of propeller use might help reduce disturbance to the shallows zone.



Bald eagles hunt and roost along the Hudson River. Kathleen A. Schmidt © 2018



Fall Kill running through downtown Poughkeepsie. E. Heffernan © 2018

CONSERVATION PRIORITIES AND PLANNING

Most local land use decisions in the Hudson Valley are made on a site-by-site basis, without the benefit of good ecological information about the site or the surrounding lands. The loss of biological resources from any single development site may seem trivial, but the cumulative effects of decision-making solely on a site-by-site basis have been far-reaching. Regional impacts have included the disappearance of certain habitats from whole segments of the landscape, the fragmentation and degradation of many other habitats, the local and regional extinction of species, the depletion of overall biodiversity, and the degradation of the human-environment connection.

The best approach to conserving habitats, biodiversity, and urban greenspaces is from the perspective of whole landscapes. The City of Poughkeepsie habitat map illustrates the location and configuration of significant habitats throughout the city. The map, together with the information in this report, can be applied directly to land use and conservation planning and decision-making at multiple scales. Below we outline recommendations for: 1) developing general strategies for land conservation; 2) using the map to identify priorities for city-wide conservation planning; and 3) using the map as a resource for reviewing site-specific land use proposals.

General guidelines for habitat conservation

We hope that the Poughkeepsie habitat map and this report will help landowners understand how their land fits into the larger ecological landscape, and will inspire them to voluntarily adopt habitat protection measures. We also hope that the city will engage in proactive land use and conservation planning to ensure that future development is planned with a view to long-term protection and restoration of important biological resources, and expanded public access to greenspaces .

Habitat Envelopes and Potential Corridors

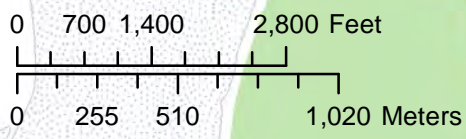
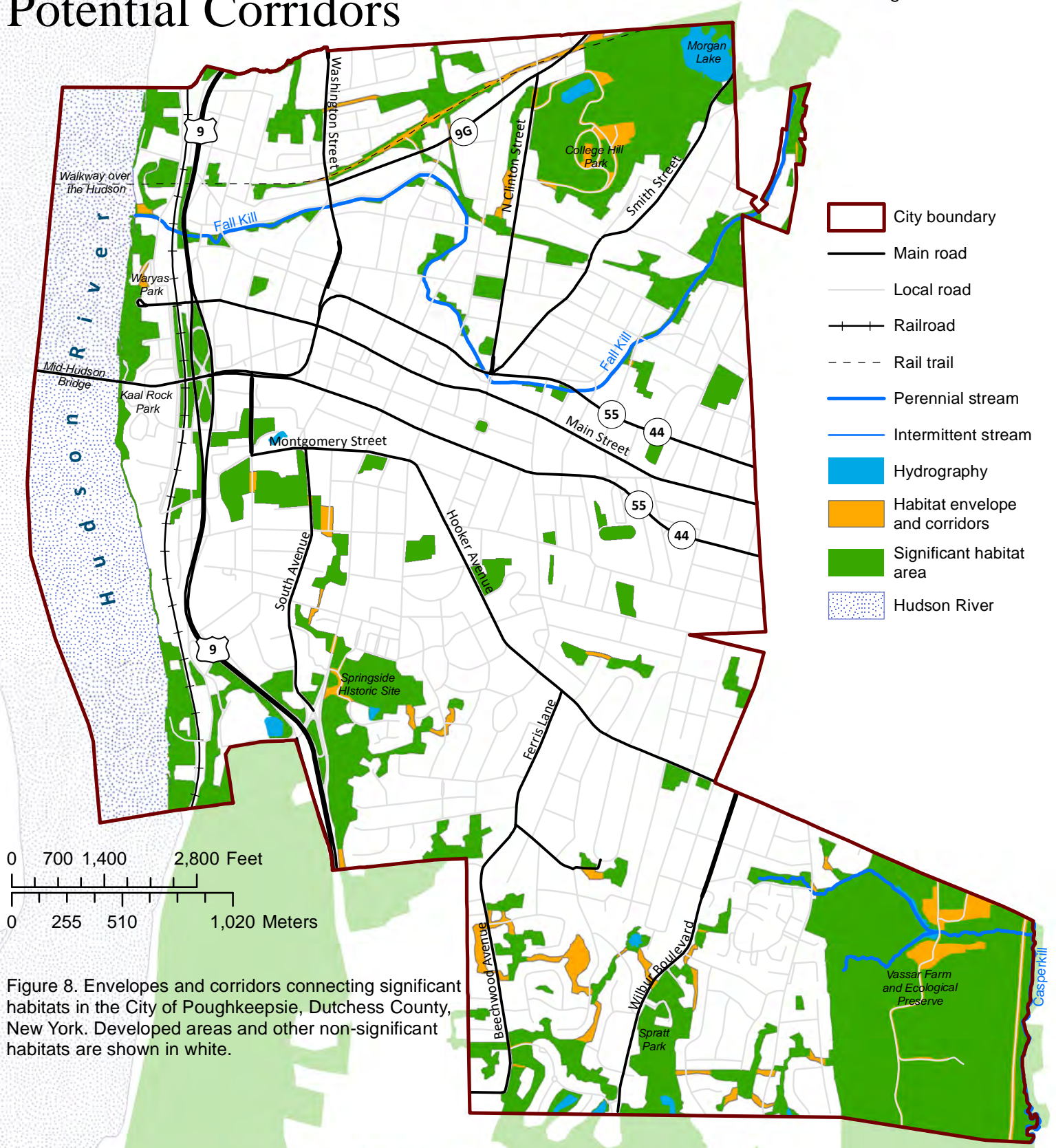


Figure 8. Envelopes and corridors connecting significant habitats in the City of Poughkeepsie, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white.

A variety of regulatory and non-regulatory means can be employed by a municipality to achieve its conservation goals, including volunteer conservation efforts by private landowners, master planning, zoning ordinances, tax incentives, land stewardship incentives, permit conditions, land acquisition, conservation easements, and public education. Section 4 of the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001) provides additional information about these and other conservation tools. Several publications from the Metropolitan Conservation Alliance, the Pace University Land Use Law Center, and the Environmental Law Institute describe some of the tools and techniques available to municipalities for conservation planning. For example, *Conservation Thresholds for Land-Use Planners* (Environmental Law Institute 2003) synthesizes information from the scientific literature to provide guidance to planners interested in establishing regulatory setbacks from sensitive habitats. The *Local Open Space Planning Guide* (NYSDEC and NYSDOS 2004) describes how to take advantage of laws, programs, technical assistance, and funding resources available to pursue open space conservation, and provides contact information for relevant organizations. *Revitalizing Hudson Riverfronts* (Eisenman et al. 2010) provides recommendations for communities along the Hudson River develop ecologically and culturally vibrant waterfront zones that are also resilient to sea level rise and other environmental change.

In addition to regulations and incentives designed to protect water resources, habitats, and other greenspaces, the city can also apply some general practices on a city-wide basis to foster biodiversity conservation. The examples listed below are adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001).

- **Protect large, contiguous, undeveloped tracts** wherever possible.
- **Protect high quality isolated habitat patches.** Relatively small, isolated habitats areas may function as refuges for uncommon plants and for animals that have small ranges or are well adapted to edge habitats and travel through developed areas. Such “islands” of habitat may protect certain plants or animals from predators, diseases, and other community processes that limit their ability to survive.
- **Plan landscapes with interconnected networks of undeveloped habitats;** preserve links and create new links between natural habitats on adjacent properties. Where possible, enhance the connective value of existing features such as streams and abandoned rail lines.



New construction along northern shore of Hudson River. E. Heffernan © 2018

- **Preserve natural disturbance processes** such as floods, seasonal drawdowns, and wind exposures wherever possible.
- **Restore and maintain broad buffer zones** of natural vegetation along streams, shores of water bodies and wetlands, and around the perimeters of other sensitive habitats.
- **Direct human uses toward the least sensitive areas and previously-disturbed areas**, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.
- **Encourage development of altered land instead of unaltered land.** Promote redevelopment of brownfields and previously altered sites, “infill” development, and re-use of existing structures wherever possible.
- **Encourage and provide incentives for developers to consider environmental concerns early in the planning process**, and to incorporate ecological conservation principles into their choice of development sites, their site design, and their construction practices.
- **Minimize areas of impervious surfaces** (roads, parking lots, sidewalks, paved driveways, roof surfaces), and maximize onsite runoff retention and infiltration to the soils, to help groundwater recharge, protect surface water quality, and moderate flood flows.

- **Along the riverfront, establish land uses that are resilient to flooding and expand public access to the Hudson River shoreline.** Examples are picnic areas, walking trails, outdoor event spaces, and other uses that require few or no permanent structures, pavement, or materials that could impede floodwaters or pose hazards if flooded.
- **Restore degraded habitats wherever possible.**
- **Modify the urban matrix to provide more habitat elements.** For example, tree-lined streets, wooded hedgerows, butterfly gardens, and rain gardens. Use public education and incentives to encourage private landowners to provide additional habitat in their yards.
- **Promote the establishment of conservation agreements** on parcels of greatest apparent ecological value.

City-wide Conservation Planning

The City of Poughkeepsie habitat map illustrates the locations and sizes of habitat units, the juxtaposition of habitats in the landscape, and the degree of connectivity between habitats, all of which have important implications for local and regional biodiversity and ecosystems. Although intact habitats were the focus of this study, biodiversity conservation efforts in an urban landscape must also consider the potential for enhancement of developed areas for supporting the well-being of human residents.

We provide general recommendations for improving habitat characteristics for native plants and wildlife. We include some measures for protecting and enhancing habitats that alone are too small to map at the city scale (e.g., individual trees, wooded hedgerows, or backyard forests), but can still be important for some native species and for the human community (Figure 8). We also address habitat corridors, with a focus on opportunities for enhancing existing connections of natural corridors in intensively developed landscapes, and creating new ones.

The city-wide habitat map and this report provide a landscape perspective that can help the city establish conservation goals and priorities. Taking a landscape approach to land use planning is much more likely to yield sound conservation decisions than the typical parcel-by-parcel approach. The map and report are practical tools that can help with selecting

areas for protection or restoration, and planning for new development where the ecological impacts will be minimized. The habitat map of the Town of Poughkeepsie, completed in 2008, can also be used for conservation planning across city-town boundaries.

Conservation Priorities in Poughkeepsie

Most of the land in the City of Poughkeepsie has been developed for residential, commercial, industrial, and transportation uses. Of the 3258 terrestrial acres in the city, 162 ac (5%) are in intensively managed parkland and recreation areas, and 496 ac (15.2%) are in undeveloped areas that are serving as ecologically significant habitat.

Urban greenspaces include small and large areas, ranging from street trees, green roofs, rain gardens, unpaved road verges, landscaped yards and gardens, community gardens, and parks. They can provide resident, temporary, and stepping-stone habitats for native plants and animals, but among their primary values are their services to the human populations of cities. Urban greenspaces offer well-documented physical benefits for people, including improved air quality, moderated air temperatures, mitigated wind speed, and reduced noise. The moderation of air temperatures can measurably reduce the costs of heating and cooling for residences and businesses.

Greenspaces invite increased physical activity, and their presence has been correlated with reduced stress, restored attention, and even reduced crime (Hladnik and Pirnat 2011, Jennings et al. 2012, Dinnie et al. 2013). Greenspaces benefit the social networks of their neighborhoods by increasing social encounters and a sense of community. They can provide space for recreation, social gatherings, community gardens, and environmental education. Greenspaces can contribute hugely to neighborhood beautification and foster a greater sense of well-being in people who live and work nearby. Greenspaces, both natural areas and intensively managed cultural areas, can be important to the development of place-based identity and social cohesion (Stedman 2002). Adaptive reuse and integration of non-public greenspaces can increase greenspace access in places of medium and high-density urban development. By increasing connectivity among disjunct cultural and natural spaces, the community identity can expand

from a neighborhood to a city-wide view. For the benefits of greenspace to be felt by current residents, however, it is important that as greenspace access improves, the city take steps to ensure that the potential increased property values do not displace current residents (Wolch et al 2014) (Figure 6).

Below we highlight some of the habitats and habitat areas that may be the most significant from an ecological standpoint.

For conservation planning in suburban or rural settings, we typically recommend consideration of a substantial “conservation zone” around important habitats, to help accommodate the physical exchange of energy, nutrients, and organic materials, and the needs of wildlife moving within and among habitats. But these zones have less relevance and fewer practical applications in the urban setting, where habitat areas are mostly surrounded by pavement and buildings, and stormwater flow is more dependent on artificial channels and piped systems than on local topography.

Still, wherever undeveloped land remains along streams or adjacent to other important habitat areas, it can serve as a valuable buffer from human activities, pollution, and other disturbances. Also, maintenance of unbuilt areas anywhere—vacant lots to closely manicured lawns to unmanaged forests—will allow infiltration of rainwater and snowmelt to the soils, and thus reduce the water volumes that must be managed by the constructed stormwater systems in the city.

Many of the “conservation zone” areas (Figure 9) that we would ordinarily recommend around priority habitats substantially overlap with intensively developed areas. We have mapped the recommended conservation zone fully aware that these zones will be impossible to carry out in a developed urban setting (for example, protecting forest areas around a wetland when there is no remaining forest). Nonetheless, we show and discuss the full extent of the conservation zones because some conservation recommendations can still be followed in developed areas, and some parts of these zones can be considered for habitat restoration or installation of other conservation features.

Conservation Zones

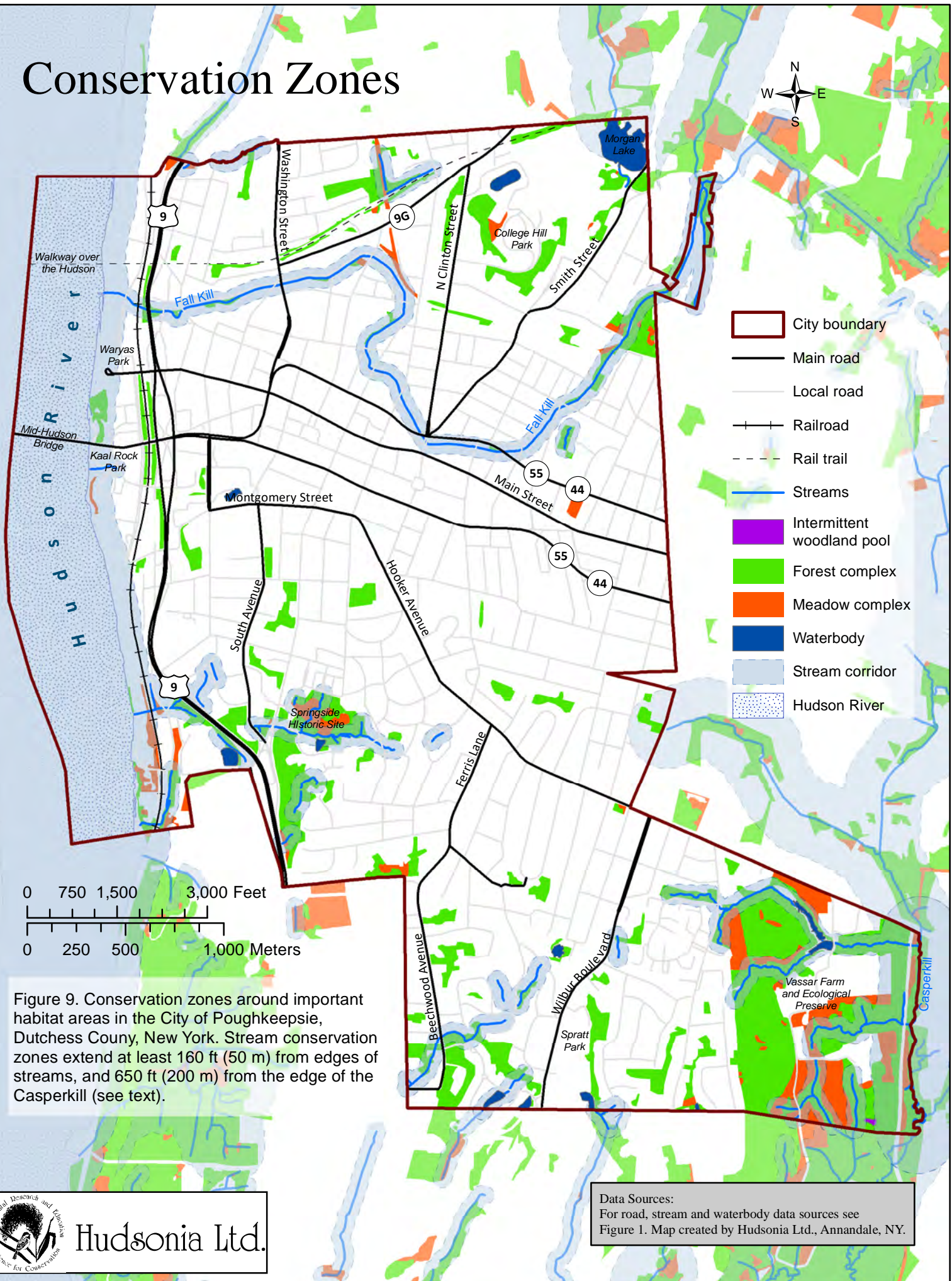


Figure 9. Conservation zones around important habitat areas in the City of Poughkeepsie, Dutchess County, New York. Stream conservation zones extend at least 160 ft (50 m) from edges of streams, and 650 ft (200 m) from the edge of the Casperkill (see text).

Large Habitat Areas

The City of Poughkeepsie still contains several large habitat patches that may have high value for wildlife. Figure 5 illustrates the locations of contiguous habitat patches in the city, and Figure 8 shows the areas that could function as corridors. The habitat map (Figure 4) does not show the full size of habitat patches that extend beyond Poughkeepsie's boundary, but that is an important consideration in understanding the habitat value of these areas. The habitat maps for the City and the Town of Poughkeepsie will enable city officials and private landowners to plan strategically across civil boundaries to ensure that large, contiguous habitat areas are conserved where possible.



The Hudson River is the largest contiguous habitat in the city. View from Upper Landing Park.
E. Heffernan © 2018

Table 2. Priority habitats and conservation zones in the City of Poughkeepsie.

Priority Habitat	Representative Species or Group of Concern	Priority Conservation Zone	Rationale	References
Large contiguous forest	Forest interior-breeding birds, spotted turtle	Unfragmented areas with a high percent of forest cover and/or wetland complexes	Maximizes the occurrence and breeding success of species.	Robbins et al. 1989, Kluza et al. 2000, Joyal et al. 2001
Large meadow	grassland-breeding birds	Unfragmented patches greater than 10 ac (4 ha)	Required for successful breeding and maintenance of viable populations.	Vickery et al. 1994
Intermittent woodland pool	pool-breeding amphibians	750 ft (230 m) from pool	Encompasses non-breeding season foraging and refuge habitats and dispersal routes between pools.	Madison 1997, Semlitsch 1998, Calhoun and Klemens 2002
Fall Kill and intermittent streams	aquatic communities of streams	160 ft (50 m) from stream edge	Provides streamside habitats, helps to reduce and filter surface runoff, provides shading vegetation, and provides organic material that supports the food web and habitat structure of the stream.	Multiple sources cited in Environmental Law Institute 2003
Casperkill	aquatic communities of streams and wood turtle	650 ft (200m) from stream edge	Encompasses most of the critical habitat including hibernacula, nesting areas, spring basking sites, foraging habitat, and overland travel corridors.	Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997
Hudson River shoreline zone	Hudson River freshwater tidal communities	400 ft (120 m) from mean high water	Accommodates storm surges, and allows for inland migration of tidal habitats in response to sea level rise.	Eisenman et al. 2010

Forests and Trees

In general, forested areas with the highest ecological conservation value include large forest tracts, mature and relatively undisturbed forests, and those with a lower proportion of edge to interior habitat. The urban setting, however, magnifies the values of street trees, wooded hedgerows, and small forest groves wherever they occur.

The scattered small forest patches in the city are unlikely to support wildlife species that are sensitive to “edge effects” or need to travel significant distances overland between habitats to meet their dispersal or life history needs. Instead these patches are likely to have wildlife species that are well-adapted to small habitat fragments and the numerous hazards of urban life; for example, American robin, gray squirrel, raccoon, striped skunk, and less mobile animals such as soil invertebrates, ants, and ground beetles. Small forest patches may also be used as resting sites for migrating birds and summer roosts for bats.

The values of small forest patches for wildlife habitat, carbon storage, and water management will be enhanced by maintaining undisturbed, uncompacted soils, and downwood and other organic debris on the forest floor, standing snags, and structural diversity. Trees along streets and in yards and hedgerows can moderate local air temperatures, reduce costs for heating and cooling of buildings, reduce noise, provide welcome shade for pedestrians, and add comfort and beauty to the urban landscape.

Meadows

Meadows of any size can provide important habitat for diverse grasses and forbs, pollinating insects and other invertebrates, foraging wild turkey and songbirds, as well as small mammals and their predators (coyote, fox, raptors). Large, contiguous patches of meadow (i.e., 10-100+ ac [0.4 – 40+ ha]) can be especially valuable for grassland breeding birds. In Poughkeepsie, the largest meadow complex (34 ac [14 ha]) was on the Vassar Farm and Ecological Preserve—a network of oldfields, shrubland and active agricultural land that is part of a larger meadow complex extending south into the Town of Poughkeepsie. These meadow areas are known to have nesting eastern meadowlark, and could support bobolink, vesper sparrow, and many other kinds of wildlife.

Many of the plants and animals of meadows are highly susceptible to harm from human activities such as mowing or applying pesticides. But meadows that are left unmanaged, or mowed only infrequently, tend to develop diverse biological communities.

Intermittent woodland pools

We identified and mapped four intermittent woodland pools in the City of Poughkeepsie (Figure 4), but only the one at the Vassar Farm and Ecological Preserve was part of a relatively large area of intact habitat, and is thus likely to support populations of pool-breeding amphibians (wood frog, Jefferson salamander, spotted salamander, marbled salamander) (Figure 9). Maintaining habitat connections between the pool, upland forests, and nearby pools outside the city boundary will support the seasonal and longer-term migrations of these amphibians.

The small forest patch surrounding the three other pools is probably insufficient for the non-breeding season habitat, so persistent populations of pool-breeding amphibians are unlikely. Those pools may nonetheless support some of the aquatic invertebrates characteristic of vernal pools, and provide habitat and water sources for other wildlife.

Streams and Riparian Corridors

The Fall Kill and Casperkill are the major perennial streams in Poughkeepsie (Figure 9). The city's network of smaller perennial and intermittent streams is also important, not only to the organisms that depend directly on the streams but also to the larger ecosystem, including the Hudson River.

Water quality in large streams depends in large part on the water quality and quantity of the small, intermittent streams that feed them, as well as the overland runoff, ditches, and storm drains, if any, that run directly into the streams. To protect water quality and habitat in intermittent streams, we recommend that undisturbed soils and vegetation on adjoining lands be protected to at least 160 ft (50 m) on each side of the stream wherever possible. Intact vegetation and soils in this zone helps to filter sediment, nutrients, and contaminants from

runoff, stabilizes stream banks, contributes organic material to the stream, regulates microclimates, and preserves other ecosystem processes (Saunders et al. 2002).

Much of the land bordering the Fall Kill in the city is intensively developed with buildings and pavements, and much of the overland runoff is captured by the stormwater system. But the 160-ft “conservation zone” can be used as a guide should opportunities arise to restore or protect streamside habitat areas. The Fall Kill and other streams throughout the city can be enhanced by simple actions such as planting trees, increasing nearby permeable surface cover, creating pocket parks, and ultimately developing streams to be aesthetic features of the neighborhoods they flow through.

The Casperkill runs through a less urbanized area just east of the Vassar Farm and Ecological Preserve, and has the potential to support wood turtles,* which use perennial streams for overwintering and at other times of the year, but also uses a variety of wetland and upland habitats during the warm months for basking, foraging, and nesting, sometimes moving long distances from the core stream habitat. To help protect the stream itself and the complex of nearby habitats that might be used by the turtles, we recommend considering a conservation zone of 650 ft (200 m) from the stream edge (Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997). Within that zone, the turtles can be adversely affected by stream alteration; removal of woody debris from stream beds; habitat fragmentation from culverts, bridges, roads, and other structures; the direct loss of wetland habitat; degraded water quality from siltation, pesticides, fertilizers, sewage, and toxic compounds; increased nest predation by human-subsidized predators; disturbance from human recreational activities; and road mortality of nesting females and other individuals migrating between habitats.

Hudson River Shoreline Zone

The “shoreline zone” in the City of Poughkeepsie includes the tidal shallows, the tidal tributary mouth of the Fall Kill, the rock riprap and native rocky shore, and the near-shore upland zone that is now or may soon be subject to tidal flooding and storm surges. Figure 7c shows the areas that are within the 100-year flood zone as currently mapped by FEMA (darkest blue areas

in the third panel), and the predicted inland advance of that zone through the end of this century (Scenic Hudson 2013). Even at present-day sea levels, at least 26.3 ac (10.6 ha) above the sea wall are within the 100-year flood zone. This area includes 10.4 ac (4.2 ha) of land with buildings and pavement, 9.2 ac (3.7 ha) of unpaved “waste ground,” and 6.7 ac (2.7 ha) of parkland and other greenspace. Of the 10.4 acres of paved, developed land within the current 100-year flood zone, new construction has begun for residential development. Notably, the 100-year flood zone was developed to represent the area that stands a 1% chance of being flooded in any given year, but can be more realistically interpreted as the area likely to flood in a major event. Increased precipitation intensity and volumes in storms have increased flood frequency and severity (Horton et al. 2011). The undeveloped waste ground areas present opportunities for restoring greenspaces that will accommodate future flooding.

Riprap has some potential habitat value for native plants and animals to the extent that it mimics some of the habitat characteristics of a natural rocky shore. Strayer et al. (2016) found that vegetation on rock riprap along the freshwater tidal reach of the Hudson River was diverse, included equal numbers of native and non-native species, and varied from sparse to dense. The reasons for the vegetation variability were not entirely explained by the factors measured in the study, but cover and composition were correlated with the age of the revetment, the size and roughness of rocks, and the degree of exposure to forces such as waves, currents, and ice. Strayer et al. suggest that denser and more diverse vegetation could be encouraged by designing riprap revetments with gentle slopes and finer material between the rocks, or perhaps adding coir mats to provide additional substrate. Plantings of desirable vegetation (and removing undesirables) could also help to hasten the development of a robust plant community.

The habitat values of the subtidal shallows and the tidal tributary mouth are immense for fish, waterfowl, and other wildlife. Minimizing disturbance to these areas from boat traffic will reduce pollution and encourage use by wildlife, and could increase bird watching along the river front.

Cultural Habitat Areas

The City of Poughkeepsie has many trail systems, parks, and athletic fields. The Walkway over the Hudson, a nationally-known pedestrian walkway, connects the Dutchess County Rail Trail to the Hudson Valley Rail Trail in Ulster County. The Walkway also connects northern Poughkeepsie to the Hudson River shoreline and Poughkeepsie Landing Park. A public-access waterfront trail planned for the One Dutchess development project will be connected to the Walkway and Waryas Park, and could ultimately connect northward to trails at Marist College and Quiet Cover Park in the Town of Poughkeepsie. Of the four trail systems within city limits (Dutchess County Rail Trail, Springside, Vassar Farm and Ecological Preserve, College Hill Park), all are independent and could benefit from connections between and among other areas.

Many parks in the city are smaller than 4 ac (1.6 ha), and the larger parks and open spaces are located on the periphery of the city (College Hill Park, Spratt Park, Poughkeepsie Landing, Springside, the Vassar Farm and Ecological Preserve), leaving the center of the city with smaller, pocket parks that are largely isolated from other greenspaces. Within many of these parks are intensively managed athletic fields; there are five public-access parks with athletic fields, and another three held by city schools and Vassar College. There are also two golf courses that are partially or entirely within the City of Poughkeepsie, at College Hill Park and at Spratt Park.



Rail trail in Poughkeepsie. E. Heffernan © 2018

Recommendations

Protecting and Restoring Habitats

We recommend that the remaining large blocks of habitat within the City of Poughkeepsie be considered priority areas for conservation, and that efforts be taken to fully protect these places wherever possible; these include 1) the area along the Fall Kill near the transfer station, Springside, and the Vassar Farm and Ecological Preserve. If new development in these areas cannot be avoided, it should be concentrated near the edges and near existing roads and other development so that as much habitat area as possible is preserved without fragmentation.

Some general guidelines for conservation of large habitat areas include the following:

- **Protect large, contiguous habitat areas** wherever possible, and avoid development in their interiors.
- **Maintain or restore habitat connections between large habitat areas.** This goal can sometimes be accomplished by protecting smaller forest patches that provide “stepping stone” connections between larger forest patches, or fitting roads with wildlife crossing structures (such as culverts or underpasses).
- **Maintain intact upland habitat connections between wetlands within wetland complexes.** These areas allow wildlife to move safely between wetland areas, and provide habitat for organisms with both wetland and upland requirements.

Forests

- **Protect patches of forest types that are less common in the city regardless of their size.** These patches include mature forests, natural conifer stands, forests with an unusual tree species composition, or forests that have other habitats (such as woodland pools) embedded in them.
- **Maintain the forest canopy and understory vegetation intact wherever possible.**
- **Maintain standing dead wood, downed wood, and organic debris, and prevent disturbance or compaction of the forest floor.**
- **Avoid leaving pitfall hazards** (such as soil test pits) that can unintentionally trap wildlife.

Meadows

For large meadows, where landowners have flexibility in their mowing and grazing practices, the following measures can reduce harm to nests and nestlings of grassland breeding birds. (In the City of Poughkeepsie, only the large meadows at Vassar Farm have potential to support these birds.)

- **Mowing after August 1** helps to ensure fledging of nestling birds; if mowing must occur before then, leave some unmowed strips or patches. Mowing even later (September or October) will allow fledging of second nests or of late-nesting birds.
- **Raising mower blades to six inches or more, using flushing bars, and avoiding night mowing** when birds are roosting all help to reduce bird mortality.

Other recommendations for meadow management for grassland birds are at

https://www.massaudubon.org/content/download/19413/274073/file/Best-Management-Practices_Grasslands_2017_web.pdf



Meadow management at Vassar Farm and Ecological Preserve; meadows are mowed in late fall. E. Heffernan © 2018

In meadows of all sizes, to preserve nectar and pollen sources for butterflies, moths, wasps, and bees, postpone mowing until late October or November; late-season flowers such as goldenrods and asters can be especially important for late-flying insects when many other flowering plants have gone to seed. If mowing must occur before then, leave some substantial unmowed strips within and at the edges of meadows.

Intermittent woodland pools

To help protect pool-breeding amphibians and the habitat complexes they require, we recommend the following measures for the pool at Vassar Farm (adapted from Calhoun and Klemens 2002) extending 750 ft (230 m) into the critical terrestrial habitat zone:

- **Avoid locating roads, pitfall hazards, and other travel obstructions or hazards** within the 750-ft zone. Pool-breeding salamanders and frogs are especially susceptible to mortality from vehicles, logging equipment, and pitfalls. Vehicle ruts and other artificial depressions that briefly hold water can act as “decoy habitats” that attract large numbers of pool-breeding amphibians, but the eggs laid in them rarely survive due to the short hydroperiod or the high sediment or pollutant loads.
- **Minimize use of heavy equipment** within the 750-ft zone of the surrounding forest, especially during the peak amphibian movement periods of spring and early summer. If equipment use during this period cannot be avoided, install temporary exclusion fencing to keep amphibians out of the active equipment-use areas.
- **Minimize soil compaction** within the 750-ft zone. Soil compaction from use of heavy equipment can destroy the habitat for invertebrates that pool-breeding amphibians rely on for food, and the small burrows and other forest floor microhabitats that they need for shelter.

Streams and Riparian Corridors

To help protect instream and riparian habitats that are used by numerous stream-associated wildlife species, we recommend the following measures:

- **Minimize impacts from new and existing stream crossings and roads.** Undersized bridges and undersized or suspended culverts may be undermined or washed out by large storms, and may constitute significant barriers to the upstream and downstream movement of aquatic organisms. If a poorly-designed or poorly-installed culvert completely blocks the passage of stream organisms, individuals can be cut off from habitats important to their life history needs. If new stream crossings must be constructed, we recommend that they be specifically designed and installed to accommodate large anticipated storm events and the passage of stream organisms. The

following prescriptions can improve the connectivity of stream corridors (adapted from Singler and Graber 2005):

- Use bridges and open-bottomed arches instead of culverts, wherever possible.
- Use structures that span at least 1.2 times the full width of the stream so that one or both banks remain in a semi-natural state beneath the structure. This may promote the overland passage of turtles and other wildlife.
- Design the structure to be at least 4 ft (1.2 m) high and have an openness ratio of at least 0.5 (openness ratio = the cross-sectional area of the structure divided by its length). Higher openness ratio values mean that more light is able to penetrate into the interior of the crossing. Brighter conditions beneath a crossing may be more favorable for the passage of animals.
- Install the crossing in a manner that does not disturb the natural substrate of the stream. If the substrate must be disturbed, re-construct the substrate of natural materials and match the texture and composition of upstream and downstream substrates.
- If the stream bed must be disturbed during construction, design the final elevation and gradient of the structure bottom so as to maintain water depth and velocities at low flow that are comparable to those found in natural stream segments just upstream and downstream of the structure. Sharp drops in elevation at the inlet or outlet of the structure can be a physical barrier to aquatic animals.



Fall Kill less channelized with natural, rocky streambank. Walls remain and channelize high flows and limit animal access. E. Heffernan © 2018

- **Daylight streams** when opportunities arise. Daylighting increases stream health and improves nutrient processing and stream biodiversity (Neale and Moffet 2016).
- **Soften streambanks** wherever possible by removing rock or concrete walls (or allowing them to deteriorate) in places where the flooding stream will not threaten other infrastructure.
- **Plant streamside trees and shrubs** in open areas to create shade for the stream and habitat for riparian wildlife.
- **Create pocket parks and other streamside greenspaces** to add visual and recreational amenities to the urban landscape.
- **Use porous pavement and add rain gardens** and other vegetated catchment basins where practical within the riparian zone, to improve water infiltration to the soils, reduce surface runoff, and reduce contaminant, sediment, and thermal pollution of the stream.

Enhancement of Developed Areas

The wildlife of urban and suburban landscapes are mostly common species (e.g., pigeon, European starling, gray squirrel, raccoon) that are adapted to human-occupied environments, but less common species may also inhabit or travel through if nearby habitats are suitable. Bats and certain species of birds (including eastern screech owl, barn owl, and Cooper's hawk) will take advantage of individual trees, small groves, and structures in developed areas. Peregrine falcons (NYS Endangered) have been nesting on the Mid-Hudson Bridge and foraging in the City and Town of Poughkeepsie since 1996 (DeOrsey and Butler 2005), and Indiana bat* (NYS Endangered) and other bats might use trees in Poughkeepsie for maternity colonies and summer roosts (Zangla 2007).

There are many practices applicable to the city that would assist in the protection of species of conservation concern. Within the developed matrix, some small areas may serve as buffers to intact habitats, some may provide travel corridors for wildlife, and some may themselves provide habitat for certain species. Hudsonia did not map these small areas or isolated habitat features (such as individual trees, forested hedgerows, and backyard forests) as habitats in their own right due the mapping protocols at a city-wide scale (see Appendix A). We did, however, identify envelopes and corridors representing possible habitat connections through backyards and small greenspaces (Figure 8). The city-wide habitat map can help to focus habitat

enhancements on locations where they will achieve the greatest returns for biodiversity conservation.

Following are some examples of conservation measures for developed areas (adapted in part from Adams and Dove 1989, and Adams 1994). There are many additional ways in which urban areas can be modified to reduce their negative environmental impacts and contribute positively to the natural environment (Beatley 2000). The costs of implementing these measures and their effectiveness at particular locations will vary. While some must be implemented by the city or other government entities, others can be practiced voluntarily by private landowners. The city can take a leading role in educating the general public about such actions and encouraging landowner participation.

Enhancing Habitat Characteristics

- **Preserve trees of a variety of species and age classes.** Trees are an important component of the habitat of many wildlife species, and some species of plants and animals can use wooded hedgerows as habitat corridors. Trees also provide services such as moderating local air temperatures, reducing wind velocities, controlling erosion, abating noise, and storing carbon.
 - Plant a variety of native tree species along streets and in hedgerows and yards, and reduce the use of salt on roads to minimize damage to the trees.
 - Allow natural regeneration of native trees where possible, to provide replacements for older trees and those that must be removed for safety reasons.
 - Allow dead trees (snags) to remain standing and fallen trees to decay in place where safety concerns allow. Standing snags provide good habitat for animals such as insects, woodpeckers, and bats; and downed wood provides both habitat and a source of nutrients for plants.
 - Preserve large trees wherever possible, and especially those with exfoliating bark that might serve as summer roost sites for bats.
- **Replace lawn areas with multi-layered landscapes.** Manicured lawns have little value for native biodiversity and lawn maintenance requires higher inputs of water and chemicals than other types of horticultural landscaping, such as wildflower meadows, perennial gardens, or ornamental woodlands. Lawns are commonly maintained with motorized lawn mowers and leaf blowers, which contribute to air and noise pollution. While the choice to maintain lawns in residential areas is often one of personal taste or safety, public education and landowner incentives can promote landscaping that

provides greater ecological services and higher quality resources for wildlife while reducing pollution in developed areas.

- **Design and manage constructed ponds (such as ornamental ponds and stormwater control ponds) for wildlife.**
 - Include irregular shorelines, gently sloped shores, and the capability to control water levels in the design of new ponds.
 - Encourage a combination of emergent vegetation and open water (i.e., interspersed shallow and deep areas).
 - Avoid the use of pesticides in ponds, and pesticides and fertilizers on the land that drains to ponds.
 - Maintain shoreline vegetation; do not mow to the pond edge.
 - Allow spontaneous recruitment of native aquatic animals instead of stocking with non-native fish.
- **Restore broad vegetated buffer zones along streams and tidal areas wherever possible.** Vegetated shorelines and floodplains serve to control erosion, moderate downstream flooding, protect water quality, provide wildlife habitat, and enhance the habitat quality of the stream or pond. They also allow for natural movements of the stream channel over time, which improves the stream's capacity to dissipate the energy of water flow. Sea level rise and increasing frequency of extreme storm events magnifies the importance of an accommodating zone along the Hudson River and the tidal portion of the Fall Kill.
- **Maximize onsite infiltration of rainwater and snowmelt.** Impervious surfaces such as pavement and roofs alter hydrological patterns by preventing precipitation from infiltrating the soil, instead promoting rapid overland flow to ditches, streams, and ponds. This prevents the recharge of groundwater and filtration of pollutants by soil and vegetation, while increasing the likelihood of flooding, stream bank erosion, and surface water pollution (including sedimentation).
 - Encourage the use of permeable materials for driveways and parking lots in residential and commercial construction and renovation.
 - Construct stormwater retention ponds, wetlands, and rain gardens that allow infiltration of surface water to groundwater.
 - Follow stormwater Best Management Practices (BMP's) in areas of new construction. Examples of BMP's include preserving natural vegetation and installing and maintaining soil retention structures, check dams, sediment traps, and silt fences.
 - Encourage the collection of rainwater for use on gardens and lawns.

Minimizing Disturbance to Resident and Migratory Biota

- **Minimize the impacts of roads on wildlife.** One of the greatest, immediate threats to wildlife in urban and suburban areas is road mortality. A study to identify the roadways with the highest incidence of such mortality and the species most commonly crossing roads in the city could be used to direct the following measures to the places where they will be most effective.
 - Reduce speed limits and post wildlife crossing signs along roads in areas where wildlife are known to cross.
 - Encourage alternative modes of transportation, such as biking, to reduce speeds and reduce pollution.
 - Install structures for safe wildlife crossing, such as culverts, overpasses, underpasses, and modified roadside curbs. The USDA wildlife crossing toolkit is an online source of information on such structures (<https://www.fs.fed.us/wildlifecrossings/>).
 - Modify the immediate roadside areas to promote safer wildlife crossings. Factors to be considered include the location of barriers such as guardrails, and roadside vegetation (type and distance to the road's edge) (Barnum 2003, Clevenger et al 2003).
- **Minimize noise and light pollution.** High levels of noise and light in cities can be a deterrent to many kinds of wildlife. While noise and light are inevitable in urban environments, certain sources can be minimized. Below are examples of actions that can be implemented and/or enforced as local or city-wide light and noise ordinances.
 - Require that outdoor lights be directed downward (rather than outward or upward) to minimize the light pollution to offsite and overhead areas.
 - Require that lights in tall business buildings be turned off or dimmed in the evenings to minimize the disorienting effect that these lights can have on migrating birds.
 - Encourage the use of light technologies (such as low-pressure sodium lights) that minimize the attraction of flying insects, and prohibit the use of “bug-zappers.”
- **Discourage human-subsidized predators and wildlife feeding.** Human-subsidized predators are species such as raccoon, opossum, striped skunk, and outdoor or feral cats, which thrive due to conditions created by humans. Human interference (such as feeding) with the habits and diets of wild animals not only impacts population dynamics, but can lead to nuisance behavior.
 - Do not intentionally feed wildlife.
 - Properly secure outdoor trash receptacles and compost bins.

- **Include biodiversity considerations in development planning.**
 - Plan for lower-disturbance human activities and developments adjacent to intact habitats.
 - Consider wildlife travel routes in placement of new developments and buildings.
- **Encourage building designs that reduce bird collisions and mortality.**

Collision with glass is responsible for more bird deaths than any other known cause in the US. The American Bird Conservancy provides recommendations for façade materials that deter bird collisions, structural designs that reduce the chances of trapping birds, shielding and direction of outside lighting, design and management of indoor lighting, and landscaping to keep birds away from dangerous parts of a building (Sheppard 2011).



View south from the Walkway Over the Hudson to the Poughkeepsie shoreline.
E. Heffernan © 2018

Important considerations

The benefits of habitat conservation and urban greenspaces are mentioned above, but a paradox of urban greenspace should be addressed in urban planning. Access to greenspace is increasingly understood as an environmental justice issue, expanding the notion beyond direct health disadvantages, such as living downstream of a pollution source, to indirect health benefits, such as increased physical activity when living near a park (Jennings et al 2012). The paradox is that as neighborhoods have better access to high quality greenspaces (Figure 6), the properties are considered more desirable and property values increase (Wolch et al. 2014). While this benefits the city in some ways, the residents of these neighborhoods are often pushed out as their rents and property taxes rise beyond their economic means. The result is that the people who would most benefit from the greenspace, and for whom the greenspace was improved, are displaced and wealthier people move into the now more attractive neighborhood (Wolch et al 2014).

New York City has examples of both rampant gentrification from greening (e.g., the High Line), but also of neighborhoods that avoided the urban greenspace paradox by integrating grass-roots community activism with anti-gentrification strategies (Pearshall 2010, Curran and Hamilton 2012). Programs that encourage affordable housing, rent stabilization and home ownership incentives enable residents to stay in their neighborhood after environmental conditions have improved (Wolch et al 2014). However, communities and city planners must work together to avoid the paradox and design a strategy that works best for the city.



Example of mix-use of Hudson River shoreline: utility space, habitat space and public access space (foreground to background). E. Heffernan © 2018

Reviewing Site-specific Land Use Proposals

In addition to city-wide land use and conservation planning, the habitat map and report can provide ecological information about proposed development sites and the surrounding areas that might be affected by new land uses. We recommend that landowners, developers, and city agencies reviewing new land use proposals take the following steps to evaluate and mitigate the impact of the proposed land use change on habitats and water resources that may be present on and around the site:

1. **Consult the large format habitat map** and Figure 4 to see if the site in question is part of a large, contiguous block of habitat or a habitat connection, and which ecologically significant habitats, if any, are located on and near the site.
2. **Read the profiles of those habitats in this report.**
3. **Check to see if any of the habitats in the area of the proposal are described in the “Priority Habitats” section of this report**, either individually or as part of a habitat complex, and note the conservation issues and recommendations for each.
4. **Consider whether the proposed development project can be designed or modified to ensure that the habitats of greatest ecological concern, as well as the ecological connections between them, are maintained intact.** Examples of design modifications include but are not limited to:
 - Locating human activity areas as far as possible from the most sensitive areas.
 - Minimizing intrusions into large, contiguous habitat areas.
 - Minimizing intrusions into forested areas that are within 750 ft (230 m) of an intermittent woodland pool.
 - Channeling stormwater runoff from roofs, paved areas, or fertilized turf into detention basins or “rain gardens” instead of directly into ditches, streams, ponds, or wetlands; installing and maintaining oil-water separators where runoff leaves paved areas.
 - Minimizing the clearing of vegetation during construction, and restoring cleared areas with native plantings instead of lawn, wherever possible.

Because the habitat map has not been 100% field checked we emphasize that, at the site-specific scale, it should be used strictly as a general guide for land use planning and decision making. Onsite observations by professional biologists should be an integral part of the review process for any significant land use change in or near existing habitat areas.

CONCLUSION

The City of Poughkeepsie is an intensively developed urban landscape but still has areas of ecologically significant habitats, including some such as intermittent woodland pool, hardwood swamp, upland hardwood forest, exposed ledge, and tidal rocky shore, that may support rare, uncommon, or vulnerable plants and animals. Habitat areas at Vassar Farm and Ecological Preserve, Springside Historic Site, and the Fall Kill tidal mouth may be especially important to local and regional biodiversity. Backyard forest groves, wooded hedgerows, and street trees provide additional resident and stepping-stone habitats for plants and wildlife, provide ecological services that improve the urban environment, and help to maintain human connections to the natural world. The city's many areas of intensively managed parks and athletic fields ("cultural habitats") contribute much to the livability of the city. Adding street trees, streamside greenspaces, and pocket parks, especially in parts of the city where greenspaces are scarce, would further improve the natural and human environments of the cityscape.

The city boasts many natural features and has the potential to entwine natural and anthropogenic features together to increase the health of both. For example, the Vassar Farm and Ecological Preserve has the largest extent of uninterrupted habitat in the city, providing both people and wildlife refuge from the demands of city life. On the opposite end, the Fall Kill traverses the city, connecting people on the eastern side of the city back to the Hudson River. In between these features, backyard forests and pocket parks weave together both the anthropogenic and natural features of the city. However, the next step is to increase, enhance and manage these features to promote the health of the whole ecosystem, both natural and anthropogenic.

Twenty-nine percent of the Hudson River shoreline in the city has been hardened by vertical concrete or concrete-and-timber bulkheads, and much of the adjacent shore zone by pavement and buildings. This kind of shoreline restricts the development of tidal shallows and tidal wetlands, creates a barrier to wildlife movements between river and land, and inhibits the natural inland migration of tidal habitats with sea level rise. Sixty-six percent of the shoreline is

of rock riprap which can provide some habitat value for plants and animals, depending on the slope and character of the rock fill. The remaining 522 feet (159 meters) of the shore is a steep ledge.

A zone of approximately 440 ft (134 m) width along the shoreline is within the 100-year flood zone designated by the Federal Emergency Management Agency. This means that the zone has a predicted 1% chance of being flooded in any given year, and a 26% chance of being flooded at least once over a thirty-year period. Because storms are predicted to continue increasing in severity and frequency over the coming decades, the chance of flooding and width of the flood zone may be even greater.

Approximately 44% of this flood-prone area is occupied by parks and other greenspaces that could accommodate flooding without incurring much damage to infrastructure, and without impeding flood flows except by the sea wall itself. Approximately 30% of this area is pavement and buildings, some of which could be damaged by flooding. And, approximately 26% is unpaved and substantially unvegetated land above the seawall that could be vulnerable to severe erosion. Fortunately, there are also two parks along the river that provide both permeable infrastructure in case of flood and recreation venues along the riverfront.

The habitat map provides a bird's-eye view of the landscape, illustrating the location and extent of existing habitat areas and their spatial relationships to each other. The habitat information can foster a better understanding the significant biological resources in the city, help the city plan for improving and expanding greenspaces to enhance the quality of life for Poughkeepsie residents and workers, and help local decision-makers focus limited resources for restoration and conservation where they will have the greatest impact.

We hope that the habitat map and this report will help landowners, developers, and city agencies consider the quality, character, and distribution of greenspaces throughout the city, and design effective measures to protect, restore, and expand the resources of greatest importance.

At the site-specific scale, we hope the map can be used as a resource for routine deliberations over development proposals and other proposed land use changes. The map and report provide an independent body of information for environmental reviews, and will help raise questions about important biological resources that might otherwise be overlooked. We strongly emphasize, however, that the map has not been exhaustively field checked and should therefore be used only as a source of general information. In an area proposed for development, for example, the habitat map can provide basic ecological information about the site and the surrounding lands, but the map should not be considered a substitute for site visits by qualified professionals. During site visits, the presence and boundaries of important habitats should be verified, changes that have occurred since our mapping should be ascertained, and the site should be assessed for additional ecological values. Detailed, up-to-date ecological information is essential to making informed decisions about specific development proposals. Because the natural landscape and patterns of human land use are dynamic, the city should consider refining and/or updating the habitat map over time.

Conservation of habitats is one of the best ways to protect biological resources and, in an urban setting, conservation and expansion of greenspaces is especially important to the well-being of residents and workers. We hope that the information contained in the habitat map and in this report will help the City of Poughkeepsie plan wisely for future development and take steps to protect natural resources. Incorporating this approach into planning and decision-making will help to integrate the needs of the human community with those of the natural communities, and protect the ecological patterns and processes that support the people of Poughkeepsie and the local ecosystems.



Tidal mouth of the Fall Kill viewed from Upper Landing Park.
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APPENDICES

A. Mapping Conventions

Mapping conventions used to draw boundaries between habitat types, and additional information on defining habitat types.

Crest and ledge. Because crest and ledge habitats constitute small areas in Poughkeepsie and are usually embedded within other habitat types (most commonly upland forest), they were depicted as a point location (a star) over other habitats. These habitats do not have distinct signatures on aerial photographs and were therefore mapped mostly based on field observations. The final overlay of crest and ledge habitats is therefore an approximation; we expect that there are additional bedrock exposures outside the mapped areas. The precise locations and boundaries of these habitats should be determined in the field as needed.

Cultural. We define cultural habitats as areas that are significantly altered and intensively managed (e.g., mowed), but are not otherwise developed with wide pavement or structures. These include golf courses, playing fields, cemeteries, and large lawns. On aerial photos it was sometimes difficult to distinguish extensive lawns from less intensively managed upland meadows, so in the absence of field verification some lawns may have erroneously been mapped as “upland meadow,” and vice versa.

Developed areas. Habitat areas surrounded by or intruding into developed land were mapped only if at least one dimension exceeded 30 m (100 ft) in all directions. This area threshold was adjusted slightly to include the mapping of some areas slightly narrower but that were part of important habitat connection in heavily developed areas. Exceptions to this protocol were wetlands within developed areas, which we mapped (along with their immediately adjacent, non-cultural habitats) if they were identifiable on the aerial photographs or if we observed them in the field. Even though such wetlands may lack many of the habitat values of wetlands in more natural settings, they still may serve as important drought refuges for species of conservation concern. Lawns near buildings and roads were mapped as developed; large lawns not adjacent to buildings and roads, and adjacent to significant habitats were mapped as “cultural” habitats.

Intermittent woodland pools. Intermittent woodland pools are best identified in the spring when the pools are full of water and occupied by invertebrates and breeding amphibians. However, because the field work for this project occurred in late summer and fall, we relied on general physical features of the site to distinguish intermittent woodland pools from isolated swamps. We classified those wetlands with an open basin as intermittent woodland pools and those dominated by trees or shrubs as swamps, but they often serve similar ecological functions. Many intermittent woodland pools can also be mapped remotely since they have a distinct signature on aerial photographs, and are readily visible within areas of deciduous forest on photographs taken in a leaf-off season.

Constructed ponds. Most or all bodies of open water in Poughkeepsie were created by damming or excavation. All ponds were classified as “constructed pond”.

Springs. Springs and seeps are difficult to identify by remote sensing. We mapped only the one we happened to see in the field. We expect there are others in the city that we did not map. The precise locations and boundaries of seeps and springs should be determined in the field on a site-by-site basis.

Streams. We created a stream map in our GIS that was based on field observations and interpretation of topographic maps and aerial photographs. We depicted streams as continuous where they flowed through ponds, impoundments, or large wetlands. We mapped the likely location of streams that are diverted underground in developed areas only when they re-surfaced at a distance of less than 200 meters (650 ft). We expect there were additional intermittent streams that we did not map, and we recommend these be added to the database as information becomes available. Because it was often difficult to distinguish between perennial and intermittent streams based on aerial photograph and map interpretation, these distinctions were made using our best judgment. Streams that were channelized or diverted by humans (i.e., ditches) were mapped when observed in the field or on aerial photos. Some larger perennial streams deposit sand or gravel bars, which we mapped upon observation and subsequent extrapolation. Gravel bars are considered part of the stream habitat, and discussed briefly in the report in the streams section. The location and size of such deposits can be highly variable from year to year.

Upland forests. We mapped just three general types of upland forests: hardwood, mixed, and conifer forest. Although these forests are extremely variable in their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other factors, we used these broad categories for practical reasons. Deciduous and coniferous trees are generally distinguishable in aerial photos taken in the spring, although dead conifers can be mistaken for deciduous trees. Different forest communities and ages are not easily distinguished on aerial photographs, however, and we could not consistently and accurately separate forests according to dominant tree species or size of overstory trees. Our “upland forest” types therefore include non-wetland forests of all ages, at all elevations, and of all species mixtures, including floodplain forests.

Upland meadows and upland shrubland. Upland meadows often have a substantial shrub component; the distinction between upland meadows and upland shrubland habitats is somewhat arbitrary. We defined upland shrubland habitats as those with widely distributed shrubs that accounted for more than 20% of the cover.

Wetlands. We mapped wetlands remotely using topographic maps, soils data, and aerial photographs. In the field, we identified wetlands primarily by the predominance of hydrophytes and easily visible indicators of surface hydrology (Environmental Laboratory 1987). We did not examine soil profiles. Along stream corridors and in other low-lying areas with somewhat poorly drained soils, it was often difficult to distinguish between upland forest and hardwood swamp without the benefit of onsite soil data. On the ground, these areas were characterized by moist, fine-textured soils with common upland trees in the canopy, often dense thickets of vines

and shrubs (e.g., Japanese barberry, Bell's honeysuckles) in the understory, and facultative wetland and upland species of shrubs, forbs, and graminoids. In most cases, we mapped these areas as upland forest. Because we did not examine soil profiles in the field, all wetland boundaries on the habitat map should be treated as approximations, and should not be used for jurisdictional determinations. Wherever the actual locations of wetland boundaries are needed to determine jurisdictional limits, the boundaries must be identified in the field by a wetland scientist and mapped by a land surveyor. We attempted to map all wetlands in the city, including those that were isolated from other habitats by development.

B. Explanation of Rarity Ranks

Explanation of ranks of species of conservation concern listed in Appendix C and Appendix D. Explanations of New York State Ranks and New York Natural Heritage Program Ranks are from the New York Natural Heritage Program website, accessed in 2018 (<https://www.dec.ny.gov/animals/29338.html>).

NEW YORK STATE RANKS

Categories of Endangered and Threatened species are defined in New York State Environmental Conservation Law section 11-0535. Endangered, Threatened, and Special Concern species are listed in regulation 6NYCRR 182.5.

ANIMALS

- E Endangered Species.** Any species which meet one of the following criteria: 1) Any native species in imminent danger of extirpation; 2) Any species listed as endangered by the US Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.
- T Threatened Species.** Any species which meet one of the following criteria: 1) Any native species likely to become an endangered species within the foreseeable future in New York; 2) Any species listed as threatened by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.
- SC Special Concern Species.** Those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 11-0535 (Endangered and Threatened Species).

PLANTS

- E Endangered Species.** Listed species are those 1) with five or fewer extant sites, or 2) with fewer than 1,000 individuals, or 3) restricted to fewer than 4 USGS 7.5 minute map quadrangles, or 4) listed as endangered by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.
- T Threatened Species.** Listed species are those 1) with 6 to fewer than 20 extant sites, or 2) with 1,000 or fewer than 3000 individuals, or 3) restricted to not less than 4 or more than 7 USGS 7.5 minute map quadrangles, or 4) listed as threatened by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.
- R Rare Species.** Listed species are those with 1) 20-35 extant sites, or 2) 3,000 to 5,000 individuals statewide.

NEW YORK NATURAL HERITAGE PROGRAM RANKS – ANIMALS AND PLANTS

- S1** Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology making it especially vulnerable in New York State.
- S2** Typically 6-20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in New York State.
- S3** Typically 21-100 occurrences, limited acreage, or miles of stream in New York State.
- SH** Historically known from New York State, but not seen in the past 15-20 years.
- SNA** A visitor to the state but not a regular occupant (such as a bird or insect migrating through the state), or a species that is predicted to occur in NY but that has not been found.
- B,N** These modifiers indicate when the breeding status of a migratory species is considered separately from individuals passing through or not breeding within New York State. B indicates the breeding status; N indicates the non-breeding status.

SPECIES OF GREATEST (AND POTENTIAL) CONSERVATION NEED (SGCN, SPCN) IN NEW YORK – ANIMALS

The lists of Species of Greatest Conservation Need were developed through a review of the status of 600 species of mammals, fish, birds, amphibians, reptiles, mollusks, crustaceans, and arthropods by a group of NYSDEC staff and species experts, with input from biodiversity scientists and taxonomists.

Species of Greatest Conservation Need - High Priority

Species that are experiencing a population decline, or have identified threats that may put them in jeopardy, and are in need of timely management intervention, or they are likely to reach critical population levels in New York.

Species of Greatest Conservation Need

Species that are experiencing some level of population decline, have identified threats that may put them in jeopardy, and need conservation actions to maintain stable population levels or sustain recovery.

Species of Potential Conservation Need

Species whose status is poorly known, but there is an identified threat to the species or features of its life history that make it particularly vulnerable to threats. The species may be declining or begin to experience declines within the next ten years, and studies are needed to determine their actual status.

AUDUBON PRIORITY BIRD LIST

Audubon New York compiled a list Hudson Valley birds of special conservation concern. A species is included on the Hudson River Valley Priority Bird list if it is found in the Hudson Valley and on one of the following priority lists: NYS Endangered, Threatened, or Special Concern; Audubon Watchlist (2007); Partners In Flight (PIF, 2005) - Continental Concern, Regional Concern, Continental Stewardship, Regional Stewardship in any of the Bird Conservation Regions in the Hudson Valley (BCRs 13, 14, 28, and 30); North Atlantic Shorebird Plan - Highly Imperiled or Species of High Concern; Mid- Atlantic, New England, Maritime Waterbird Working Group - High Concern, Moderate Concern.

C. Status of Animals of Conservation Concern Mentioned in this Report

E = NYS Endangered; T = NYS Threatened; SC = NYS Special Concern; S1, S2, S3 = NYNHP active inventory ranks; SPCN = NYS Species of Potential Conservation Need; SGCN = NYS Species of Greatest Conservation Need; SGCN-HP = High Priority SGCN. For Hudson Valley Priority Birds (Audubon New York), the season they are found in the Hudson Valley are indicated by B = breeding; M = migration; W = winter. All ranks are explained in Appendix [B].

Species	NYS Rank	NYNHP Rank	SGCN/SPCN	Hudson Valley Priority Birds
VERTEBRATES				
Reptiles and Amphibians				
blue-spotted salamander	SC		SGCN-HP	—
four-toed salamander			SGCN-HP	—
Jefferson salamander	SC		SPCN	—
marbled salamander	SC	S3	SGCN	—
eastern box turtle	SC	S3		—
spotted turtle	SC	S3	SGCN-HP	—
map turtle		S3	SGCN	—
wood turtle	SC	S3	SGCN-HP	—
Blanding's turtle	T	S2S3	SGCN-HP	—
eastern racer			SGCN	—
eastern ratsnake			SGCN	—
northern copperhead		S3	SGCN	—
eastern hognose snake	SC	S3	SGCN-HP	—
Birds				
American bittern	SC		SGCN	B,M
least bittern	T	S3B, S1N	SGCN	B,M
American black duck		S3B, SNRN	SGCN-HP	
northern harrier	T	S3B, S3N	SGCN	B,M,W
osprey	SC			
sharp-shinned hawk	SC			B,M,W
Cooper's hawk	SC			B,M,W
red-shouldered hawk	SC		SGCN	B,M,W
broad-winged hawk				B,M
American kestrel			SGCN	B,M,W
common gallinule		S3S4		
king rail	T	S1B	SGCN-HP	
American woodcock			SGCN	B,M
barn owl		S1S2	SGCN-HP	
long-eared owl		S2S3B, SNRN	SGCN	
common nighthawk	SC	S2S3B	SGCN-HP	B,M

(continued)

C. Status of Animals (cont.)

Species	NYS Rank	NYNHP Rank	SGCN/SPCN	Hudson Valley Priority Birds
Birds (cont.)				
sedge wren	T	S3B	SGCN-HP	
marsh wren				B,M
wood thrush			SGCN	B,M
brown thrasher		S3S4B	SGCN-HP	B,M
blue-winged warbler			SGCN	B,M
golden-winged warbler	SC	S3B	SGCN-HP	B,M
black-throated green warbler				B,M
prairie warbler			SGCN	B,M
cerulean warbler	SC	S3?B	SGCN	B,M
black-and-white warbler				B,M
Canada warbler			SGCN-HP	B,M
scarlet tanager			SGCN	B,M
eastern towhee				B,M
field sparrow				B,M
savannah sparrow				B,M
clay-colored sparrow		S3S4B		
bobolink			SGCN-HP	B,M
eastern meadowlark			SGCN-HP	B,M
purple finch				B,M,W
yellow-breasted chat	SC	S2?B	SGCN-HP	B,M
Mammals				
small footed bat	SC	S1S3	SGCN	—
Indiana bat	E	S1	SGCN-HP	—
Fishes				
American eel		S2S3	SGCN-HP	—
brook trout			SGCN	—
INVERTEBRATES				
northern oak hairstreak		S2S4	SGCN-HP	—
dusted skipper		S2S3		—
gray petaltail	SC	S2	SGCN-HP	—
tiger spiketail		S1	SGCN-HP	—
Piedmont groundwater amphipod		SNR	SPCN	—

D. Common and Scientific Names of Plants Mentioned in this Report

Scientific names follow the nomenclature of Weldy et al. (2017). E = NYS Endangered; T = NYS Threatened; R = NYS Rare; S1, S2, S3 = NYNHP active inventory ranks. All ranks are explained in Appendix B.

Common Name	Scientific Name	NYS & NYNHP Ranks
agrimony, small-flowered	<i>Agrimonia parviflora</i>	R, S3
arum, arrow	<i>Peltandra virginica</i>	
arrowhead, broad-leaved	<i>Sagittaria latifolia</i>	
ash, green	<i>Fraxinus pennsylvanica</i>	
ash, white	<i>Fraxinus americana</i>	
aspen, quaking	<i>Populus tremuloides</i>	
azalea, swamp	<i>Rhododendron viscosum</i>	
barberry, Japanese	<i>Berberis vulgaris</i>	
beggar-ticks, estuary	<i>Bidens bidentoides</i>	R, S3
bergamot, wild	<i>Monarda fistulosa</i>	
berry, porcelain	<i>Ampelopsis glandulosa</i>	
birch, gray	<i>Betula populifolia</i>	
birch, river	<i>Betula nigra</i>	R, S3
bittersweet, oriental	<i>Celastrus orbiculatus</i>	
blackberry, northern	<i>Rubus allegheniensis</i>	
bladderwort	<i>Utricularia</i>	
blueberry, highbush	<i>Vaccinium corymbosum</i>	
bluejoint	<i>Calamagrostis canadensis</i>	
bluestem, little	<i>Schizachyrium scoparium</i> var. <i>scoparium</i>	
bur-marigold, smooth	<i>Bidens laevis</i>	T, S2
canary-grass, reed	<i>Phalaris arundinacea</i>	
cattail	<i>Typha</i>	
cedar, eastern red	<i>Juniperus virginiana</i> var. <i>virginiana</i>	
cherry, black	<i>Prunus serotina</i> var. <i>serotina</i>	
cliffbrake, purple	<i>Pellaea atropurpurea</i>	
cliffbrake, smooth	<i>Pellaea glabella</i> ssp. <i>glabella</i>	T, S2
corktree, Amur	<i>Phellodendron amurense</i>	
cottonwood, eastern	<i>Populus deltoides</i>	
dodder, buttonbush	<i>Cuscuta cephalanthi</i>	E, S1
dodder, field	<i>Cuscuta pentagona</i>	R, S3
dogwood, gray	<i>Cornus racemosa</i>	
dogwood, silky	<i>Cornus amomum</i> ssp. <i>amomum</i>	
duckweed, common	<i>Lemna minor</i>	
elm, American	<i>Ulmus americana</i>	

(continued)

D. Plant Names (cont.)

Common Name	Scientific Name	NYS & NYNHP Ranks
elm, slippery	<i>Ulmus rubra</i>	
false-mermaid	<i>Floerkea proserpinacoides</i>	
featherfoil	<i>Hottonia inflata</i>	T, S2
fern, cinnamon	<i>Osmundastrum cinnamomeum</i> var. <i>cinnamomeum</i>	
fern, marsh	<i>Thelypteris palustris</i> var. <i>pubescens</i>	
fern, sensitive	<i>Onoclea sensibilis</i>	
flag, blue	<i>Iris versicolor</i>	
garlic-mustard	<i>Alliaria petiolata</i>	
goldenclub	<i>Orontium aquaticum</i>	T, S2
goldenseal	<i>Hydrastis canadensis</i>	T, S2
hawthorn	<i>Crataegus</i>	
hemlock, eastern	<i>Tsuga canadensis</i>	
hickory, pignut	<i>Carya glabra</i>	
hickory, shagbark	<i>Carya ovata</i> var. <i>ovata</i>	
holly, winterberry	<i>Ilex verticillata</i>	
honeysuckle	<i>Lonicera</i>	
honeysuckle, Bell's	<i>Lonicera</i> × <i>bella</i>	
hornbeam, hop	<i>Carpinus caroliniana</i> ssp. <i>virginiana</i>	
knotweed, Japanese	<i>Reynoutria japonica</i> var. <i>japonica</i>	
knotweed, slender	<i>Polygonum tenue</i>	R, S3
locust, black	<i>Robinia pseudoacacia</i>	
loosestrife, purple	<i>Lythrum salicaria</i>	
mannagrass	<i>Glyceria</i>	
maple, Norway	<i>Acer platanoides</i>	
maple, red	<i>Acer rubrum</i>	
maple, sugar	<i>Acer saccharum</i>	
may-apple	<i>Podophyllum peltatum</i>	
meadowsweet	<i>Spiraea alba</i> var. <i>latifolia</i>	
monkey-flower, winged	<i>Mimulus alatus</i>	R, S3
oak, black	<i>Quercus velutina</i>	
oak, pin	<i>Quercus palustris</i>	
oak, red	<i>Quercus rubra</i>	
oak, swamp white	<i>Quercus bicolor</i>	
oak, white	<i>Quercus alba</i>	
pine, Scotch	<i>Pinus sylvestris</i>	
pine, white	<i>Pinus strobus</i>	
pinweed, slender	<i>Lechea tenuifolia</i>	T, S2
plantain, heartleaf	<i>Plantago cordata</i>	R, S3

(continued)

D. Plant Names (cont.)

Common Name	Scientific Name	NYS & NYNHP Ranks
pond-lily, yellow	<i>Nuphar advena</i> ssp. <i>advena</i>	
pond-lily, white	<i>Nymphaea odorata</i>	
pondweed	<i>Potamogeton</i>	
prickly-pear, eastern	<i>Opuntia humifusa</i>	
raspberry	<i>Rubus</i>	
rattlebox	<i>Crotalaria sagittalis</i>	E, S1
reed, common	<i>Phragmites australis</i>	
rose, multiflora	<i>Rosa multiflora</i>	
rush, soft	<i>Juncus effusus</i> ssp. <i>solutus</i>	
saxifrage, golden	<i>Chrysosplenium americanum</i>	
sedge, cattail	<i>Carex typhina</i>	E, S2
sedge, Davis'	<i>Carex davisii</i>	T, S2
sedge, tussock	<i>Carex stricta</i>	
skunk-cabbage	<i>Symplocarpus foetidus</i>	
spicebush	<i>Lindera benzoin</i>	
spruce, Norway	<i>Picea abies</i>	
starwort, terrestrial	<i>Callitriche terrestris</i>	T, S2S3
stiltgrass, Japanese	<i>Microstegium vimineum</i>	
sycamore, eastern	<i>Platanus occidentalis</i>	
tree-of-heaven	<i>Ailanthus altissima</i>	
violet	<i>Viola</i>	
water-nymph, Hudson River	<i>Najas muenscheri</i>	E, S2
wall-rue	<i>Asplenium ruta-muraria</i>	
watermilfoil	<i>Myriophyllum</i>	
water-chestnut	<i>Trapa natans</i>	
water-plantain	<i>Alisma triviale</i>	
weed, Joe-Pye	<i>Eutrochium maculatum</i>	
wisteria	<i>Wisteria</i>	
woolgrass	<i>Scirpus cyperinus</i>	